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DON’T GET HACKED

30 TIPS AND TRICKS TO LOCK DOWN YOUR PC AGAINST THEFT, RANSOMWARE AND UNWANTED INTRUSIONS p100

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- GUARD AGAINST DODGY WI-FI HOTSPOTS
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The strange materials that could replace silicon in our computers p112

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A s editor of Shopper, I get to read all the articles in the magazine as part of my job. While I can attest to the high quality of each article that appears (I would say that, wouldn't I?), I have to admit I don't carry out every project or buy every recommended product – with 140 pages each month, that would be a pretty time-consuming and costly enterprise.

But most months, there are one or two articles that I put on my to-do list, to come back to once the madness of press week is out the way. This issue is one of those rare occasions where I found myself carrying out the project during the editing stage. 

I'm sure I'm not alone in worrying about the myriad security threats out there – everything from being spied on via my webcam to having my bank details stolen to having my mobile pinched by a moped thief. So proof-reading our 'Don't Get Hacked' cover feature, I found myself checking the 30 tips and tricks extra carefully, to make sure I was properly protecting myself.

Turns out, for the most part I'm pretty security-conscious and was already following a lot of the advice. I was particularly relieved that my visit to haveibeenpwned.com revealed that, of my various email addresses, there was just one breach, which means I'm on a spam list somewhere, along with 711 million others. But in other areas, such as my Facebook account, I was leaving myself exposed to potential breaches and so quickly locked these down.

My advice is, don't put this article aside to follow at some point in the future – turn to page 100 and check as many of these steps as you can now. You'll be surprised at what you discover.

Stay safe!

Madeline Bennett, Editor
madeline@computershopper.co.uk
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Letters

With Windows 10 full of irritating features, would it be better if schools saved their money and stuck with older versions of the operating system?

Whine seller

@ I am looking to change my LG G4 SIM-only phone and bought your magazine as the cover indicated a smartphone review (Shopper 369). I was interested in the Samsung Galaxy S8 as a friend had also recommended it, and I looked on Amazon as suggested by your review as the best place to buy.

However, I was concerned by some of the one-star reviews saying this price was a scam, as buyers had been sent phones with European plugs, and others had said the phones were faulty and couldn’t get a refund as it was from a third-party seller.

Do you check all this before recommending a company? I note that Carphone Warehouse has it at £499; possibly the phone is more genuine? I am now unsure what to do.

Kev Lane

Shiny Windows

@ I read your ‘12 ways to make Windows 10 better’ feature (Shopper 370). I was surprised you missed two of the biggies I head to after 30 years in the game, although that might be because they’re most effective when you have several PCs in a network, so aren’t that applicable to home users.

First, block www.msn.com and www.msn.co.uk, preferably at the firewall. Multiple PCs loading the media-heavy, bandwidth-crushing title-tattle is a big hit on productivity.

Second, use gpedit to completely disable OneDrive. Go to Computer Configuration, Administrative Templates, Windows Components, OneDrive and set ‘Prevent the usage of OneDrive for file storage’ to Enabled.

We agree about not upgrading for the sake of it, but that might not be the attitude of parents if their children are at risk from hacks and other security threats due to their school running an unsupported operating system.

Case in point: last year’s WannaCry ransomware attack was blamed on the NHS running outdated Windows XP machines that were open to security breaches.

It’s perhaps easier to take that risk when it’s just us as individuals who we need to take responsibility for – generally, when students are involved, extra protection layers and safety checks are required.

Education matters

@ I find it hard to understand why you think that schools put upgrading computers top of the list (‘Rants & Raves’, Shopper 370). This letter is being written on Windows 7, which has worked perfectly for years except when the memory failed.

Primary schools do not need the latest gizmos. My mantra is never upgrade (anything). It always leads to trouble. For Windows 7, you just turn off automatic updates until you are ready.

The old black boxes you write about will not run Windows 10. I read in the i newspaper that many of our schools are falling apart; money is shared out among many fields.

Also, I have just read in your magazine about Windows 10: you can’t turn off automatic updates so they interrupt your work; there are no drivers for old printers and scanners (even for Windows 7); and many other niggles. Do you think that a poorly trained and overworked teacher has time to sort out all these problems?

I keep an old Windows XP PC to run my excellent Epson Photo 740 and a good scanner. In fact, I would teach using Windows XP as it is so easy to follow. Just turn off the internet.

If kids have the internet, they either search for porn or play games. Programming can be learnt on this platform very easily. I learnt basic on a Spectrum and Pascal on a Prime minicomputer.

I should also say that it is most likely that funding in the school is controlled by a headteacher and/or a bursar, not the local authority. When the roof leaks, do you buy new IT stuff?

Tony

Star letter

Do you wish your computer was faster when booting and loading applications? Thanks to Crucial, you can achieve your dream of a faster PC or laptop with a 500GB MX500 SSD. The writer of our Star Letter will be awarded one of these solid-state devices, which can be installed in a desktop PC or a laptop.

This SSD is 45 times more energy efficient than a typical hard drive and has sequential reads/writes up to 560/510 MB/s and random reads/writes up to 95K/90K IOPS, making it the perfect replacement for the ageing hard drive in your sluggish PC.

Write in and win

We agree about not upgrading for the sake of it, but that might not be the attitude of parents if their children are at risk from hacks and other security threats due to their school running an unsupported operating system.

Case in point: last year’s WannaCry ransomware attack was blamed on the NHS running outdated Windows XP machines that were open to security breaches.

It’s perhaps easier to take that risk when it’s just us as individuals who we need to take responsibility for – generally, when students are involved, extra protection layers and safety checks are required.
This will reduce the boot time of a decent workstation below the 15 minutes you are likely to see with OneDrive enabled.

Mark Pattison

Thanks for sharing those tips. Hopefully readers responsible for running multiple networked Windows 10 machines will find them useful.

Mark Pattison

Nowadays, there are few competing products and Microsoft seems content to defend its revenue stream by forcing everyone to use its ‘rented’ Office 365 products. Small, not-for-profit organisations really don’t want to become dependent on that kind of software.

Unfortunately, it is difficult even to find a legitimate vendor of a recent desktop version of Access.

I'm experimenting with the free LibreOffice Base, but it leaves at least one unresolved issue, which is to determine the underlying data format. The obvious answer would be Microsoft’s .accdb, but that remains proprietary and Microsoft doesn’t publish the documentation. I’m also unconvinced by the web-based products that I can find.

What do others do in this situation?

Paul Martin

Thanks for writing in with this query. We plan to run an article looking into this topic once we’ve had a chance to properly investigate the various database options out there. In the meantime, we’d be keen to hear from readers about which database products they’re using or any you’d like us to cover.

Turing test

It tends to put you off an article when there is a serious boo-boo in the first line ('The Lowdown', Shopper 370). Alan Turing didn’t invent the Enigma code, he cracked it with the help of the others at Bletchley Park, so how can we believe the rest of the text?

Ian Williamson

We refer to Turing as the Enigma machine creator, and definitely agree he didn’t invent the Enigma code. Turing is widely credited – by sources such as the Imperial War Museum – for playing a key role in cracking the Enigma code, "inventing – along with fellow code-breaker Gordon Welchman – a machine known as the Bombe. This device helped to significantly reduce the work of the code-breakers.”

Best left out?

While the article on mobile phones was instructive (Shopper 369), it focused on three phones each from Honor, Motorola and Samsung, with two from Alcatel. It must have slipped your mind that Xiaomi is now one of the biggest players in the budget phone marketplace with the best camera/software marriage around. Please next time try to include the best.

Tim Wells-Cole

Xiaomi is currently not widely available in the UK, apart from grey market retailers. However, the Chinese company plans to open a store in London soon, and mobile operator Three is in talks to start selling Xiaomi handsets. As soon as they’re available through authorised dealers or direct in the UK, we’ll start reviewing Xiaomi smartphones for inclusion in Shopper articles.

In the next issue

Small packages
The best mini PCs on test

Better backups
How to manage this ongoing tech burden quickly and easily

GPS turns 40
We look back at the development of sat nav and consider what might happen should it ever disappear

COMPUTER SHOPPER ISSUE 372 ON SALE IN NEWSAGENTS FROM 6th DECEMBER
You can call me Al

Modern Iranian programmers such as Mel Croucher’s talented friend Young Al are following in a long tradition of Middle Eastern technological innovation.

Nearly every aspect of maths and computing has its origin in Middle Eastern culture.

Computer Games was set up by the government, and began to provide a surprising amount of seed money and support for developers like my friend young Al. And that’s when people like me started to get interested.

In fact it was young Al’s line manager who educated me to the fact that nearly all mathematical and programming concepts I take for granted have their origins in his ancient culture. Young Al’s line manager is called Adarhoshang. Adarhoshang is a Zoroastrian name meaning ‘fire of knowledge and intelligence’, and in his case it is, or was, highly appropriate.

Young Al is, or was, also a Zoroastrian, a member of one of the oldest religious groups in the world, going back thousands of years, and they both have, or had, the magnificent oiled hair, curly beard and love of purifying eternal flames to prove it.

Eastern Promise

Our culture here in the west is affected in almost every way by the algorithms pioneered in the Middle East. We computer folk have always known what they are, what they do, and how important they are. But now the mainstream media can’t stop worrying themselves sick about them and the ethics of how they are used.

Algorithms are named after the mathematician Al-Khwarizmi, who was knocking around Persia, now known as Iran, in the 9th century. Unless you are a Zoroastrian, in which case he was probably knocking around Persia in the 33rd century. Anyway, old Al-Khwarizmi not only gave birth to algorithms, he also invented the rules for computing calculations, the decimal point, linear and quadratic equations, and Facebook. Well, maybe not Facebook, but certainly all the algorithms that suck it dry.

In fact, nearly every aspect of maths and computing has its origin in Middle Eastern culture. Even the terminology we use today is mostly Arabic. Apart from the obvious ones like algorithm and algebra, there are words like cipher, zero, average, degree, even cube. And let us not forget the Arabic origin of the word alcohol, which most programmer chums of mine regularly wash their wits in.

The Iranian student alcohol industry has had something of a setback since the Islamic Revolution of 1979, but back then they only had about 100,000 university students. Now they’ve got around five million of them. They are producing graduates at a faster rate than almost any other country on the planet, and a full 60% of those graduates are women. Their graduates in computer programming are among the best I’ve ever come across, and I come across a lot.

To my mind young Al is, or was, among the best of the bunch. I first met him on a fact-finding tour, and because I am a fully paid-up member of the satanic US/UK axis, I had to have a government-appointed minder with me at all times that did not involve a bed or a toilet. But young Al is, or was, a smart cookie, and he rigged it so we could slip off and have some quality time together in the company of a Russian laptop and a hotel Wi-Fi connection. I was mostly interested in getting a user interface for a children’s video game translated into Persian, Kurdish and Arabic, and he was mostly interested in getting help to download the latest death metal and heavy metal music. I remember he was particularly impressed with an all-female quartet from Nashville called Atomic Blonde.

Metal Guru

We did some good work that day, and I didn’t think much about our session afterwards. In fact I only thought about it quite recently, after Donald Trump withdrew America from the Iran nuclear deal in his quest to make America great again. Perhaps our use of key words and search terms involving heavy metal, atomic and death were not such a good idea after all. Maybe some of those pesky algorithms picked them up, made the wrong assumptions and flagged young Al as a wrong ‘un. Or maybe young Al has simply changed the style of music he favours, and his non-response to my carefully coded communications don’t indicate anything more sinister than a new-found love for Ed Sheeran or Kylie.

On second thoughts, that really would be a fate worse than death.
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Is your computer spying on you?

A sensational news story has claimed that the Chinese government inserted microscopic spy chips into our electronics devices. Are we really under attack?

The technology to create very small computers exists, and it's technically possible to build one that takes information at the hardware level and sends it back to a central server.

IT COULD HAVE been the plot of a James Bond film: tiny spy chips embedded in our electronic devices, delivering secrets back to the Chinese government. Yet far from being fiction, this was a serious report delivered by Bloomberg, claiming that the Chinese government had embedded chips no bigger than a grain of sand into motherboards used by US companies including Apple and Amazon.

According to the report, the chips were implanted on motherboards manufactured by the Taiwanese-American firm Supermicro, before being assembled into computers and used by some of the biggest tech companies in the world.

In many ways the story is plausible. China manufactures a high percentage of electronics, and its government isn't particularly shy about spying on people. We know that the technology to create very small computers exists, and that it's technically possible to build one that takes information at the hardware level and sends it back to a central server.

More than that, a hardware hack such as this would prove to be much harder to detect (and fix) than a software hack. Indeed, it's usually via software that such spying is achieved, such as with backdoors programmed in for the likes of the US's own PRISM programme.

IT'S COMPLICATED

However, after the Bloomberg story came out, so came the very firm rebuttals from Apple and Amazon. Both companies, which don't usually make detailed statements on this kind of thing, said in no uncertain terms that there's no proof of the hack, that they hadn't had to call in the FBI and that no chips had been found in their servers.

Several tech experts have come out to say that the hack is unlikely, including the UK's National Cyber Security Centre (NCSC), which said it had no reason to doubt Amazon's detailed investigation and results.

The truth is that although the technology undoubtedly exists, implementation is quite hard. For a tiny computer to interface with motherboard chips and transmit data, the layout and control of the motherboard would need to be changed. In essence, a new design would be needed to incorporate the spy chip.

While China certainly has the technical nous, getting this redesign done fast enough and without ringing any alarm bells becomes tricky. Not so tricky that it would be impossible, just that there currently isn't the evidence to back up the report.

CHINA CRISIS

There is a general worry about Chinese companies, particularly those that manufacture critical infrastructure components. Already, UK telecommunications companies have been warned not to use equipment manufactured by ZTE (a state-owned company), for fears of having too much Chinese equipment running critical infrastructure.

And now the CEO of the NCSC, Ciaran Martin, has warned that we're likely to see a major state-sponsored cyber attack.

In a recent report, Martin said: "I remain in little doubt we will be tested to the full, as a centre, and as a nation, by a major incident at some point in the years ahead, what we would call a Category 1 attack.*

Category 1 attacks are those defined as causing sustained disruption of essential services or affecting national security, causing severe economic or social consequences, or even loss of life.

Both Russia and China have been linked with state-sponsored cyber attacks, but Martin warns that outside of these countries the risk to the UK is still high. If it sounds scary, then it is: the price of living in such a connected era is that critical systems are now open to attacks in a way that they weren't even 10 years ago.

YOU CAN BE SERIOUS

If anything, the good news is that preparation for attacks is improving, and the knowledge and fear of state-sponsored attacks are making government agencies and companies rightly paranoid.

When Bloomberg reported the spy chips, Apple and Amazon performed rigorous assessments of the risk. Both companies perform security analysis of their entire supply chain, looking for anomalies or things out of place. It's this kind of scrutiny that will help prevent a future where such spy chips could be inserted.

Likewise, with government agencies aware of this kind of attack, they can prepare, monitor and advise UK companies and individuals on the best course of action and warn about using technology from certain firms.

It's a brave new world out there, and what was once science fiction and the stuff of exciting stories is rapidly becoming science fact. Yet the knowledge of this helps prepare defences against such attacks.

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*Category 1 attack: A cyber attack that would cause sustained disruption of essential services, affecting national security, causing severe economic or social consequences, or even loss of life.
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The machines are taking over, thanks to advances in artificial intelligence. If only they could just be a little more polite about it.

David Ludlow

**RANTS & RAVES**

**COMPUTERS AND SMARTPHONES** are making us ruder. I don’t mean that in a heads-down-ignoring-all-human-contact kind of way, I mean in a deliberate, plotted and calculated way, and it’s all thanks to AI. Google, Apple, Microsoft and the like are all trying to be clever and save us time by suggesting automatic replies to our text messages, emails and instant messages.

By scanning the content, the companies attempt to pull meaning out of the messages and then give canned responses to save us having to craft a reply. It sounds great in theory, but it’s fair to say that no algorithm has quite mastered the art of being nice.

It started with the Apple Watch, which had a bunch of dumb, pre-programmed replies you could use for text messages. Sending 'OK' back to someone isn't exactly the right way to endear yourself or avoid a future argument, is it? Smarter analysis has now become the norm, with the replies on services such as Gmail now based on the text of the message sent to you. Yet the same problem remains. Get a long work email stuffed full of information and Gmail might suggest something like 'Very interesting!' – where Google misses out on polite responses, it’s surely mastered the art of sarcasm.

Even when it seems to get the point of a message, Gmail’s pre-set answers are terse: ‘Great!’, ‘Thanks!’, ‘Get stuffed!’ Well, OK, maybe not the last one, but it might as well be.

Far from bringing us together, automated replies are doing the opposite: they’re stopping us communicating or reading the original message properly, and the canned responses are so bad.

Then there’s the danger that you get in a loop with a canned reply to a canned reply. What’s next – taking humans out of the equation and just letting the computers send messages to each other? On second thoughts, checking out my list of unread email, maybe that’s not such a bad idea after all.

Roland Moore-Colyer

‘THE CUSTOMER IS always right’; ‘we listened to feedback’; ‘we've heard your concerns’; ‘we asked the community’. These are all things that tech firms spout when presenting new products to the masses.

But most of the time it seems hardware makers don’t give a hoot about what their customers really want, and would rather force users down a certain path than build products around community requests.

Now I appreciate that some things people want are pie-in-the-sky requests, but a lot of the time big tech firms eschew features that folks enjoy to opt instead for some vision of cutting-edge design.

Take Apple’s MacBooks: these all come with USB Type-C ports and those ports only; there’s no USB Type-A for supporting older peripherals. So not only do MacBook buyers have to shell out a good wad of cash for the machine, they also have to buy dongle accessories and lug them around as well. Sure, Apple is trying to push a new world where everything uses USB Type-C connections, but it could have kept one USB Type-A port.

Then there’s the case of not having a Type-C port, which is something tech fans want, due to a reluctance to move with the times. Case in point: Microsoft’s Surface Pro 6 and Surface Laptop 2, both of which lack the Type-C port and go with a single Type-A port.

The same can be said of the smartphones that seem determined to get rid of the 3.5mm headphone jack. This lack of consideration about what customers want needs to be flushed away. I’d love to see more tech companies actually listen to what their audience want, even if just a little.

There are firms that attempt to do this. Eve-Tech is a company that crowdsourced ideas to create the Eve V, a pseudo Surface Pro that comes with things such as a Thunderbolt 3 port and better battery life, as per the community’s request. The device wasn’t perfect, but at least it was created with its buyers in mind.

The same can be said with OnePlus. The phone manufacturer seems to test ideas with its community and absorb user feedback before it rolls another handset off the production line. While very good, the OnePlus phones aren’t perfect, but they definitely feel as though they’ve been designed with users in mind rather than to stroke the egos of product designers.

I feel this is an attitude more technology companies should follow, so we can enjoy gadgets that tread the line between giving us what we want and still maintaining scope for some engineering wizardry.

---

*David Ludlow*

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The biggest stories from the tech world, and what they mean for you

Intel’s new processors come out swinging

**SAY WHAT?**

**IT’S BEEN TEASING** us for most of the year, but Intel has finally released its ninth-generation processors, making official a lot of the details we already knew thanks to masses of leaks.

Heading up the new line-up is the Core i9-9900K (see page 28 for full review), which Intel claims is the “world’s best processor for gaming”.

Such a statement sounds somewhat hyperbolic, but the processor comes with eight cores and 16 threads, two more than the previous high-end Core i7-8700K and the powerful Core i9-8950HK laptop CPU.

The processor has a base clock speed of 3.6GHz that boosts to 5GHz out of the box on one of the cores, so it promises proper gaming power as many games still mostly benefit from nippy single-core speeds.

The processor is based on a refreshed take on Intel’s Coffee Lake architecture and improved 14nm fabrication process. The Core i9-9900K has a thermal design power of 95W, so uses the same amount of power as the previous top chips, despite being faster.

The processor has a hefty price of £600, so you’ll need to fork out for the performance on offer.

The Core i9-9900K sits at the top of the ninth-gen Core family, bumping the Core i7 off its place at the head of the table. However, the Core i7-9700K is still shaping up to be a very capable CPU with eight cores, the same number of threads and a clock speed that hits 4.9GHz. That processor will set you back £500.

Then comes the Core i5-9600K, a successor to the Core i5-8600K, a solid all-round performance desktop chip that we suspect many PC builders may opt for.

The Core i5-9600K is a small upgrade, featuring six cores and six threads with a clock speed that can hit 4.3GHz. For £350, it also looks to offer the bang-for-the-buck of its predecessor processor. All three chips appear to be squarely aimed at consumer desktop PCs, which are expected to be used by gamers, content creators and anyone who wants a nippy desktop computer.

For higher-end duties such as video rendering or computer-aided design work, Intel has the Core X-series of ninth-gen chips. These CPUs have been geared up for multithreaded workloads that spread compute tasks across all the processor cores, making use of Intel’s Hyper Threading technology which, with the exception of the Core i9-9900K, isn’t enabled on the new mainstream Core CPUs. Naturally, the Core X-series chips come with suitably high prices that fit their professional-grade performance, so don’t expect to be slotting one into your everyday desktop.

Microsoft targets game streaming with Project xCloud

**SAY WHAT?**

**AS FAR AS** bad names go, Microsoft has nailed it with its Project xCloud, the moniker it’s given to the service that aims to bring Xbox game streaming to all manner of devices.

First touted back at E3 2018 in June, Microsoft Xbox boss Phil Spencer talked of a game-streaming service that would not only allow Xbox One games to be piped to Windows 10 devices through the power of the internet, but also push those games to smartphones and tablets.

It sounded like a lofty ambition that could be a long way off, as while there are a good few gaming services around, they have limitations and haven’t exactly seen people move away from the downloading and installing of games synonymous with traditional console and PC gaming.

But Microsoft is planning public testing next year and even has custom hardware in the data centres that support its Azure cloud infrastructure – the second largest public cloud service in the world – which means xCloud testing is coming sooner than we thought.

“We’ll begin public trials in 2019 so we can learn and scale with different volumes and locations,” said Kareem Choudhry, corporate vice president of the gaming cloud division at Microsoft.

“Our focus is on delivering an amazing added experience to existing Xbox players and on empowering developers to scale to hundreds of millions of new players across devices,” explains Ariel Weidenheim, corporate vice president of the gaming cloud division at Microsoft.

“Our goal with Project xCloud is to deliver a quality experience for all gamers on all devices that’s consistent with the speed and high-fidelity gamers experience and expect on their PCs and consoles.”

The streaming will not be constrained to a home broadband connection, as Microsoft has plans to offer support over 4G. So in theory, a game could be started on a large 4K TV and Xbox One X, then when a person needs to take a trip into town, they could resume playing that game on an iPad or smartphone linked to an Xbox One controller.

This is a step up from many of the larger gaming streaming services currently available or under testing, such as Nvidia’s GeForce Now service.

And Microsoft’s ace up its sleeve not only looks to be its cloud infrastructure but also custom xCloud Blade servers. Details are thin on the ground, but these servers look like they can squeeze in multiple takes on Xbox One hardware into a single blade server that’s then combined into a server rack, many of which can be fitted into a data centre.
SO WHAT?

YOU MAY SHRUG at the trio of ninth-generation Core processors, and we wouldn’t blame you. While the Core i9-9900K brings a new level of top-tier performance to Intel’s mainstream CPUs, the Core i7 and Core i5 models are but minor upgrades over the previous eighth-gen chips.

That’s because Intel has yet to find a way to move its mainstream CPUs off the 14nm fabrication process to its 10nm process, which promises to deliver processors with better performance and higher power efficiency.

So you might ask why Intel bothered putting out these new chips. Well, it needs to be seen to be keeping competitive with AMD, which is currently enjoying the success of the Zen architecture in its Ryzen processors.

While AMD once languished at the low end of the market, the Ryzen CPUs offer high performance and multicore processing at a competitive price.

As such, Intel has been forced to improve upon its 14nm process several times to push out chips that can compete with its newly reinvigorated rival.

Intel’s ninth-gen Core processors are aimed at general computing and software, including games, that take advantage of high single-core clock speeds rather than maxing out clock speed across all cores simultaneously, which takes a lot of power and some hefty cooling.

Intel seems to be happy to let AMD steal the lead in higher core counts and multithreaded performance, as well as ensure there’s a clear delineation between mainstream Core CPUs and the professional Core X-series.

This might come as a disappointment for Intel fans who want do-it-all processors, but for most tasks the new Core CPUs look set to be more than up to the task.

However, they haven’t done much to surge in front of AMD’s Ryzen 2 family. That’s actually good news for users, as it means both Intel and AMD will be working hard on producing the next high-flying processor to steal the lead on each other, which means more innovation and competitive pricing for people looking to buy or build their next PC.

GAME STREAMING HISTORY to date hasn’t exactly been a resounding success. Back in 2010, the now-defunct firm OnLive launched a service that promised to deliver demanding games such as Deus Ex: Human Revolution to machines that couldn’t run them locally, all through a broadband connection.

The service launched in the UK in 2011 and we managed to get the aforementioned game running on a netbook through a poor ADSL connection. OnLive was impressive, but the service was criticised for latency and its lack of games, while video-streaming compression meant the games didn’t look as appealing as they do when running on a powerful desktop machine.

Furthermore, OnLive offered PC games but none of the modification PC gamers could get from running a game locally. And console exclusive games were just that, so OnLive couldn’t really attract Xbox 360 and PlayStation 3 fans.

OnLive essentially failed and major parts of it were bought up by Sony and effectively became part of PlayStation Now. Sony’s successful if limited PlayStation game-streaming service.

Other game-streaming services have also struggled. Nvidia’s GeForce Now service looks promising but is still in the beta stage.

Given the rocky history of game streaming, Project xCloud has plenty of challenges to overcome if it’s to succeed.

But Microsoft knows a thing or two about powering software using the cloud, given the Office 365 suite is essentially streamed to users.

Redmond has also already proven it knows how to deliver solid online services, especially with Xbox Live. So that collection of cloud, software, gaming and service knowledge, combined with custom hardware, means xCloud could really shake up game streaming as we know it.

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OnePlus 6T puts fingerprint scanner under the display

AT FIRST GLANCE, the OnePlus 6T is just a slightly upgraded take on the excellent OnePlus 6 (Shopper 367).

That's true to an extent. It still has Qualcomm’s Snapdragon 845 chip set and either 6GB or 8GB of RAM, with storage going from 128GB to 256GB. The same front and rear cameras are present, as are software features such as Night Mode and gesture control.

But there are two notable differences. The first is the shrinking of the display notch from the OnePlus 6’s trapezoid cutout to a small teardrop notch that houses only the front-facing camera and nothing else; you’ll find the speaker the notch once held now fitted into an almost imperceptible slit on the handset’s top edge.

This notch shrinking has also seen the screen-to-body ratio increase to 86%, meaning the bezels around the AMOLED panel have been slightly trimmed, giving the phone more screen space than ever before. The display is also protected by Corning’s latest Gorilla Glass 6, so it should survive a drop or two. And it all looks rather lovely, especially as it comes running Android 9 Pie out of the box.

The other big change is an under-display fingerprint scanner, something the biggest phone brands such as Apple and Samsung have yet to create. Using a green light sensor, the 6T can scan a person’s finger when it’s pressed to the bottom section of the 6.41in display, and unlock the handset in 350ms.

It’s neat technology that required some clever engineering, but comes at the cost of the 3.5mm headphone jack that was previously found on the OnePlus 6.

Thanks to some clever hardware layout, the OnePlus 6T also comes with a larger 3,700mAh battery, which should keep the phone ticking along for longer.

OnePlus told us there have also been a range of software tweaks that promise better performance in Gaming Mode and some smarter camera tricks, as well as improved notifications.

Google’s swathe of hardware serves as a software showcase

GOOGLE HAS LAUNCHED the third generation of its Pixel smartphones, as well as a hybrid tablet-cum-Chromebook that aims to challenge Microsoft’s Surface Pro.

The chassis design of the Pixel 3 and Pixel 3 XL has been tweaked using glass backs that not only feel smoother in the hand but also enable wireless charging. The displays of both Pixel 3 models have been improved, although the Pixel 3 XL now has a display notch than no-one would describe as attractive.

That notch contains a new front-facing dual-camera array – the camera is also on the top left of the Pixel 3 – which allows for wide-angle selfies.

The camera hardware on both Pixel 3 models is pretty much the same as their predecessors. But Google has been busy with its artificial intelligence tech and has a swathe of software tweaks to boost the camera’s performance.

Now, smart algorithms will not only stitch together multiple snaps to present the best photo, but will also remove blurring and artefacts when getting close-ups with the camera’s digital zoom. Early results are very impressive, if not equal to the photos phones equipped with a telephoto lens can produce.

There’s also a mode that allows the new Pixels to snap pictures automatically when they detect a person smiling and cleverly track someone’s face while they move about.

And that’s really what the Pixel 3 phones are all about: showcasing smart software and features over awe-inspiring hardware.

The same is arguably true of the Pixel Slate, which takes a 12.3in tablet and pairs it with a keyboard cover accessory that magnetically snaps on to it much like the keypads of the iPad Pro and Surface Pro.

Rather than running Android like previous Google tablets, the Pixel Slate runs Chrome OS. The operating system looks to have been given a nip and tuck to work neatly when used as a tablet, as well as in a laptop orientation.

As such, the Pixel Slate is less about the hardware on offer – which includes an Intel processor, a fingerprint scanner, and up to 16GB of RAM – and more about showcasing the steps Google has made with Chrome OS to be a versatile, all-round platform.
Zuck out of luck as Facebook shareholders ask him to step down as chairman

A HANDFUL OF Facebook's most prominent shareholders want founder Mark Zuckerberg to step down as chairman of the world's largest social network.

State treasurers from Rhode Island, Pennsylvania and Illinois joined forces with the New York City Pension Fund, and signed off on Trillium Asset Management's proposal for Zuckerberg's removal from his seat on the board. Combined, these organisations hold almost five million Facebook shares between them.

The proposal calls for an independent chairman, citing Facebook's mishandling of several key controversies, including “Russian meddling in US elections, sharing personal data of 87 million users with Cambridge Analytica, data sharing with device manufacturers, including Huawei, which is flagged by US Intelligence as a national security threat, proliferating fake news, propagating violence in Myanmar, India and South Sudan, depression and other mental health issues, including stress and addiction, and allowing advertisers to exclude black, Hispanic, and other 'ethnic affinities' from seeing ads”.

All of this is happening in the wake of Facebook's recent data breach, which put more than 30 million accounts at risk.

This isn't the first time shareholders have called for Zuckerberg's replacement. A similar proposal was filed in April, shortly before Zuckerberg's Senate testimony concerning the Cambridge Analytica scandal.

“Facebook plays an outsized role in our society and our economy,” said New York City comptroller Scott Stringer.

“An independent board chair is essential to moving Facebook forward from this mess, and to reestablish trust with Americans and investors alike.”

Stringer's opinion is shared by everyone who signed off on the proposal.

Jonas Kron, a senior vice-president at Trillium, added: “As we confront the ways in which Facebook’s technology has outstripped our ability to understand how it affects society... it is time to put limits on Zuckerberg and make some structural changes.”

The proposal will be voted on during 2019’s shareholder meeting, but it's unlikely to go through. Zuckerberg currently controls about 60% of the company's voting power. This makes the proposal more symbolic than anything else.

Still, this unrest could have some major effects. Facebook's stock price has been falling since late July, going from $217 (around £165) to $159 (£121). The shareholders hope the unrest will cause Zuckerberg to step down from his role, but that seems unlikely.

The company has publicly slammed the idea of separating the CEO and chairman role, stating that this split would “cause uncertainty, confusion and inefficiency in board and management function and relations.”

Time will tell if this is the end for Zuckerberg as the figurehead for Facebook, but we suspect not.
US
Robot declaration
Robots and chatbots will be forced to tell humans that they are automatons, after California signed into law Senate Bill 1001, which forbids automated services and smart software from impersonating people.

The idea is to prevent the use of bots from surreptitiously incentivising people to buy goods or services or vote in a particular manner by pretending to be humans. Bots have already been seen as one way to weight the results of elections in one party’s favour, and California is keen to stamp that out.

South Korea
Take five
Clearly deciding that dual-camera setups on some of the major flagship phones aren’t enough to cut the mobile mustard, LG has decided has decided to slap five cameras on its new V40 ThinQ.

That means there’s a trio of rear cameras and a brace of snappers on the front. For people who like such tech, the rear array comprises a 12-megapixel f/1.5 aperture lens, a 16-megapixel f/1.9 wide-angle lens, and a 12-megapixel f/2.4 lens with a 2x optical zoom. Combined with some artificial intelligence tech, this trio of cameras will work together to get the best photo possible even if you have all the talent of a damp dishcloth.

Canada
Call of the wild
For people who live out in the Canadian sticks, getting good internet connectivity is a stickier situation than a maple syrup-covered grizzly bear.

The Canadian Radio-television and Telecommunications Commission (CRTC) has earmarked C$750m for a Broadband Fund to bring fast broadband to rural parts of Canada.

The Broadband Fund is aiming for 25Mbit/s download speeds and 5Mbit/s upload speeds, half the proposed 50/10Mbit/s target the CRTC had last year. Consumer rights group OpenMedia called the decision a “stunning step backwards” that “demonstrates a serious lack of ambition”.

France
Clever cars on show
The Paris Motor Show demonstrated the growing obsession with advanced tech that car makers love to show off.

Renault’s EZ-ULTIMO concept car is less of an automobile and more a luxury mobile lounge, with plush seats for passengers to kick back in while the car uses the latest tech to drive itself.

The Peugeot e-Legend, meanwhile, comes equipped with an AI-powered voice assistant, autonomous driving modes and a massive 49in wide display, complete with a soundbar that sits in front of the driver and passenger when the car is driving itself.

Russia
Bear-faced lies
Russian spies have been accused of being behind four major hack attacks across the globe against targets ranging from political institutions to sports organisations.

UK foreign secretary Jeremy Hunt blamed Russia’s GRU intelligence agency for conducting “indiscriminate and reckless” attacks.

“These cyber attacks serve no legitimate national security interest, instead impacting the ability of people around the world to go about their daily lives free from interference,” said Hunt.

Russia refutes the accusations.

Japan
Game Boy goes mobile?
Nintendo could be bringing classic Game Boy games to smartphones if its latest patent is anything to go by.

The Japanese gaming giant filed a patent that denotes what appears to be a case for a smartphone in the guise of the classic Game Boy handheld console. The case looks to come equipped with the d-pad, A and B buttons, and the start and pause buttons the original Game Boy sported.

There’s also what appears to be a cutout for a front-facing camera, which would hint at offering some kind of retro-reimagining of the Game Boy camera from some 16 years ago.

GLOBE TROTTING
**THE LOWDOWN**

**Ray-tracing**

A brilliant lighting technique that might just be the future of graphics

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**RAY WHAT?**

Ray-tracing in a nutshell is the process of rendering all the paths of light rays in a computer-generated image, including the way light bounces off and is refracted on different surfaces.

Essentially, ray-tracing allows for the realistic implementation of global illumination, which renders not only the effects of direct light from a single source on objects and graphics assets, but also the rays from the same source, which bounce off other things in a virtual environment. So a teapot in a virtual kitchen can accurately reflect the light on it from an overhead lamp, as well as render the light from the same source that is being reflected at it from a nearby chrome kettle.

The use of global illumination with ray-tracing means different objects and surfaces interact with light rays bouncing all over the place, rather than just interacting with direct light from one source.

You’ve almost certainly seen ray-tracing at work in films that use a lot of CGI, where pre-rendered graphics are used to create realistically lit scenes.

But real-time ray-tracing is a lot more demanding, which meant it has previously been out of the reach of consumer PCs and graphics cards. As such, a technique called rasterisation was used to handle lighting instead, which creates 3D images for 2D screens out of virtual triangles and polygons.

Rasterisation has improved vastly over the years – just look at graphically impressive games such as Rise of the Tomb Raider and The Witcher 3: Wild Hunt – but shaders were needed on top to create lighting and its effects, which can’t replicate illumination and reflections as realistically as ray-tracing.

**BUT THE FUTURE OF GRAPHICS?**

OK, there are a few areas that will drive better graphics and visuals, with higher resolutions, smoother refresh rates and high-dynamic range presentation. But seeing ray-tracing in full effect is very impressive and makes CGI images look seriously realistic.

Nvidia is leading the way with ray-tracing, and some of its demos of the technique look superb. In one recent demonstration, rendering an elevator scene based on the The Force Awakens era of Star Wars, the graphics giant took a massively powerful $60,000 system with multiple graphics accelerators packed into it to render the visual snippet.

Tracing the path of vast amounts of light rays takes an awful amount of graphical grunt, and has therefore been something the average PC gamer or computer builder isn’t likely to have access to.

**SO IT’S OUT OF REACH?**

It was, until Nvidia took the covers off its latest high-end GeForce graphics cards using the new Turing architecture (see ‘The Lowdown’, Shopper 370), which promises to deliver real-time ray-tracing on a single card, the £1,000 GeForce RTX 2080 Ti. Upcoming games such as Shadow of the Tomb Raider, Metro Exodus and Battlefield V showcase their integration of ray-tracing, which ranges from impressive to stunning.

Ray-tracing also doesn’t seem to need game developers to change their graphical assets to tap into the rendering technique; rather, some tweaks are necessary, which could mean mastering a game to use ray-tracing might not be a big strain for game makers.

There are also techniques used to make ray-tracing less demanding, with Nvidia using a process called reciprocity, which traces rays from a person’s viewpoint or virtual camera out to objects, essentially reversing the way light works its way to our eyes.

This means only rays that will contribute to what is being viewed on screen in real time will be rendered, and rays that don't really add any noticeable effects will be ignored. So while the end result might not be 100% accurate, it will allow ray-tracing to be delivered in a more efficient manner.

AMD may not have any consumer-grade cards that currently support ray-tracing, but its Radeon ProRender supports the technique, so we can expect the next Radeon graphics cards to have some form of ray-tracing capacity.

**I’M SENSING A ‘BUT’ SOMEWHERE…**

The power-hungry nature of ray-tracing means the games showcased on Nvidia’s new GeForce cards were running at 1080p resolution and at 60 frames per second (fps) at best.

Now 1080p at 60fps is arguably a base target for graphical performance for PC gamers; many prefer to go for 1440p or 4K resolutions, or to run games with frame rates suitable for monitors with high 144Hz refresh rates.

Running ray-tracing on a single card means high resolution and frame rates beyond 60fps are currently off the table, at least in the demos that have appeared so far. Optimisation and graphics card drivers after the new GeForce cards hit the market could improve ray-tracing performance, but it looks as though people wanting the best lighting in games will need to make do with Full HD resolutions, which some PC gamers might find an unacceptable compromise.

Then there’s the fact that most games are developed for games consoles and PC simultaneously. The difference in graphical performance between the powerful Xbox One X and even a high-end PC is fairly wide.

So we’re not sure if any but the largest of game developers will be willing to commit extra resources mastering their games for ray-tracing, if only a fraction of their target audience have the hardware to power it.

It’s still early days for ray-tracing, but we expect it’s here to stay and the next generation of Nvidia and AMD cards, as well as future games consoles, will have the grunt to power real-time ray-tracing; after all, ray-tracing simply looks too good to fall by the wayside.

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The next generation of graphics cards will have the grunt to power real-time ray-tracing.
FROM THE LAB

London’s sewers set to be flushed with 5G

**DARK, FILTH, RATS:** three things you'd expect to find in London’s sewers. You wouldn't think those ancient grimy tunnels would be the place to consider setting up a 5G network.

But that’s what telecoms firms O2 and Three are planning to do, in partnership with Scottish energy and telecoms network company SSE. The three companies are planning to build the infrastructure to support the rollout of 5G in the capital’s sewers.

Rather than pipe 5G signals around tunnels designed to filter human waste to treatment plants, the idea is to use the tunnels to connect the 5G masts that will eventually be erected around London to provide connectivity for a new era of mobile broadband and wireless communication.

By using the existing 19th-century tunnels, the trio of companies hope to avoid the need to dig up new swathes of the capital in order to lay down the fibre-optic backbone infrastructure that will be needed to support 5G and improved 4G connections as a stop gap.

"Networks will fundamentally underpin the UK’s digital economy and will be essential to 5G services," said Colin Sempill, managing director of SSE Enterprise Telecoms.

"With this high capacity core in the London sewers, Three and O2 are tapping into our unique, diverse connectivity and putting their networks in a strong position to trial 5G offerings, while enhancing existing services for their customers."

Tim Berners-Lee’s new startup is aiming to protect your data

**WORLD WIDE WEB** creator Sir Tim Berners-Lee has a problem with how companies use our personal data. After the Cambridge Analytica scandal, and with the prevalence of hackers regularly acquiring personal information, there’s a real possibility that information you put online could easily find itself in strangers’ hands.

To combat that, Berners-Lee hopes his new startup Inrupt can protect user data. The company’s first project, Solid, is an open-source platform that safely stores user data, letting apps and sites access it only when the user authorises it.

Solid (social linked data) is hosted by the Massachusetts Institute of Technology. The idea is to let users safeguard personal data, such as photos, music, contacts and calendar events.

National Theatre’s smart glasses ‘see’ sound

**WATCHING A PLAY** is something you probably take for granted, especially if you live in London. But for those who have suffered deterioration in hearing, a theatrical performance can go from a spectacle to a confusing jumble of half-heard sounds. So the National Theatre (NT) has turned to tech to make the theatre more accessible for the hard of hearing.

Working with tech consultancy Accenture, NT has developed ‘smart caption glasses’. Using Epson’s Moverio BT-350 smart glasses, usually found in industrial and enterprise scenarios, the specs provide wearers with a synchronised transcript of the dialogue and sounds from the on-stage action. This means those who are hard of hearing can follow a play without taking their eyes off the action to glance at a script or leaf through a transcript.

The project required the NT’s technical department and the Accenture Extended Reality group to work with captioners trained by live and digital subtitling charity Stagetext. They carried out testing with a group of audience members with hearing loss, and the results look good so far.

“The one thing that has struck me is that it’s almost impossible to describe their impact to a ‘normal’ hearing person,” said Dave Finch, a member of the audience testing group.

“For someone hard of hearing they literally represent the difference between being able to go to the theatre whenever you choose and staying away.”

**SOUND BYTES**

"This claim is without merit, and we’re pleased the court has dismissed it"

Google throws shade at the accusation it exploited iPhone user data

"This is not the kind of business I would like to see in Houston, and certainly this is not the kind of business the city is seeking to attract”

Houston mayor Sylvester Turner doesn’t want to see robot sex dolls in his city

"Supply is undoubtedly tight, particularly at the entry-level of the PC market”

Intel interim CEO Bob Swan claims growth in PC sales has led to a shortage in the company's 4nm chips

"The next technical frontier for streaming will be much more demanding than video”

Catherine Hsiao, product manager at Google, sheds light on the search giant's game-streaming efforts

"It was a method of escapism. He could forget about his problems, and he derived immense pleasure from it”

Manoj Kumar Sharma, professor of clinical psychology, discusses a man addicted to video games
Internet Explorer
The history of Microsoft’s enduring web browser

ANY PC FAN worth their silicon and below a certain age will struggle to claim any familiarity with Microsoft’s own web browser Internet Explorer.

Despite being the default browser of many versions of Windows until Windows 10, anyone with a bit of nous will have deliberately loaded up Internet Explorer just once, only in order to download Google’s Chrome or Mozilla’s Firefox browsers, both of which are regarded as nipper, smarter and slicker browsers than Internet Explorer.

Nevertheless, Internet Explorer was at one point the most used web browser in the world, and it has endured for more than 20 years. It has earned its place in tech history, albeit perhaps not on the pedestal of greatness Microsoft would like.

WHERE IT ALL BEGAN
Before Internet Explorer, the browser world was the domain of Mosaic and Netscape, the latter being the dominant web-surfing tool before Microsoft knocked the crown.

In 1994, the Internet Explorer project was started by American computational neuroscientist and Microsoft employee Thomas Reardon. He took the Mosaic browser source code from the now defunct software firm Spyglass to lay the foundations for Internet Explorer.

Microsoft licensed Mosaic from Spyglass for a quarterly fee and a percentage of the profits the Redmond firm made from non-Windows software revenues. Thus the first version of Internet Explorer, known as Microsoft Internet Explorer at the time, was born on 16th August 1995. It came as part of the Internet Jumpstart Kit found in Microsoft Plus!, an enhanced take on Windows 95.

Within a few months, Internet Explorer 1.5 was released for Windows NT, offering extra features. Subsequent versions of the browser followed suit in rather rapid fashion.

One trick Microsoft had up its sleeve was that by bundling Internet Explorer into its Windows operating system free of charge, notably with Internet Explorer 3.0 in Windows 95, the company initially avoided paying Spyglass royalties for using its Mosaic source code.

That approach backfired in January 1997, when Spyglass filed a lawsuit against Microsoft and ended up winning $8m as a settlement. Such a lawsuit didn’t quell Microsoft’s efforts to get Internet Explorer into the hands of PC users, and new iterations of the browser regularly debuted with new versions of Windows. However, Microsoft still had to fight for its dominance in the browser arena, as the Netscape Communicator browser went toe-to-toe with Internet Explorer. Both organisations churned out updated versions in rapid succession to pack in features that trumped the other’s offerings. Such a situation became known as the ‘browser wars’.

But Netscape started losing ground to Internet Explorer as the former’s releases came plagued with buggy features. So Microsoft and Internet Explorer won the browser wars, but the victory wasn’t long lived.

RAVAGED BY Rivals
Between 2006 and 2014, Internet Explorer was faced with renewed competition in the form of Mozilla’s Firefox browser, the spiritual successor of Netscape Navigator, which received praise from its users by offering better features, performance and security than Internet Explorer.

It rapidly became a popular replacement for Redmond’s browser and, at the end of 2009, Firefox became the world’s most popular browser for a short time.

That put Internet Explorer in its place. But it was the debut of Google’s Chrome in September 2008 that sealed the fate of Microsoft’s browser.

Chrome offered a slicker, more secure and better-performing service than either Internet Explorer or Firefox, particularly as it developed more integrations with Google’s popular web-based tools. Chrome is now the most popular browser around.

This meant Internet Explorer lost its once dominant position, even though it remained the default browser in some organisations, such as universities and hospitals, due to being bundled into Windows and the limitations of such organisations in using third-party browsers and tools.

Microsoft worked hard to improve Internet Explorer, making it easier to use and introducing new features. But it was not enough and the browser entered its end-of-life period in 2015. It no longer receives new features or updates, although Microsoft is maintaining it as part of its support policy for older versions of Windows.

Internet Explorer is still alive on Windows 10 but you’ll need to go looking for it, as the Edge browser is now the default web tool in Windows.

EDGING BACK
Microsoft debuted the Edge browser in January 2015. This was the spiritual successor to Internet Explorer that the firm hoped, and still hopes, would win back favour with PC users. While the DNA of Internet Explorer can be seen in Edge, the new browser is faster, sleeker and more feature-packed than its predecessor.

It is, however, far from perfect, and thus far has failed to knock Chrome off its spot as the browser king.

Nevertheless, the Edge browser and the enduring nature of Internet Explorer show that Microsoft is not yet ready to hand victory to the likes of Firefox or Chrome.

And that, for us PC fans, is a good thing, as it ensures there’s still competition in the browser world and thereby keeps the likes of Google, Mozilla and Microsoft innovating and providing us with ever-slicker features and tools for surfing the web.
NEW GRAPHICS CARDS are rarely as exciting as the Nvidia GeForce RTX 2080 Ti. This flagship GPU doesn’t just deliver the usual performance boost: it also has enticing new features that could drastically improve lighting effects and transform how anti-aliasing is applied, potentially helping games look better even as they run faster.

The GeForce RTX 2080 Ti, along with the lower-spec GeForce RTX 2080 and RTX 2070, uses Nvidia’s new Turing architecture, which was first introduced on Quadro professional GPUs in August 2018. It’s by far the most well-specified of the RTX family, being equipped with 11GB of GDDR6 memory and 4,352 CUDA cores, but it’s the underlying technology we’re more interested in.

TRACE AGAINST TIME
Turing doesn’t just promise as straight power improvement over the preceding Pascal architecture, upon which cards such as the GTX 1080 Ti were built. It also introduces two concepts that, on paper, promise great things for both the visual quality and the frames-per-second performance of your games.

The first, ray-tracing, is a technique for rendering light, shadows and reflections with much more detail and accuracy than the traditional rasterisation process (see ‘The Lowdown’, page 19). Whereas rasterisation renders objects on a pixel-by-pixel basis, approximating how they might look under light or shadow, ray-tracing models how beams of light would bounce around a scene and into our eyes (or, in the case of games, the camera). It’s a technique that, by more closely re-creating how light works in real life, produces more natural-looking lighting effects. As such, it’s long been used in CGI films, but has proven too computationally intensive to run on a consumer GPU – until now.

The second feature, Deep Learning Super Sampling (DLSS), uses machine learning to produce a take on temporal anti-aliasing (TAA) that won’t hurt frame rates as much. Developers can allow Nvidia’s very own supercomputer, Saturn V, to analyse images of a game and produce an AA algorithm that’s pushed out to RTX cards as a driver update. The supported game can then be rendered at a lower resolution while the card’s dedicated Tensor cores analyse the existing anti-aliased graphics, and use it to produce an image at high resolution with fewer undesirable effects, such as the transparency and blurring TAA can cause.

Basically, since half the work is being performed by the Tensor cores, the GPU can dedicate more resources to simply running the game – meaning you potentially get high-quality edge-smoothing without the usual hit to frames-per-second.

CASH OR CARD
In theory, ray-tracing and DLSS should be great additions. In reality, the situation is a little more complex, and not just because you’d be paying an enormous premium for them.

Nvidia’s self-designed RTX 2080 Ti Founders Edition costs £1,099, and even the cheapest partner cards only start from £1,080, going up to as high as around £1,500 if you want one with factory overclocking and a custom three-fan cooler. Considering the GTX 1080 Ti launched at £699, and the GTX 1080 at £619, this is easily Nvidia’s most expensive flagship card ever.

The other RTX 20-series cards aren’t exactly budget alternatives, either. The RTX 2080, which is also available now, will set you back £749, while the RTX 2070 – the GTX 1070 replacement – is £569. These, too, are big price hikes over their 10-series equivalents.

WAITING GAME
As if these hurdles weren’t big enough, there’s another issue: at the time of going to print, neither ray-tracing nor DLSS currently work. You can’t boot up a game today and take advantage of them.

Only 11 games are confirmed either to launch with or be updated to include ray-tracing support, but of those already released games that will have it patched in, such as Shadow of the Tomb Raider, the update simply hasn’t arrived yet. Likewise, all the games that will support ray-tracing at launch, such as Battlefield V and Metro: Exodus, aren’t yet on sale.
DLSS isn’t available on day one, either. The list of compatible games is considerably longer, and includes the likes of PlayerUnknown’s Battlegrounds, Shadow of the Tomb Raider and Ark: Survival Evolved, but because the AI needs to be programmed on an application-by-application basis, it might take some time for even already-released games to be patched with DLSS support.

**BRAIN SURGERY**

Away from these two misfiring additions, Nvidia has beefed up Turing in more conventional ways. There are improvements to integer and floating-point operations, better shaders, and improved memory and texture caching. Turing cards mark the debut of GDDR6 memory, which has 27% more bandwidth than the GDDR5X in older cards. The flagship RTX 2080 Ti uses the TU102 GPU and has 18.9 billion transistors, which is almost 7 billion more than the GTX 1080 Ti. It has 4,352 stream processors compared to the 3,584 included in the older GPU, and they’re divided into blocks that are half the size of the GTX 1080 Ti, so they’re more versatile. The RTX 2080 Ti rattles along at 1,350MHz and a standard boost speed of 1,545MHz. Those are high speeds indeed, but the GTX 1080 Ti is faster, with speeds of 1,480MHz and 1,582MHz. This older card had 11GB of memory as well, so the only improvement is the switch to faster GDDR6. However, remember that base clock speeds are less important now that GPUs spend more time bouncing between different boost clocks. Nvidia’s Turing software allows users to tweak boosting algorithms and overclock with more ease, and most users will buy cards from board partners with factory overclocks. The new card also has a single-precision performance output of 14.2 teraflops (Tflops), which is approximately 2.5 Tflops better than the GTX 1080 Ti.

**FULL SPEED AHEAD**

With this much sheer power, the RTX 2080 Ti supplants the GTX 1080 Ti as the best single graphics card for 4K gaming. The Founders Edition model we tested either met, exceeded or managed only 40fps. Running on Ultra settings, the RTX 2080 Ti again proved its prowess, with 155fps in Dirt Showdown, 188fps in Metro and 194fps in Tomb Raider. At 4K, even Metro stayed smooth throughout, ultimately averaging 50fps, while Dirt and Tomb Raider sailed to 150fps and 59fps respectively.

**TOO MUCH, TOO SOON**

What’s less clear is whether these performance gains alone are worth the extra money. You can get a GTX 1080 Ti for about £600 nowadays, so without factoring in ray-tracing and DLSS, you could well end up paying over £500 more for an extra 10-20fps, depending on the game. It’s an improvement on the Pascal generation, sure, but not one that’s proportional to the price bump.

It’s feasible that ray-tracing and DLSS could make the investment worthwhile, but this just makes it all the more vexing that Nvidia would choose to release the first RTX cards without either feature being ready and playable on day one. We can’t even give a first-hand appraisal of how well they work until the requisite games and post-release patches are released.

That’s the biggest issue with the RTX 2080 Ti, and why we can’t wholeheartedly recommend it right now. The more conventional upgrades to Turing work well, making 4K/60fps a much more consistent reality, but it’s impossible to say how much of an impact ray-tracing and DLSS – the two big, headline features – will have.

When a graphics card costs north of £1,000 and its main features don’t yet work, then it’s worth waiting instead of buying immediately. The RTX 2080 Ti offers speedy performance, but if you wait for a couple of months – or even until early 2019 – then the new features will be better supported, more board partner cards will be available, and the prices may have even dropped a little.

Mike Jennings
THE GAMER RTX has more cutting-edge parts than most PCs, even past the lofty £2,000 mark: both its Intel Core i7-9700K processor and GeForce RTX 2080 graphics card are more or less brand new. This is also our first chance to see both parts in action outside of the trusty Shopper testing rig.

POWER OF EIGHT

The Core i7-9700K is an octa-core chip, like the Core i9-9900K (page 28), running at a base clock speed of 3.6GHz with a maximum boost of 4.9GHz. Scan has left these stock speeds unaltered and, with the aid of 16GB of DDR4 RAM, they produced some very high scores in our tests. 173 in the image test points towards excellent single-core performance, while 258 in the video test and 304 in multitasking indicate strong multicores as well. Overall, the Gamer RTX scored 267, one of the highest we’ve recorded from a pre-built gaming PC.

However, these scores only represent about a 10% improvement on the Core i7-8700K. It’s also worth noting that the Chillblast Fusion Ryzen 2700X Custom (Shopper 369), which uses the E300 AMD Ryzen 7 2700X, scored 291 overall. The Core i7-9700K still runs well enough to suffice for media editing and other content creation, but at £500, it’s not the big leap we were hoping for. We suspect two culprits: Intel’s baffling decision to remove Hyper-Threading (leaving the Core i7-9700K with eight total threads, half of the Ryzen 2700X’s), and the boost speed dropping to 4.6GHz when all eight cores are being used.

Likewise, the RTX 2080 is massively powerful, but on performance alone doesn’t take the GeForce brand as far as the RTX 2080 Ti does. It will thrash most older or less demanding games: Dirt Showdown had no trouble averaging 144fps at both 1,920x1,080 and 2,560x1,440, and 3,840x2,160 only produced a dip to 126fps.

In the tougher Metro: Last Light Redux, it’s only on near-equal terms with the GTX 1080 Ti, a considerably cheaper GPU. With the Gamer RTX averaging 115fps at 1,920x1,080, 68fps at 2,560x1,440 and 29fps at 3,840x2,160, the difference between this and the best of Nvidia’s last-gen cards is often negligible.

In fairness, you also get ray-tracing and DLSS; the former has the potential to produce far better-looking lighting effects in immersive games, and the latter might just provide anti-aliasing without a performance drop. However, both of these are still waiting to be implemented in games, so it will likely be a few months before either feature becomes a truly compelling reason to choose RTX over GTX.

COMPETITIVE EDGE

If all this sounds disappointing, it should be said that the Gamer RTX’s key parts offer performance bumps over their precursors, even if they’re not big ones, and because the CPU is unlocked, watercooled and installed in a Z390 motherboard, you could squeeze out even more power by overclocking it yourself.

More impressively, some research suggests that £2,100, far from being a rip-off, is very competitive for what you get. Scan itself does a rip-off, is very competitive for the two M.2 slots on the motherboard), but its AS SSD results of 496.9MB/s sequential read speed and 413.3MB/s are decent enough, and it helps the system boot incredibly quickly.

Internal expandability and external connectivity also both pass muster, with the rear I/O panel ditching USB2 entirely in favour of four USB3 ports and two USB3.1 ports. There are also a couple of antenna mounts for the convenient onboard 802.11ac Wi-Fi, and we love how the graphics card has a USB Type-C port next to its HDMI and DisplayPort outputs. It’s designed to work with VirtualLink VR headsets, rather than being a monitor output, but it also works as a regular Type-C socket for data transfers and device charging.

PASTURES NEW

We’re stopping short of giving the Gamer RTX an award, partly because its two main components aren’t amazing in themselves and partly to avoid jumping the gun; it’s early days for both Nvidia’s RTX series and Intel’s 9th-gen chips, and better pre-builds could well appear in the coming months. But this is undoubtedly a well-crafted PC that looks straight to the future instead of clinging to the past.

James Archer
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### Acer Aspire S 24

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**VERDICT**
This AIO is both stylish and cheap, though its display and storage dampen enthusiasm.

**THERE’S A CERTAIN** lack of affordable all-in-one (AIO) PCs being made today, which isn't that surprising when you think about it: the task of fitting good-quality components, a display and all the connectivity required of a full desktop into a single compact package, all while keeping the price down, can't be a very attractive one to manufacturers.

The Acer Aspire S 24, however, looks to have taken a decent crack at it. The particular spec we’re testing only costs £869 – that’s mid-range Windows desktop territory – and yet includes a quad-core Intel Core i5-8250U processor, 8GB of RAM, a large 2TB hard disk and a 2kIn Full HD display, not to mention a mouse and keyboard.

**FINE TUNED**
It looks great, too. All the key components are stuffed in the base, but this is still a very manageable size, and the screen is incredibly thin, with only some tiny bezels around the top and sides. Even if the gold accents aren’t to everyone’s tastes, Acer has done a terrific job at making this PC appear more expensive than it actually is. There’s even a Qi wireless charging pad built into the base – a nice but very cool little bonus.

Ports are split between the left, right and rear of the base unit. Smartly, the ones you’re likely to fiddle with the least – the two HDMI ports (one input, one output), power and Ethernet cables – are all at the back, along with one USB3 port. The left side better serves hot-swapping, thanks to the two full-size USB3 ports, single USB Type-C port and a SD card slot, while the right side rounds things out with a USB2 port (intended for the mouse and keyboard’s wireless receiver), plus 3.5mm microphone and headphone jack.

It’s a pretty good selection, and there’s also built-in 802.11ac Wi-Fi if you can’t or don’t want to use the Ethernet port. That said, it would have been nice if the keyboard and mouse could have connected without a receiver, even if it was via simple Bluetooth, as in effect you’re losing a USB port. Then again, the bundled peripherals are more than slightly basic, so we’d recommend upgrading from them as soon as budget allows.

The screen sits on a narrow, angled stand. Vertical tilt is the only adjustment available, but that’s to be expected given the price. It’s the quality of the display that proves to be the bigger problem.

The 1,920x1,080 resolution is fine for a 24In screen, but it’s a very bland-looking panel. We measured sRGB colour gamut coverage at 86.9%, which isn’t that great, and contrast is a lowly 693:1, so blacks sometimes look more like greys. Average delta-E comes in at 2.86, so colours are reproduced inaccurately as well, and with brightness peaking at just 247.7cd/m², it’s almost entirely up to the screen’s matt finish to see off reflections.

Application performance is better. It’s worth noting that the Core i5-8259U is a low-profile chip designed for laptops, but together with the 8GB of RAM it scored a respectable 96 in our 4K benchmark’s image test, 85 in the video test, 65 in the multitasking test and 77 overall.

**HARD KNOCKS**
To give a loose comparison, the Lenovo IdeaCentre 620S (Shopper 363) scored 80 overall with its Core i5-7400T, but this mini PC cost £780 when we reviewed it and didn’t come with a monitor, so the Aspire S 24 offers similar value. The Acer seems comfortable being an everyday home PC rather than an AIO workstation alternative, which, again, for £900 is fair enough.

That said, just because it’s not made for hardcore workloads doesn’t make the mechanical hard disk any less slow. While its results in AS SSD were adequate – a sequential read speed of 135.8MB/s and a sequential write speed of 83.5MB/s – the lack of any solid-state storage makes booting up and loading programs feel a bit slow.

We notice there’s a £900 model that includes both a TB hard disk and a 128GB SSD, which seems like a much better idea.

Don’t expect to do much gaming on this PC, either. Intel’s integrated UHD Graphics 620 could only put out 14fps in Dirt Showdown, running at Ultra quality and native 1080p resolution, and dropping to 1,280x720 with High quality only pushed it to 24fps. The less said about Metro: Last Light, the better – at 1080p with Very High settings, the benchmark did splutter all the way though to the end, but only at an average of 4fps.

**PACKAGE DEAL**
We’ve been quite down on the Aspire S 24 in places, but it’s not a bad AIO, really. Its modest performance is in line with the price, and even the poor display quality is balanced by strong design and good connectivity. If you are tempted, don’t bother with the specification we tested – go for the SSD model, which is identical save for the price and storage.

*James Archer*
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LAUNCHING WITH AN uncharacteristically quiet fanfare are Intel’s 9th-gen desktop processors, the first wave being led by the mid-range Core i5-9600K, the high-end Core i7-9700K and the crowning Core i9-9900K. This is a bit of a departure for Intel, which has historically chosen the top Core i7 chip as its flagship (the Core i7-8700K, Core i7-7700K and so on). This time, the Core line-up is headed by the far more expensive Core i9-9900K, which also has the distinction of being Intel’s first mainstream octa-core, 16-thread processor, as well as the first widely available CPU to hit 5GHz boost speeds out of the box.

EIGHT ‘N’ SWITCH Considering the base clock is 3.6GHz, that’s an enormous amount of work for Turbo Boost 2.0 to be putting in, but as per usual you shouldn’t expect all eight cores to consistently hit the maximum speed. In fact, the Core i9-9900K only boosts to 5GHz in single- and dual-core operations; when three or four cores are in use at once, the highest possible boost clock is 4.8GHz, and using all eight cores will drop this further to 4.7GHz. These are still high speeds for an octa-core chip, especially compared to AMD’s flagship Ryzen 7 2700X, which starts at 3.7GHz but only boosts to 4.3GHz at stock speeds.

In AMD’s defence, the Ryzen 2700X is half the price of the Core i9-9900K, the £600 cost of which makes Intel’s ‘mainstream’ definition stretch somewhat. There is some good news on the money front: you don’t need to pay extra for a brand-new motherboard as well. While the 9th-gen Core chips were designed for the new Z390 chipset, they still use Intel’s trusty LGA1151 socket, and are compatible with 8th-gen Z370 motherboards.

We still opted for a Z390 motherboard to conduct our testing; the Asus ROG Maximus XI Hero WiFi (see full review on page 30). For such big money, we were hoping for big performance, and the Core i9-9900K – for the most part – delivered.

Multithreaded work is a particular strength, even with lowered boost clocks: whereas the Core i9-9900K’s image test score of 173 is good, beating the Ryzen 7 2700X’s 169, its video and multitasking scores of 319 and 390 truly stand out. Overall, the CPU comes out with an overall score of 330, a full 99 points higher than the most powerful Ryzen chip.

When paired with a 6GB Nvidia GeForce GTX 1060 graphics card, the Core i9-9900K also proves significantly better for gaming, at least in games that are more CPU-reliant, rather than those that lean more on the GPU. Case in point, at 1080p resolution with Very High settings, Metro: Last Light Redux averaged 50fps, just 2fps more than with the Ryzen 7 2700X and identical settings. Dirt Showdown, on the other hand, is more CPU-heavy, so a 109fps result with the Ryzen chip leapt to 127fps with the Core i9-9900K.

Overclocking this chip is a little unusual: the highest stable clock speed we could get with our AIO cooler was 5GHz (helped along by a 1.38V core voltage change). Being unable to overclock past the stated boost speed sounds rubbish, until you remember that all eight cores are permanently set to that speed, not just one or two under light loads. We would have liked to go even further, but although we could boot at 5.1GHz and even 5.2GHz, the system invariably crashed during our benchmarks. Besides, at 5GHz we measured load temperatures around 91-94°C, with a peak of 100°C, so further pushing seemed unwise.

Even with these high temperatures, we managed to eke out improved performance: the Core i9-9900K’s image test score rose to 179, its video score to 333, multitasking to 408 and its overall score to 345. Dirt Showdown also got a further bump up to 137fps, although the overclock didn’t do anything at all for Metro, which stayed at 50fps.

FINE NINE Limited overclocking is fairly incongruous with the Core i9-9900K’s positioning as a performance-lover’s component, but it’s still a pretty good CPU, even at that high price. In terms of both cost and performance, it occupies the middle ground between mainstream processors and the £1,000-plus Intel X-series, so for content creators with a little extra cash to spend, it’s a worthy choice, even if most people are better off with Ryzen.

James Archer

Intel’s octa-core, 16-thread processor is the first widely available CPU to hit 5GHz boost speeds out of the box

are in use at once, the highest possible boost clock is 4.8GHz, and using all eight cores will drop this further to 4.7GHz. These are still high speeds for an octa-core chip, especially compared to AMD’s flagship Ryzen 7 2700X, which starts at 3.7GHz but only boosts to 4.3GHz at stock speeds.

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We still opted for a Z390 motherboard to conduct our testing; the Asus ROG Maximus XI Hero WiFi (see full review on page 30). For such big money, we were hoping for big performance, and the Core i9-9900K – for the most part – delivered.

Multithreaded work is a particular strength, even with lowered boost clocks: whereas the Core i9-9900K’s image test score of 173 is (again using 1080p and the highest possible settings). Intel processors have always been slightly better than AMD’s in gaming, but it’s been a few generations since we’ve seen double-digit fps differences like this.

SOLDER BOY Another under-the-hood tweak Intel has made to the 9th-gen Core chips is replacing the cheap thermal paste between the heat spreader and the processor die with solder. In theory, this should produce better thermal performance than on preceding chips, as solder is more effective at transferring heat.

Unfortunately, when used with our Cooler Master MasterLiquid Pro 240 watercooler, the Core i9-9900K still runs slightly warmer than the Ryzen family, even if it’s just by a few degrees. Not to be too harsh on it, however; at stock speeds, the idle temperature of 30°C is just fine, and the absolute peak we recorded of 74°C isn’t remotely cause for concern. Under load, individual cores tend to flick around the 68-70°C region, which is 8-10°C higher than the Ryzen 7 2700X with the same watercooler, but still decent.
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ONE OF THE more unexpected strengths of Intel’s 9th-gen Core series chips is their ability to work – socket allowing – with motherboards that use either the new Z390 chipset or the previous Z370. With recent generation changes, the new CPUs have always demanded the very latest chipset, which meant that upgrading was always that much more expensive.

Z390 boards, such as Asus’ ROG Maximus XI Hero WiFi, therefore have a lot of work to do to prove they’re worth investing in over an older, cheaper Z370 model. For this specific motherboard, that means a fresh design, some new UEFI tricks and improved memory overclocking support over the Z370 ROG Maximus X Hero (Shopper 365).

SMARTEN UP
Z390 itself doesn’t represent a massive leap from the 8th-gen chipset, but it does offer some advantages. Support for integrated 802.11ac Wi-Fi is now included at the chipset level, rather than being something manufacturers must add in themselves, and 10Gbit/s USB3.1 support is built in as well.

Still, these additions alone don’t make the Z390 chipset a must-have; in particular, we’ve never seen a problem with manufacturers adding Wi-Fi to their motherboards via M.2 modules, so it’s mainly up to the ROG Maximus XI Hero WiFi’s hardware and design.

Fortunately, Asus has done a great job with the latter. It still has all the pronounced, angular covers and heatsinks one would expect from a ROG-branded motherboard, not to mention the customisable RGB lighting throughout, but the whole thing is visibly cleaner and neater than its predecessor.

Once again, there are two M.2 slots for NVMe SSDs or Intel Optane Memory, but now both of them – not just one – are covered by a heatsink. The selection of expansion slots is kept to a high standard in general, with three PCI-E x16 slots, three PCI-E x1 slots and four slots for DDR4 RAM. Both two-way Nvidia SLI and three-way AMD Crossfire configurations are supported, so you’re not too limited by your GPU choice.

As mentioned, RAM overclocking has received a decent little upgrade, with the maximum speeds increasing from 4,133Hz to 4,600MHz. That’s a fitting change for a motherboard that, judging from its price alone, is clearly going after the experienced overclocker crowd. This is further evidenced by the ROG Maximus XI Hero’s nicely extensive cooling support, including eight 4-pin cooling headers for case fans and watercooling systems alike. There’s also a highly convenient array of onboard tools that make experimenting and troubleshooting easier, particularly the integrated power and reset buttons, and the POST code display.

COUNTER INTELLIGENCE
Equally OC-friendly is the UEFI BIOS, which is rammed with both CPU and memory options. Since this is the first Z390 motherboard we’ve tested, we don’t yet know how it compares to others in terms of pushing 9th-gen Intel chips to their limits, but after a lot of trial and error we were able to get the Core i9-9900K to run all eight cores at 5GHz (up from 4.7GHz) with an AIO watercooler and a respectable core voltage of 1.38V.

When tested with a 8th-gen Core i7-8700K, we again found that the highest stable overclock we could get with this board was 5GHz, the same as on our current favourite Z370 model, the MSI Z370 Gaming Pro Carbon AC (Shopper 365).

To clarify, these results were all achieved manually; if there’s a disappointment with the ROG Maximus XI Hero WiFi, it’s that Asus’ new ‘one-click’ overclocking features don’t pan out. The first we tried was loading a ‘CPU 5G OC Profile’, which simply set the Core i7-8700K’s Core Ratio Limit to 50 (resulting in a 5GHz target speed). Without any accompanying voltage changes, however, this rough overclock led to our PC crashing under load.

The second, more highly vaunted feature is AI Overclocking Mode. It works thus: you run a stress test benchmark at stock speeds, which gives the UEFI data on how far it can safely auto-overclock your CPU. After enabling the AI Overclocking option and restarting, it should apply the overclock, which on our Core i7-8700K was a seemingly conservative 4.9GHz. Sadly, even this crashed during further benchmarking, and the only suggested solution to fix any AI-related problems is to change settings manually yourself, defeating the purpose of an automatic system in the first place.

Things got even worse when we tried it with the Core i9-9900K. Not only did the system once again crash, but the BIOS listed a different post-AI clock speed to what we saw in the CPUID and Core Temp software (the BIOS claimed a 5GHz overclock, the software 5.1GHz). Considering AI Overclocking Mode aims to make overclocking easier for beginners, it can get awfully confusing.

EXPERIENCE NECESSARY
Still, at £296, we wouldn’t recommend this to first-time PC builders to begin with. The Z370 Gaming Pro Carbon AC is a much better deal: it’s nearly half the price, but is almost as well equipped, including 802.11ac capability.

Real enthusiasts, however, won’t be let down by Asus’s board. Besides the headline Wi-Fi and Bluetooth 5.0, it’s got everything required for a high-end PC, and while Z390 isn’t an essential upgrade it does have a small impact, even if here it’s just a couple of extra USB3.1 ports at the back.

James Archer

SPECIFICATIONS
PROCESSOR SOCKET LGA1151 • DIMENSIONS 305x244x30mm • CHIPSET Intel Z390 • MEMORY SLOTS 4 • PCI-E 16 SLOTS 3 • PCI-E 1 SLOTS 3 • PCI-SLOTS 3 • USB PORTS 2x USB2, 2x USB3, 3x USB-C • USB Type-C • VIDEO OUTPUTS 1x HDMI, 1x DisplayPort • WARRANTY Two years RTB • DETAILS www.asus.com • PART CODE ROG Maximus XI Hero WiFi

VERDICT
It’s not cheap or beginner-friendly, but this Z390 board does well by its higher-end features.
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WE'RE ALL GAMERS.
**LOGICALLY, IT DOESN’T** seem as though there would be much room for a new budget SATA SSD on the market: the SATA platform’s throughput limit means new drives won’t necessarily be faster than old ones, so why not just buy a higher-end drive that’s had a few years to drop in price?

Of course, not all NAND is created equal, and even if an SSD promises to max out the speed limits of what SATA can allow, it might fall far short of those speeds in more demanding transfer jobs, so there are still opportunities for new drives to impress on performance, even in the entry-level arena. Crucial’s latest hopeful is the BX500, which follows the MX500 and MX300 (Shopper 351), both 2.5in SSDs that managed to balance good speeds and low prices.

**LIGHT TOUCH**
The new BX500, however, is even cheaper. There are only three different capacities available, but all offer tremendous value on paper: the 120GB model works out at 20.4p per gigabyte, while the 240GB model (which we tested) costs just 16.7p per gigabyte. Lastly, the 480GB model is a mere 14.2p per gigabyte. This is about as affordable as branded SATA SSDs come.

Crucial claims a maximum sequential read speed of 530MB/s and a maximum sequential write speed of 500MB/s, so despite the pricing it’s evidently confident in the BX500’s ability to keep up with at least mid-range drives. There are a couple of hidden costs, however: first, there are no fancy features, like the MX300’s built-in encryption, although for most home users that won’t be a big deal.

Somewhat more concerning, at least if you’re a heavy PC user, is the BX500’s relatively low durability. The 240GB model, for example, is rated at 80TBW, meaning you can expect to write 80TB of data to the drive before it starts developing problems.

**VERDICT**
Dirt-cheap and surprisingly fast, the BX500 is everything you could want in an entry-level SSD

That might be fine for casual users, but anyone who works with large media files, or installs and uninstalls a lot of games, would be wise to keep an eye on their backups. The 120GB model is even shorter-lived, being rated at just 40TBW, while the 480GB model is rated at a more reassuring 120TBW.

This is quite clearly a no-frills SSD, then, but when it comes to straightforward speed the BX500 exceeds expectations for a budget drive. For starters, it blasted through CrystalDiskMark’s standard sequential read and write tests, recording 561.6MB/s and 524.7MB/s respectively. That’s not just an improvement on the MX300, on both counts, but it’s a very similar set of results to what you’d see on a top-tier SSD such as the Samsung 860 Evo (Shopper 364).

The BX500 also did moderately well in the tougher 4K test, where it produced a read speed of 248.2MB/s and a write speed of 221MB/s. While these results aren’t as high, relatively speaking, as those of the standard sequential test, they’re still pleasantly close to mid-range territory.

**PLUCKY SHOT**
For a more true-to-life test, we also ran our own file transfer benchmarks using DiskBench. Starting with the huge files test, the BX500 managed a middling read speed of 440.5MB/s, but its write speed of 495.8MB/s was another very encouraging showing. Likewise, its read speed result in the large files test – 427.5MB/s – is extremely competitive for the money.

In the large write speed test, this SSD exhibited the same behaviour as the 860 Evo: it actually writes the files faster than Windows can keep up with, effectively confusing DiskBench into recording a theoretically impossible speed – in this case, an average of 600.9MB/s. The good news is that this still demonstrates very high speeds; we just can’t accurately measure how high exactly.

The small file test is the only portion that the BX500 struggled with, its read and write speeds dropping to 256.5MB/s and 301.1MB/s respectively. Unlike in the huge and large tests, the old MX300 is actually faster here, scoring a 337.6MB/s read speed and an excellent 519.1MB/s write speed.

Even so, the BX500 performed well overall, considering it’s a budget SSD without any speed-boosting cache trickery. It even came close to the performance-minded Adata XPG SX950U (Shopper 369); no small feat when the BX500 is about 10p per gigabyte cheaper than Adata’s equivalent 240GB model.

**FIRST STEPS**
Some PC enthusiasts might look at the TBW limits or small file transfer speeds and scoff, but then the BX500 was never for them. This is a simple yet sufficiently quick entry-level SSD, priced accordingly, which means almost anyone can upgrade from their desktop or laptop hard disk. In the absence of any more serious flaws, that’s good enough for a Recommended award.

*James Archer*
SEAMLESS, SECURE WHOLE-HOME WI-FI
Antivirus & Parental Controls
Powered by Trend Micro™

Deco M5 Whole Home Wi-Fi System

Antivirus
Protects every connected device from viruses and malware - even the devices that visitors use at your home.

Parental Controls
Restrict content, schedule Wi-Fi access by user or device, view activity reports or pause the internet.

Bandwidth Prioritisation
Quality of Service (QoS) assigns bandwidth to the devices you use the most or prioritises your favourite activities.

Compatible with the Deco App (available from the Apple App Store or Google Play)

Works with Amazon Alexa

facebook.com/TPLINKUK
uk.tp-link.com
twitter.com/TPLINKUK
MICROSOFT Surface Go

VERDICT
It's not the most powerful or longest-lasting 2-in-1, but the Surface Go is still a charming mobile companion.

A SMALLER, CHEAPER version of the Microsoft Surface Pro (Shopper 355) has always sounded like a good idea, but the Surface Go is almost too compact for its own good; as a standalone tablet, this 10in device can make Windows feel awfully cramped when you've got the onscreen keyboard up. Add the actual keyboard attachment, however, and it's transformed into a much more appealing 2-in-1.

The Surface Go comes in two configurations: one with 4GB of RAM and a 64GB eMMC drive, the other with 8GB of RAM and a 128GB SATA SSD. The latter configuration is more expensive (leaping from £399 to £509), but we wouldn't recommend the former, lesser specification. When you're running Windows 10, you need every ounce of performance you can get.

You're therefore looking at paying £509 for the higher-specification tablet, plus either £99 for the basic, black keyboard or £125 for the fancier, hydrophobic Alcantara keyboard. That all adds up to at least £608 for the bundle, which is quite a lot of money.

In the context of the main competition, however, the price doesn't look so bad. The recently launched Samsung Galaxy Tab S4 (Shopper 370) is £599 plus £119 for the add-on keyboard, while the iPad Pro 10.5in (Shopper 356) is £619 plus £159 for the keyboard. All three are more accessible than the Surface Pro, which starts at £799 for the tablet and £100 for the keyboard.

JUST A LITTLE
That said, even the more powerful Surface Go model isn't going to win any awards for speed. It scored 2,050 in the single-core Geekbench 4 test, rising to 4,026 in the multicore portion. That's slow compared to Apple's iPad and iPad Pro devices, and is demolished by every comparable Android device, too. Nor did it shine in our own Windows-based benchmarks, with an overall score of 20 being one of the lowest we've seen this year.

Still, benchmarks don't always tell the whole story, as the Surface Go proved perfectly serviceable in everyday use. Web pages don't spring to life as quickly as they do on more powerful 2-in-1s, but they're not far behind. Likewise, it's fine for tapping away in Word, rendering PDFs and editing the occasional photo. We wouldn't want to edit a film on the Surface Go, but for the most common daily tasks, it's just fine.

Windows can still be a bit claustrophobic on the 10in display, even without a digital keyboard hogging the screen. Poking at icons on the taskbar is fiddly (you'll end up using the generously sized trackpad on the keyboard most of the time), and this is one consistent area of superiority for iOS and Android: they're actually designed for fingers. You can tell Windows 10 to switch into Tablet mode, but the UI still isn't as touchscreen-friendly as it is on other operating systems.

SHOW OFF
Fortunately, the screen itself is terrific. A resolution of 2,160x1,440 translates into a sharp 217ppi, and with a maximum brightness of 426cd/m² it's readable outside in all but the brightest conditions. We were pleasantly surprised by its colour accuracy, too: a respectable 90% sRGB gamut coverage was backed up by a superb average delta-E of 1.44.

We actively went looking through videos for lost details in shadows: and any other defects that might spoil the viewing pleasure, but the Surface Go sailed through with ease. With regards to entertainment duties specifically, it also helps that the audio from the two side-mounted speakers is surprisingly strong, with great handling of speech, and there's a 3.5mm jack built into the tablet if you want to plug in headphones.

GO HOME
One inconvenience is that, by default, the Surface Pro runs Windows 10 in S mode, which means you can only install apps from the Microsoft Store, thus adding a layer of
and coming in blue, burgundy and silver. For most people, the basic £100 keyboard is surely the way to go: it looks stylish and matches the black bezels of the tablet.

It’s also extremely enjoyable to type upon. The main keys are large enough that you shouldn’t hit their neighbours by mistake and, while it’s small compared to most 2-in-1 keyboards, we had no difficulties hitting the same level of touch-typing speeds as normal. There’s also a reasonable amount of travel on the keys and they don’t make much noise when you bash down; always a positive for a machine designed for use on your travels.

Naturally, the Surface Go uses a kickstand to support the screen in laptop mode, but this is one area where its size helps: even if you have relatively short legs you should find it possible to rest the Go on your lap and keep typing (although it’s a more pleasant experience on a table). The touchpad is spacious and responsive, while the backlight means it’s still usable in dim or dark conditions.

Bereft of the keyboard, however, there’s nothing special about the Surface Go’s design. At first glance, it’s almost indistinguishable from an iPad, with chunky black bezels surrounding the screen. There’s no Home button, with just a power button and volume up/down rockers on the right-hand edge.

**ADDITIONAL CHARGES**

Microsoft again goes its own route with its choice of connections. Along with the proprietary magnetic connector that holds the keyboard in place, there’s a microSD slot, a Surface Connect port and a USB Type-C port, which can be used for peripherals, charging or as a display output.

Whether you use the Type-C socket or the actual power connector, you’ll be refuelling quite often. Windows 10 is inherently a more power-intensive OS to run than iOS or Android, and because you have a full x86 processor inside, it consumes more electricity than the ARM chips inside its rivals.

Sure enough, the Surface Go only lasted for a modest 6h 44m in our video rundown test, well short of the nine hours Microsoft says you can get out of it. It’s still not terrible, but the 10.5in iPad Pro and Samsung Galaxy Tab S4 both did far better in the same test, scoring 12h 59m and 17h 10m respectively.

This all leaves the Surface Go in a tricky position. On the one hand, you’ll never get the same range of keenly priced tablet-focused apps as you do on iOS; the apps you can buy from Microsoft Store are mostly repackaged pieces of software designed for Windows with a mouse and keyboard, not to be used with touch.

You also can’t buy the same range of third-party accessories, so you’ll be paying through the nose for the Surface Pen (£100), Surface Go Keyboard (£100 to £125) and Dial (£90). Likewise for power supplies, where a second Surface Go adaptor costs £35.

**AT YOUR SURFACE**

We must also reiterate that we’ve reviewed the high-end model with 8GB of RAM and a 128GB SSD. We’d steer clear of the 4GB/64GB Surface Go for numerous reasons: for one, our 128GB unit had around 110GB of usable storage, so you’d only get 45GB of space with the lesser spec. More annoyingly, it will feel much more sluggish in use: 4GB of RAM is right at the limit of Windows 10’s usability, while an eMMC drive is also a poor choice.

With those caveats in place, there are numerous positives that earn the Surface Go a Recommended award: the keyboard is truly excellent and turns this machine into a fully fledged laptop when you need it; the screen is superb, making it a great tablet for watching videos; and it’s more versatile than any of its rivals – even the iPad Pro – with its ability to run any Windows software, old or new, at least once you upgrade to Windows 10 Home. It’s especially pleasant to be able to use a proper file system, which lets you move files around the nose for the Surface Pen (£100), Surface Go Keyboard (£100 to £125) and Dial (£90). Likewise for power supplies, where a second Surface Go adaptor costs £35.

If you’re the sort of person who’s been frustrated by tablets before because they can’t do all the things you want, then we urge you to take a look at the Surface Go.

*Tim Danton*
CHROME OS LAPTOP

ACER Chromebook 14 (2018)

★★★★

£230 • From www.currys.co.uk

VERDICT
A beautifully crafted Chromebook, albeit one with some display and storage issues

CHROMEBOOKS ARE TYPICALLY small and basic laptops that sacrifice looks for affordability, but Acer’s new Chromebook 14 is aiming to shake up that trend. In an effort to prove that it’s possible to build a cheap laptop without the usual trade-offs, Acer is treading an unusual path with its latest Chrome OS portable.

In fact, you could be forgiven for mistaking the Chromebook 14 for a MacBook Air at first glance. The Chromebook 14’s wedged shape and gold or silver aluminium chassis, black plastic hinge at the rear and sunken keyboard are all reminiscent of Apple’s classic laptop; only the brushed finish on the lid and Acer logo give the game away.

CLOUD AND PROUD
Still, the whole thing feels reassuringly expensive and barely flexes a millimetre if you try to twist and bend it. It’s as chunky as a MacBook at 17mm thick, although at 1.68kg it’s not quite as lightweight.

There are a couple of variants available: the £230 model we tested gives you a 14in, 1,366x768 resolution display, an Intel Celeron processor and 2GB of RAM, while £280 will give you an upgrade to a Full HD resolution and 4GB RAM. This being a Chromebook, both models only include 32GB of flash storage, so you’ll be reliant on cloud-based storage solutions for most of your files.

The Scrabble-tile keys are another aspect of the design that seem to pay homage to the MacBook Air, and the keyboard is also similar in layout. Critically, the keys are all nicely spaced out and large, with decent travel resulting in comfortable typing.

The sizable touchpad is responsive, too, but since it’s running Chrome OS, there aren’t as many multitouch gestures to take advantage of when compared with other operating systems.

Sadly, as is the case with most cheap Chromebooks, the display isn’t quite up to scratch. It’s a decent size at 14in, but quality-wise it’s a letdown. It’s not particularly sharp at 1,366x766, and peak brightness is merely acceptable at 213cd/m², but it’s the contrast ratio of 287:1 that really lets it down.

It’s the same sorry story with colour accuracy, too, with the TN panel displaying only 54% of the sRGB colour gamut. It all leads to a washed-out, dull display, with a clear lack of richness and vibrancy. While this is largely par for the course with entry-level Chromebooks, there have been a few exceptions over the years, such as the Toshiba Chromebook 2, with its impressive full HD IPS display, and Acer’s own Chromebook R11 (Shopper 344), which has a smaller yet far better-quality touchscreen.

Performance is also behind the pack, although not as much as display quality. Both versions of the Chromebook 14 include the Intel Celeron N3060 processor, which comes clocked at 1.6GHz with a Turbo Boost speed of 2.48GHz, so it’s worth keeping expectations in check, especially considering the frugal 2GB of RAM on this £230 spec.

A JetStream score of 477 isn’t exemplary, with the HP Chromebook 14 scoring a higher 52.9. Surprisingly, in the WebGL 3D Cubes test the Acer laptop achieved a result of 22fps, bringing it roughly in line with the Acer Chromebook R11, and is double that of the HP.

In general use, it felt responsive and reasonably fast for the most part. Just don’t expect it to run as fast with multiple Chrome tabs open: the 2GB of RAM will see to that.

LONG TIME GOING
The good news is that battery life is excellent. In our video rundown test, it beats the HP’s Chromebook by over an hour, lasting 10h 22m, and it beats many more serious Windows-based laptops along the way. That’s more than enough to get you through a full working day.

In terms of connectivity, there’s a good selection of ports and sockets. It has two USB3 ports and an HDMI output for connecting external displays, and there’s a 3.5mm headset output for your headphones. Wireless support extends to dual-band 802.11ac wireless and Bluetooth 4.2, too.

The downside is that there’s no Ethernet port and, more significantly, no SD card slot, so you’re stuck with the 32GB of onboard storage and whatever you have in the cloud.

The built-in speakers are reasonable, but nothing out of the ordinary. They’re clear, reasonably loud and mostly distortion free (this only kicks in at very high volume levels). However, as with most laptops and tablets, the sound doesn’t have much weight to it or any bass to speak of. If you want that, you’ll have to plug in your headphones.

MEMORY LOSS
Acer’s latest attempt at a Chromebook ends with mixed results. Its metal-clad chassis is excellent, the keyboard is great, and for such a cheap device, you’re getting superb build quality. The display is a big disappointment, however, as is the lack of an SD card slot.

If you don’t mind something a little smaller, you’d be better off choosing the Chromebook R11, which has a similar price and a better screen that’s touch-sensitive as well.

Tom Bruce

SPECIFICATIONS

| Processor | Quad-core 1.6GHz Intel Celeron N3060 |
| RAM | 4GB |
| Dimensions | 334x236x17mm |
| Weight | 1.68kg |
| Screen size | 14in |
| Screen resolution | 1,366x766 |
| Graphics adaptor | Intel HD Graphics 400 |
| Storage | 32GB |
| Operating system | Chrome OS |
| Warranty | One year RTB |

Battery Life

| Battery Life | 0% | 10h 22m | 10h 30m | 0% |

See page 70 for performance details.
Vivid, true-to-life colours in an elegant design

276E7QDSW
There may be nothing too innovative about the Yoga 530’s design to speak of, but it’s what lies within this convertible that’s most interesting: a Ryzen 7 2700U processor. So far, we’ve only seen this in the business-focused - and far more expensive - HP EliteBook 745 G5 (Shopper 370), so the prospect of this high-end chip powering a more affordable consumer device is an enticing one.

Human Error
It’s a shame, then, that the Yoga 530 is so humdrum on the outside. At 1.67kg and 328x229x17.6mm, it’s neither particularly light nor unusually thin, and you get only a fairly basic selection of ports: two USB3, one USB Type-C, one HDMI output and an SD card reader. Next to this card slot is the power button, placed rather awkwardly on the right edge; we repeatedly ended up pressing it by accident. The fingerprint sensor, on the other hand, is a great inclusion, capable of unlocking Windows in less than a second.

Audio-wise, the laptop has a pair of Harman Kardon-branded speakers, buried either side of the laptop’s keyboard, complete with ‘Dolby Audio Premium’ processing. While these sound fine up close, they’re not strong enough to fill a room; walk back several paces and the quality drops off significantly. Vocals and guitars pick up extremely well, but when a heavy drum solo or bass drop kicks in, things get a little fuzzy. It doesn’t cope well with sharp increases in volume, either, cracking a tad through the transition.

The keyboard, happily, is sensible and satisfying. The keys are well spaced and provide pretty decent tactile feedback, while a cool blue backlight makes the Yoga 530 practical when working in dark conditions.

The touchpad is pretty good as well. It isn’t quite as good as a MacBook Pro touchpad and, initially, it seemed to have trouble differentiating between three-finger and four-finger commands, but it worked well once we bumped up the sensitivity.

Display quality could be better, however. The 1,920x1,080 resolution is more than fine, but colours look flat and dull. According to ourcolourimeter, the Yoga 530’s screen could cover only 54.6% of the sRGB gamut. Brightness also peaked at a thoroughly average 250cd/m²; only the high contrast ratio could salvage things, hitting a high 1,781. As such, it’s not a total disaster, but we expect better for £750.

At least it’s also a touchscreen, and as an input method, the display works well. We found it fantastically responsive to taps, swipes and pinch gestures, and it works with styluses, too, although the Lenovo Active Pen isn’t included in the box, sadly.

Ryzen Damp
Moving on to the aforementioned Ryzen chip, it puts this particular Yoga 530 spec at the top of the range. You can also find cheaper Ryzen 5 and Intel Core i5 versions, and even an Intel Pentium Gold 4415U model for £379, but this also only has 4GB of RAM and a 128GB SSD. Our £750 model, by contrast, is equipped with 8GB of RAM and a 256GB SSD.

It finished our 4K application benchmarks with an image score of 109, a video score of 75, a multitasking score of 54 and an overall score of 70. That puts it in a very similar position to the HP EliteBook 745 G5: it’s a powerful laptop, although perhaps not quite as powerful as could be expected, given the hardware. For one thing, the Acer Swift 3 (Shopper 364) - which we tested with a lower-spec Ryzen 5 2500U - scored a slightly higher 74 overall, while the Core i5 8250U-powered Asus ZenBook 13 (Shopper 367) scored 75 (although, unlike the Swift 3, this is more expensive than the Yoga 530).

At the same time, any disappointment is tempered by the fact that it also beat the pricier Microsoft Surface Laptop (Shopper 356), which scored 49 overall. Besides, for £750, 70 isn’t even that low - it’s just not the best. Most users will be happy with how the Yoga 530 tackles everyday tasks, as well as basic media editing and content creation.

The 256GB storage drive also showcased some impressive speeds. Tested with AS SSD, we recorded sequential read and write speeds of 1,334MB/s and 706MB/s respectively. That’s much quicker than, say, the ZenBook 13, which only scored 476MB/s read and 369MB/s write speeds.

Unfortunately, battery life is a disaster.

The Yoga 530 only lasted a mere 3h 47m, making it unsuitable for mobile working and use on long journeys. The only consolation is that the Swift 3 lasted even less, at 3h 16m.

Spin Out
That doesn’t make the Yoga 530 a bad laptop. It’s roughly as fast as or faster than most of its closest rivals, the SSD is quick, the 360° hinge works as well as any on the market, and the keyboard and trackpad are both excellent.

Nonetheless, the Ryzen 7 2700U chip is clearly not as efficient as its Intel counterparts, and that woeful battery life limits the Yoga 530’s flexibility as a mobile device. Display quality is a letdown, too.

Tom Bruce

VERDICT
Lenovo’s latest flippy hybrid is weighed down by poor battery life, despite successes elsewhere.
THE PG27UQ LAYS claim to two world firsts. Not only is it the first gaming monitor to combine a 4K resolution with a 144Hz refresh rate, it’s also the first to provide ‘proper’ HDR thanks to its 384 individual backlight zones.

While we’ve seen HDR monitors before – most recently the BenQ EX3203R (Shopper 370) – they’ve had to make do with a handful of backlight zones, making it impossible for them to deliver the true high-contrast HDR of a TV. But the PG27UQ is the real deal, with full-array local dimming (FALD) backlighting.

It doesn’t come cheap. The PG27UQ is currently the most expensive gaming monitor on the market, just ahead of the Acer Predator X27, another 4K, 144Hz HDR monitor that launched shortly after Asus’s display. And while there are some extras such as Nvidia G-Sync support, you’re only getting a 27in screen.

GOT LEGS
It isn’t shy of making a statement style. Lights shine out from just about every angle, and the stand and rear of the display are sculpted into distinctive angular patterns. As on the ROG Strix XG32VQ (Shopper 370), Asus’s Light Signal and Light in Motion features can project light on to your desk and wall as well.

This flashiness is tempered by an elegant, all-metal base. It’s not as practical for small desks as a flat-based stand, but it looks great and offers a full range of adjustments. You can also remove the stand completely, and VESA-mount the monitor by itself.

What you won’t be looking at is slimline bezels. This has become something we expect from premium displays, but here the sophisticated backlight system has forced Asus to stick with a somewhat bulkier design.

There aren’t many extra features, either. Some displays include headphone stands, audio pass-throughs and side-mounted USB ports, but here you get just two video inputs – one DisplayPort 1.4 and one HDMI 2.0, plus two USB3 ports at the back. Like most G-Sync displays there’s also no room for an internal power supply, so you’ll just have to find somewhere to stow the power brick.

The only other physical feature of note are the controls for the onscreen display (OSD). These sit on the rear of the display and consist of a mini joystick and four buttons. Here we have no complaints at all: they work fantastically well together, and make it quick and easy to navigate the OSD and get things set up.

LIGHT FANTASTIC
Of course, the main appeal of the PG27UQ isn’t its physical design but its HDR-powered image quality, and Asus has delivered in spades. The 384-zone backlighting presents truly dazzling levels of peak brightness for highlights, but it’s the increase in the colour gamut – the variety of onscreen colours – which makes the biggest impact. Bright greens such as grass on a sunny day pop in a way that non-HDR simply can’t manage. At first it looks excessively vivid and oversaturated, but once you settle into it you realise this is how the world should look.

There are times when the difference is more subtle. HDR only really delivers its full potential in extreme circumstances, when there’s strong contrast and bright colours. If the image doesn’t have those elements anyway, you don’t see the effect on the screen.

Also, while Windows 10 itself has improved HDR integration, only a few games support it. There’s a certain sense that this is more of a future-proofing move than one that reaches its full potential right now.

That said, even without HDR content, the PG27UQ performs superbly. Keep the dynamic backlighting enabled and contrast soars to 6.42:1, several times higher than the XG32VQ, while sRGB coverage is a strong 97.6% and delta-E is a professional-quality 0.14.

The 144Hz refresh rate also helps games look beautifully smooth, especially if you have an Nvidia graphics card and enable G-Sync. The 4K resolution is both a strength and a weakness, however: everything looks pin-sharp, but to actually reach the high frame rates required to take advantage of the refresh rate, you’ll need a very powerful GPU indeed – ideally one of the new GeForce RTX cards, which are incredibly expensive in their own right. Since this is only a 27in screen, you’ll also need to adjust Windows scaling to make text size and other desktop elements readable.

POMP CULTURE
If your priority is image quality, however, you won’t be disappointed. This is the finest 27in gaming monitor you can buy, and arguably the best gaming monitor of any size thanks to the sheer quality of its HDR and SDR images.

The combination of 4K, a 144Hz refresh rate and proper HDR makes for image quality and gaming performance that only the Predator X27 can hope to match. Even now Acer’s display has been released, however, the PG27UQ remains a monitor to lust after.

Edward Chester

VERDICT
Outrageously expensive, but the 144Hz IPS panel and FALD backlighting provide the best HDR gaming experience yet

HDR GAMING MONITOR
ASUS ROG Swift
PG27UQ

E2,277 • From www.amazon.co.uk

SPECIFICATIONS
SCREEN SIZE 27in • RESOLUTION 3,840x2,160 • SCREEN TECHNOLOGY IPS • REFRESH RATE 144Hz • VIDEO INPUTS HDMI, DisplayPort • WARRANTY Three years RTB • DETAILS www.asus.com • PART CODE PG27UQ

CONNECTION PORTS
HDMI • DisplayPort • USB3 x2

COMPUTER SHOPPER
JANUARY 2019

ISSUE 371
IF YOU'RE GOING to be spending nearly £150 on a printer, you'll want it to look special, and Canon's Pixma TS8250 certainly does. Made from glossy black plastic, brightened up with chrome trim, and controlled by a huge colour touchscreen, this multifunction peripheral (MFP) is about as uncluttered and classy as they come. It's highly specified, too, with a socket for printing from or scanning to SD cards, and comprehensive support for cloud services, including Google Drive.

The TS8250 is aimed at creative use including photography, and to this end its six-ink printer combines the typical black, cyan, magenta and yellow tanks with an additional pigment black for strong text, plus a 'photo blue' for reduced grain and improved colour reproduction.

Paper handling and media support is particularly good, with automatic duplex (double-sided) printing and two paper inputs. You can print CD labels and even fingernail stickers, should the mood take you.

SET AND MATCH

If you're sharing the TS8250 over Wi-Fi, it's best to perform the initial setup from a wireless Windows device such as a laptop. Try to set it up from a device with a wired connection and you'll first need to cancel the default Ready to connect mode and get it on to your network via one of the other available methods.

In most ways, the TS8250 performs very well. Scans are swift, and photo prints were also impressive, with black and white shots pleasingly neutral, and colour images exhibiting good shade control. On plain paper, black text was crisp, and graphics were punchy. Dark colour fills and progressions were let down slightly by subtle banding; something we wouldn't usually expect in this class of inkjet. They weren't especially quick, either, with the TS8250 managing a pedestrian 3.6 pages per minute (ppm) on our graphics test, and 11.6ppm when printing text, although draft mode lifted this to 13.8ppm. Duplex colour graphics were slow by recent standards, with 10 sides printing on to five pages in four-and-a-half minutes: just 2.2 images per minute.

THE JOY OF SIX

Canon makes each of the TS8250's six ink tanks in three capacities: standard, XL and XXL. Stick with the best-value XXL size and print costs are still on the high side, with a page of mixed text and graphics coming in at 9.1p. Technically, black ink comprises a steep 3.1p of this total, although in practice the dye-based black ink is barely used on plain paper: the pigment black alone works out at 2.7p per page.

In most ways, the TS8250 performs very well. Scans are swift, and photo prints were also impressive.

THE VERDICT

The Pixma TS8250 is classy and fairly capable, so long as you can afford it.

Simon Handby
The wizards at Creative have done it again. The Sound BlasterX G6 is upon us and not only does it support your favorite PC titles, it also works with the PS4, Xbox One, and Nintendo Switch. W00t! Finally you can amp those headphones or speakers up with all the crystal-clear sound of the Sound Blaster platform at home or on the go. I’m especially stoked to use the G6 with my Switch and the sound processing and virtual surround make a “HUUUUUGE” difference.

- GameTyrant

SOUND BLASTER X

G6

HI-RES GAMING DAC & USB SOUND CARD WITH HEADPHONE BI-AMP

Immerse in true quality gaming and authentic, lossless audio with the Sound BlasterX G6. The external sound card boasts Xamp, our award-winning custom-designed discrete headphone amp, and is able to drive performance-grade sensitive 16Ω in-ear monitors all the way up to professional gaming headsets and studio-grade 600Ω headphones with an ultra-low 1Ω output impedance. The external sound card also houses a high-quality external DAC with hi-res playback of up to 32-bit/384kHz as well as playback of DSD64 & DSD128 format over PCM audio.

blasterX.com
THE UE BOOM 2 (Shopper 345) was an instant classic: this distinctively cylindrical Bluetooth speaker was built with IPX7 waterproofing, looked fantastic and sounded excellent, all of which set it apart from its competitors. It’s taken a few years (and a few spin off devices), but the Boom 3.

It’s even more stylish than the Boom 2. The knitted fabric mesh that wraps around the speaker has a much finer weave than before, and it has a natty two-tone colour that shifts under bright ambient light.

PARTY ANIMAL
At the front of the Boom 3 are two large, stylised plus and minus buttons to adjust the volume. Spin it around and you’ll see a small fabric loop that allows you to hang it up. There’s no metal D-Ring as there was on the UE Boom 2, but the speaker can be charged by popping it on the optional charging dock (sold separately for £35).

If you don’t want to spend extra, you can charge via Micro USB; there’s a port located under the rubber flap at the rear. It’s great to see that this has been moved from the underside (as the Boom 2’s Micro USB port was) to the side, as this allows you to charge the speaker while listening to it.

At the top of the UE Boom 3 are three buttons. There’s the power switch, plus a PartyUp button, which allows you to daisy-chain up to 150 UE Boom and Megaboom speakers together, including older models. Even if you don’t somehow own 150 Bluetooth speakers, as long as you have just two Boom 3 speakers, you can also run them as a stereo pair.

The third button is the Boom 3’s newly added Magic Button. In addition to play, pause and skip controls, this allows you to access up to four of your Apple Music or Deezer playlists, set via the UE app, with more supported services promised later this year.

As for its size, the Boom 3 is 184mm tall and has a diameter of 73mm. With a weight of just 608g, it’s pretty easy to carry around.

The Boom 3 connects via Bluetooth using the SBC codec. Another improvement over the Boom 2 is range: the Boom 3 can be placed 45m away from its Bluetooth source, up from 30m. Better still, you can connect the Boom 3 to eight different sources, two of which can be used simultaneously. The battery lasts a healthy 15 hours, and takes around two hours to charge to full from empty.

On a slightly more downbeat note, there’s no sign of the higher-quality aptX codec, and UE has also ditched the 3.5mm aux-in port in favour of a sleeker design.

LIQUID GOLD
Weather resistance has long been a staple of UE’s wireless speakers, and the Boom 3 is no different. It’s rated at IP67, which means it’s both dust- and water-resistant to a depth of up to a metre of water for up to 30 minutes.

There’s another new addition here, and that’s the Boom 3’s ability to float. This was a handy (if situational) feature on the Wonderboom (Shopper 367), and we’re glad to see it replicated on the Boom 3. It helps prevent water damage by keeping the speaker near the surface should it be accidentally knocked into a pool or lake.

As far as sound quality goes, the speaker has the same frequency range as before (90Hz to 20kHz) and a maximum volume level of 90dBa. Producing this audio are two 2in drivers and a pair of 4in passive radiators. Sonically, it’s identical to the Boom 2, so if you loved the fun sound signature of its predecessor, you’ll love the sound of the Boom 3, too.

Specifically, the Boom 3 has a pronounced mid-bass slam, which is both controlled and precise. It isn’t overpowering, so the speaker doesn’t sound like a bassy mess, but it doesn’t reach right down into the very lowest notes either. It’s noticeably worse in this department than the larger Megaboom, which is able to extend down to 60Hz.

The mids are slightly pushed back and recessed, too, but that’s not to say the Boom 3 sounds bad. In fact, it creates a somewhat warm sound profile, which is ideal for mainstream music.

The highs roll off at the top end, which creates a softish sound. There is a drawback, however: in some songs, the instrumentals aren’t as sharply detailed as they could be.

IN THE ROUND
As for the soundstage, the speaker has a 360° sound that’s big enough for small outdoor gatherings or a medium-sized living room. The speaker’s instrument separation is impressive, too. Altogether, it’s excellent for its size.

Save for the missing 3.5mm port, the Boom 3 is a comprehensive improvement on what came before. It’s better looking and more durable than the Boom 2, and also more portable than the UE Megaboom and the Megablast (Shopper 367).

There’s no smart speaker functionality, as you get with the Alexa-powered Megablast, but this is the only significant way in which the Boom 3 is inferior. If you’re not interested in smart speakers and want something that can float, the Boom 3 is a great choice.

Christopher Minasians
OWNING A WATERPROOF speaker has its advantages. Even if you’re not into watersports or regularly hitting the pool, a weather-resistant speaker is a lot more versatile than a regular plug-in speaker that sits next to your living room sofa.

The Xtreme 2 is JBL’s second attempt at a waterproof Bluetooth speaker, but it’s been built with confidence: not only is it IPX7-certified, which allows it to be submerged to a depth of one metre for 30 minutes, it also has two metal bars to hook on the bundled strap.

This is more useful than it sounds, as while the Xtreme 2 can be taken out and about, it’s no UE Boom 3 (opposite) – it weighs 2.4kg and measures 136x288x132mm, so the ability to add a strap is a very welcome one. The strap’s buckle also doubles up as a bottle opener, adding to the speaker’s party credentials.

BACK IN GREATER NUMBERS The Xtreme 2 is protected by a fabric mesh. There’s a large JBL logo at the front of the speaker, while at the top there are six physical buttons, two of which are illuminated – Power and Connect+. The Connect+ is an upgrade over the previous iteration; you’re now able to pair up to 100 JBL Connect+ enabled speakers, in the unlikely event that’s needed.

At the back, JBL has ditched the zip-like design of the first Xtreme. Instead, the rear ports are protected from water by a rubberised pop-out panel. Prise this aside and you’ll find a 3.5mm headphone jack, a DC coaxial output, a USB port capable of fast-charging your smartphone and a Micro USB port, the sole purpose of which is for servicing.

As for wireless connectivity, the speaker connects via Bluetooth with a maximum range of 20 metres. Battery life is good at around 15 hours’ playback time, although the Xtreme 2 takes around three-and-a-half hours to charge. Unfortunately, there’s no Wi-Fi connectivity, which means no Amazon Alexa or Google Assistant to answer your every call. That’s a slight shame when the UE Megablast (Shopper 367) comes with Alexa built-in.

It’s also worth mentioning that the Xtreme 2, like its predecessor and the Boombox (Shopper 369), doesn’t support the Bluetooth aptX codec, so you won’t get CD-quality playback via Bluetooth.

Still, JBL has a knack for fun-sounding speakers, which more often than not have punchy bass and a warm sound signature. The Xtreme 2 somewhat bucks that trend; it still has the healthy bass punch that you’d expect from a JBL speaker, but it also has a surprisingly good mid-range.

NEW AND IMPROVED The issue with the Xtreme and the Boombox is that both suffer from a heavily recessed mid-range, which means vocals often sound pushed back. The Xtreme 2, conversely, has much more forward-sounding mids. They’re still a tad pushed back, but nowhere near the amount we were expecting.

The Xtreme 2 shines in songs with strong vocals and a punchy bassline, which are often a harsh test of a speaker; case in point, the JBL Boombox struggles to reproduce engaging mids. That’s not the case for the Xtreme 2; it’s engaging and makes songs feel alive, yet preserves a colourful sound.

Bass tones are well represented, too. The Xtreme 2 has a strong, punchy mid-bass with plenty of control, and a sumptuous sub-bass extension, much more so than its predecessor. The healthy 15Hz bass extension is lower than the original Xtreme, and it can be felt.

The highs extend blissfully, and combined with a wide, 360° soundstage, the JBL Xtreme 2 is captivating. Vocals and instruments are clearly separated and layered, adding to the depth and detail of each track.

The Xtreme 2 also goes extremely loud without distorting or clipping. It will suffice for a garden party or a large living room, and due to its shape, can be used both horizontally or vertically – ideal if you’re cramped for space.

BOOM TUBE The Xtreme 2 may not have any smart features, but it’s an excellent weatherproof Bluetooth speaker, from the design to its sound quality. The only thing to give us pause is the price: at £235, it’s a lot more expensive than the UE Megablast, which is similarly durable and capable of pumping out high-volume tunes but has dropped in price from £270 to just £180. It has full smart speaker functionality, too, thanks to Alexa integration.

That said, the Xtreme 2 does sound better (and beefier) to our ears, so it does at least partly make up for that price difference. Both are great choices, so don’t be afraid to splash out on JBL’s speaker if you demand the absolute best audio quality.

Christopher Minasians

SPECIFICATIONS

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<tr>
<th>DRIVER</th>
<th>RMS POWER OUTPUT</th>
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CONNECTOR None WIRELESS Bluetooth DIMENSIONS

136x288x132mm WEIGHT 2.4kg WARRANTY One year

RTB DETAILS uk.jbl.com PART CODE JBLXTREME2BLKEU

VERDICT

With top-quality sound and a versatile design, this is a great – if expensive – rugged Bluetooth speaker.
VERDICT
LG has upgraded its 'entry-level' OLED TV, and the results are sensational.

HOLD ON TO your credit cards: the LG B8 is the new 'entry-level' OLED TV from the South Korean brand. With a starting price of £1,799 for the 55in model it's still by no means cheap, especially when the 65in model we were sent costs £2,299, but with the latest OLED technology on show, not to mention an upgraded image processor, this big-screen TV looks set to deliver a spectacle to remember.

Whereas LG's higher-ranking C8, E8, G8 and W8 series TVs feature the company's new top-end Alpha 9 processor, the OLED65B8 uses an Alpha 7 processor, which is essentially a modified version of last year's chipset.

This means the OLED65B8 doesn't feature LG's most advanced picture processing technologies, but it still manages to pack the latest WRGB OLED panel from LG Display, multi-HDR support for the open-standard HDR10, broadcast-friendly Hybrid Log-Gamma, Dolby Vision and Technicolor HDR formats.

FRONT OF THE Q
It's also equipped with LG's intuitive and responsive WebOS Smart TV platform (dubbed ThinQ AI), which now has Google Assistant and Amazon Alexa compatibility.

The design of the OLED65B8 is almost identical to 2017's C7 OLED, with a slim black bezel and a central sloped stand bearing an LG OLED inscription. The connections at the rear left include four HDMI inputs, all of which are full-bandwidth HDMI 2.0b ports with HDCP 2.2 compliance. You can therefore plug your Xbox One X, PS4 Pro, Apple TV 4K box or 4K Blu-ray player into any of these four HDMI connections, and enjoy 4K HDR content at a higher frame rate, chroma or bit depth without any issues.

The bundled grey Magic Remote works brilliantly. The mouse pointer function makes it supremely easy to navigate the WebOS front end, and switching between apps and sources is a joy, rather than the button-clicking chore it can be on rival TVs.

The improvements brought by the WRGB OLED panel are clear to see. Uniformity is generally better than last year's OLED panels, and when displaying brighter full-field grey slides, our OLED65B8 didn't exhibit any colour tinting, banding or dirty screen effect at all. In very dark scenes, no consumer OLED TV is completely free of thin vertical streaks, but the OLED65B8 is one of the cleanest we've seen in this regard.

We barely noticed any vertical banding in shadowy movie scenes, which often prove challenging for OLED-based TVs.

INDEPENDENTLY MINDED
As ever, OLED has more than its fair share of plus points. As every pixel can be turned on and off individually – the display technology is self-emissive – the OLED65B8 is capable of delivering the kind of true blacks, vibrant colours and wide viewing angles other TVs can only dream of. OLED's pixel-level light control also allows HDR content to sparkle with pop and depth, since bright highlights can coexist beside inky blacks without blooming artefacts.

A further benefit is that the panel can be calibrated to an extremely accurate level, allowing memory colours – colours that we instinctively know to be lifelike or otherwise, such as skin tones – to look stunningly realistic and natural.

Motion-wise, the LG OLED65B8 offers both frame interpolation and black frame insertion (BFI) to combat motion blur. However, we don't think many viewers will be able to tolerate the flicker that comes with the latter, which can become tiring in brighter scenes with the 50Hz broadcast content we get in the UK and Europe.

Avid video buffs will be disappointed to find that the OLED65B8 doesn't appear to have the decontouring filter available on LG OLEDs with an Alpha 9 processor, such as the C8, E8, G8 and W8 series. This is probably because the B8 series is only using an upgraded Alpha 7 chipset.

Peak brightness on the OLED65B8 measured 670cd/m² on a 10% window after calibration to D65 white point, and 135cd/m² on an all-white screen. DCI-P3 colour gamut coverage was a near-perfect 99%, as we've come to expect from WRGB OLED panels in recent years.

Input lag measured 21ms in both 1080p SDR and 4K HDR Game modes on the OLED65B8, making it one of the most responsive TVs for playing games. Because LG's 2017 OLEDs have been accused of being too dark for playing HDR games that are mastered to 10,000 nits, the firm has not only revised its 2018 tone-curve to look brighter at baseline, but has also made dynamic tone-mapping available in Game mode that can brighten 10,000-nit games even further.

PLAYING TO WIN
The OLED65B8 offers some welcome extra features over LG's 2017 OLED TVs, but in our opinion, the number one reason to buy the 2018 model over the 2017 one is for the increased brightness in HDR Game mode.

The result is that HDR games from your Xbox One X or PS4 Pro console will have never looked better on OLED – and the comprehensive HDR format support means that HDR movies and TV look fantastic, too.

The price is the real clincher, however. If you've been tempted by OLED's charms, then the LG OLED65B8 is the perfect meeting point between price, performance and big-screen HDR thrills.

Vincent Teoh

The panel can be calibrated to an extremely accurate level, allowing colours to look stunningly realistic and natural.

Will Schorer
Illustrator and graphic designer

Illustration: Baboon

“I’m blown away with Affinity Designer for iPad. Having the freedom to work from a sketch to a finished vectorised artwork all without any cables, in one app is a dream come true and a huge time saver.”

Affinity Designer for iPad

No subscription. Now available to purchase on the App Store.
THE MOST POWERFUL iPhone of Apple’s 2018 line-up, the iPhone XS Max is quite simply the best smartphone Apple has ever produced, yet it’s also one that few people, if any, should go out and buy.

We’ll explain the technical excellence of the XS Max – bigger brother to the standard iPhone XS – shortly, but frankly nothing outweighs the fact that it’s just too expensive.

Specs start at £1,099 for the 64GB model, and that rises to £1,249 and £1,449 for the 256GB and 512GB versions respectively.

In all three cases, it’s an outrageous amount to be charging even for a premium flagship, and the fact that Apple’s brand recognition will be enough to have people stumping up anyway is not an excuse.

FACE FRONT
It’s not as if this is a radical redesign of the now-outdated iPhone X (Shopper 361), either. The volume buttons, power button and do-not-disturb switch have all been left unmoved from their positions on the iPhone X, and there’s still no 3.5mm headphone jack.

At the rear, the phone’s slightly protruding dual-camera module perches in the top-left corner, with the quad-LED True Tone flash flanked by the twin lenses of the 12-megapixel camera. On the front, the screen fills most of the front panel, with a broad notch eating into the top of the screen. It’s a shame Apple couldn’t find a way around this rather inelegant solution, especially when other manufacturers are already making tentative steps forwards in this regard.

The lack of a fingerprint reader also leaves Face ID as the sole biometric sign-in method. It works, but again it’s something Apple hasn’t really improved over the past year: the fact that you have to lift the phone, stare at it, wait a second for recognition and then swipe up to get past the lock screen is a pain when other manufacturers are already making tentative steps forwards in this regard.

Fortunately, there are some improvements. One of the bigger ones is an upgrade from IP67 water- and dust-proofing to IP68, so the iPhone XS Max can be submerged in up to two metres of water for half an hour without damage – that’s twice as deep as the iPhone X. The new model also copes better with more troublesome liquids such as tea, coffee and soft drinks.

SOUND CHOICE
The speakers have also been upgraded, with noticeably more volume and a wider soundstage; nice for the odd occasion when you’ve forgotten your headphones or don’t have access to a Bluetooth speaker.

There’s also dual-SIM capability and a four-microphone array for positional stereo audio recording, both firsts for the iPhone.

The screen hasn’t changed much, but in Apple’s defence, the iPhone X’s OLED display was already outstanding. The screen in the iPhone XS Max measures 6.5in diagonally, with a resolution of 2,688x1,242 and a pixel density of 458ppi. It peaks at 628cd/m², far brighter than the 502cd/m² iPhone X, but this is the only significant improvement.

There’s still support for HDR10 and Dolby Vision, so movies and TV shows supporting those standards look spectacular. Colour reproduction is excellent, with superb colour accuracy and sRGB colour coverage at 92.6%.

In addition, you get Apple’s wonderful True Tone screen tech, which monitors the colour temperature of the ambient light and adjusts the screen’s white point to match, thus making it less of a chore for your eyes to readjust when you pull them away from the screen for a moment or two.

LUCKY NUMBER SEVEN
The biggest new addition by far is Apple’s hexa-core A12 Bionic processor. Until Huawei’s Kirin 980 appears in a consumer-ready handset, this is the very first smartphone chip that’s been built with a 7nm manufacturing process, allowing for more transistors to be squeezed into the same space as previous chips. Typically, this leads to both faster processing speeds and more efficient running.

The iPhone XS certainly lasts longer than the iPhone X: it called it quits in our battery test after 14h 18m, thrashing the iPhone X’s 9h 22m. However, it’s not quite up there with the best flagships, as the Samsung Galaxy...
Note 9 (Shopper 370), Huawei P20 Pro (Shopper 366) and OnePlus 6 (Shopper 367) managed 19h 35m, 14h 35m and 17h 18m respectively.

It’s straight horsepower where the A12 Bionic proves itself supreme. Not only does it make the phone feel instantaneously responsive in everyday use, it also set new records in our benchmarks: namely, 4,816 in the GeekBench 4 single-core test and a huge 11,480 in the multicore test. By comparison, the iPhone X scored 4,254 and 10,390, while the most powerful Android phone – the Galaxy Note 9 – reached 3,728 and 9,089.

The A12 Bionic is also fantastic for gaming, pushing the iPhone XS Max to 59fps in GFX Bench’s Manhattan 3 onscreen test and 11fps in the offline test. Again, no other phone outpaces it. Perhaps if Apple wanted to justify the price, it should have included a 120Hz display rather than a 60Hz display, so games aren’t effectively limited to 60fps; as it happens, the touchscreen input system does run at 120Hz, but that doesn’t extend to how often the onscreen pixels are refreshed.

**HOT SHOT**

Apple has also upped its game with the iPhone XS Max’s cameras. Of the two rear sensors, the ‘main’ one now has larger pixels (up from 1.22um to 1.4um on the iPhone X), which enhances its abilities in low and poor light, with the software having to work less hard to produce cleaner, sharper images and video.

All of this translates into a clear quality boost in everyday use. Still looks sharper, with less noise and more contrast, and more details are captured than the iPhone X. Colours appear more natural, too, and stabilised 4K video footage looked better than anything we’d recorded on a smartphone camera.

As a stills camera, however, there are still slightly better alternatives: the P20 Pro is even better at capturing fine details, thanks to its 60-megapixel sensor, and the Google Pixel 2 and Pixel 2 XL (Shopper 359) are both superior for selfies. Even with the improved bokeh settings on the iPhone XS Max, it’s not perfect; the edges of faces and hair are spoilt by background objects poking through.

**Mystery of Disguise**

The latest round of iPhones don’t just bring hardware improvements. There are also a load of new software features on the iPhone XS Max, courtesy of the iOS 12 update.

One of the most useful is that the face-unlock feature can now recognise multiple faces. This is very useful, though not so much for allowing other people to unlock your phone: rather, it’s handy when your primary facial profile might not otherwise work, because you’re wearing sunglasses or headwear, for instance. Now, you can save multiple versions of your own face, improving the chances of a successful unlock.

There’s also the controversial Screen Time. Its main focus is recording how much time you spend using the phone, something that will likely worry the privacy-conscious, although it does have some useful tools, such as the ability to set time limits for apps and have those apps apply content warnings – parental controls by another name.

Another new feature is Shortcuts, which lets you tap into third-party apps and create macro-style shortcuts, like IFTTT. You need to download the Shortcuts app to get this to work, but once downloaded you’ll be able to combine elements from apps such as Photos and the sharing menu and other apps, and perform programmable actions with them. The resulting macros can then be assigned to desktop shortcuts or Siri-based voice phrases.

The interface for creating your own shortcuts from scratch is quite daunting, however, and a lot to get your head around, so there’s a gallery of examples to choose from to help you get started. Useful tools include one for AirDropping your most recent screenshot, searching for a link on Twitter or asking where a photo has been captured.

**Maxed Feelings**

That’s the iPhone XS Max, then: a premium smartphone with good software and truly excellent hardware. As we said, however, even the fastest handset in the world doesn’t convince us that it’s worth £1,099, and that’s at the very least.

Not only are the iPhone XS and the upcoming iPhone XR much cheaper, it’s not as if the closest Android equivalents – which will also put much smaller, if still relatively large, dents in your wallet – are poor by comparison. The Galaxy Note 9 still feels mighty powerful even after using the iPhone XS Max, and the P20 Pro keeps its claim to be the best smartphone camera. This may be Apple’s finest work, but it still doesn’t justify the mammoth price.

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Jonathan Bray

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**SPECIFICATIONS**

- Processor: Hexa-core Apple A12 Bionic
- Screen: 6.5”
- Resolution: 2,688x1,242
- Rear cameras: 12 megapixels/12 megapixels
- Storage: 64GB
- Wireless data: 4G
- Dimensions: 158x77x7.7mm
- Weight: 208g
- Operating system: Apple iOS 12
- Warranty: One year RTB
- Part code: iPhone XS Max

Battery life: 14h 18m
**Android 9.0 Smartphone**

**SONY Xperia XZ3**

£699 • From www.amazon.co.uk

**VERDICT**

Sony's first OLED-equipped smartphone is a success, but it still has a tough time standing out.

**SMARTPHONE INNOVATION IS a mixed bag.** For every attractive full-body display and triple camera arrangement, there's some gimmick such as side-squeezing controls or naff 3D face-scanning.

For its latest flagship, Sony hasn't exactly gone where no smartphone has gone before, but its big new feature is exciting nonetheless: a 6in OLED screen, with technology borrowed from the firm's Bravia line of TVs.

This is framed by minuscule notch-free chin and forehead bezels, above and below the screen. The panel wraps around the sides of the device ever so slightly, too, just like the Samsung Galaxy S9 (Shopper 364).

**OLED BY EXAMPLE**

Sony has also borrowed a feature originally included on Samsung's phones. Side Sense lets you double-tap anywhere along the length of either side of the screen, which launches a sub-menu for easy access to your most-used applications. AI learning plays a big part, too, with the phone adjusting the displayed apps depending on your location and the time of day. Essentially, the Xperia XZ3 will make sure the apps you want are always at your beck and call; a clever use of the extra screen space.

The panel itself is seriously good, too. In standard mode, we measured contrast at a perfect Infinity:1, while sRGB gamut coverage hit 99%. Switching to Super Vivid mode in the display settings pushed this to 100%, while keeping the same contrast level and boosting brightness from 334.9cd/m² to 336.8cd/m². The large size and resolution of 2,960x1,440 also make it a pleasure for watching videos, while text is kept crisp and sharp.

There is an issue, however, which is most noticeable when white text is displayed on a black background. There's clear evidence of colour fringing, with hints of purples or blues in the outlines of text. While this issue is common with OLED-equipped smartphones – the OnePlus 6 (Shopper 367) suffers from it to a lesser degree – it is much more noticeable here than with any other we've tested thus far. It's a minor niggle rather than a dealbreaker, but it's a shame when Sony gets so close to screen perfection.

Another letdown is the removal of the 3.5mm headphone jack, although the Xperia XZ3 goes a long way to make up for it. Not only has Sony done a much better job at making this phone look good, compared to the boxy Xperia XZ2 and other previous Xperia devices, but it comes with full IP68 protection against water and dust.

**FAMILIAR AFFAIR**

Processing power comes from the octa-core Qualcomm Snapdragon 845, a staple of high-end smartphones in 2018. It's paired with 4GB of RAM and 64GB of onboard storage, which can be expanded up to 400GB via microSD.

As you imagine, it performs about as well as any other Snapdragon 845 device out there, scoring 2,400 in the Geekbench 4 single-core test and 8,950 in the multicore test. This also puts it behind the Exynos 9810-powered Galaxy S9 on single-core performance, though it seems to slip ahead on multicore muscle, with Samsung's handset scoring 8,804 in this portion of the test.

GPU performance is also appropriately high, with the Xperia XZ3 scoring 45fps in the GFXBench Manhattan 3 onscreen test and 76fps in the offscreen test. The former might seem a big step backwards from the Xperia XZ2, which produced 59fps, but that can be explained by the newer phone's much higher-resolution display.

Unfortunately, the screen also means battery life takes a hit. Whereas the XZ2 kept going for 20h 5m in our video playback test, the XZ3 ran out of juice after 13h 3m. That's still not bad, although the Galaxy S9 and particularly the OnePlus 6 is just as good, if not better, and costs up to £230 less – do the maths.

**SPECIFICATIONS**

- Processor: Octa-core 2.7GHz Qualcomm Snapdragon 845
- Screen size: 6in
- Screen resolution: 2,960x1,440
- Rear camera: 19 megapixel (f/2.0)
- Storage: 64GB
- Wireless data: 4G
- Dimensions: 158.5x73.1x10mm
- Weight: 193g
- Operating system: Android 9.0
- Warranty: One year RTB
- Part code: 136-6797

**Battery life:** 13h 3m

You can also record footage at 4K resolution with HDR enabled, just like on the XZ2, and the XZ3 can capture super-slow motion Full HD video at 960fps. Videos look crisp with loads of detail and, although 4K HDR footage is capped at 30fps, we didn't notice any frame rate judder issues.

**UNDERCUTTING RETORT**

The Xperia XZ3 is a welcome return to form for Sony. Following an abundance of middling smartphone launches, the XZ3 gets everything right where it counts: top-tier performance, high screen quality and a wish redesign.

Why, then, is it only getting four stars and no award? It's because £699 is a lot to ask for a phone which, as good as it is, doesn't significantly outperform any of its rivals (including cheaper alternatives) in any particular department. The OnePlus 6 is just as good, if not better, and costs up to £230 less – do the maths.

Nathan Spendelow

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**VERDICT**

Sony's latest flagship is exciting nonetheless: a 6in OLED screen, with technology borrowed from the firm's Bravia line of TVs. However, the screen also means battery life takes a hit. Additionally, the removal of the 3.5mm headphone jack is a letdown, although the Xperia XZ3 goes a long way to make up for it. Not only has Sony done a much better job at making this phone look good, compared to the boxy Xperia XZ2 and other previous Xperia devices, but it comes with full IP68 protection against water and dust. Processing power comes from the octa-core Qualcomm Snapdragon 845, a staple of high-end smartphones in 2018. It's paired with 4GB of RAM and 64GB of onboard storage, which can be expanded up to 400GB via microSD. As you imagine, it performs about as well as any other Snapdragon 845 device out there, scoring 2,400 in the Geekbench 4 single-core test and 8,950 in the multicore test. This also puts it behind the Exynos 9810-powered Galaxy S9 on single-core performance, though it seems to slip ahead on multicore muscle, with Samsung's handset scoring 8,804 in this portion of the test. GPU performance is also appropriately high, with the Xperia XZ3 scoring 45fps in the GFXBench Manhattan 3 onscreen test and 76fps in the offscreen test. The former might seem a big step backwards from the Xperia XZ2, which produced 59fps, but that can be explained by the newer phone's much higher-resolution display. Unfortunately, the screen also means battery life takes a hit. Whereas the XZ2 kept going for 20h 5m in our video playback test, the XZ3 ran out of juice after 13h 3m. That's still not bad, although the Galaxy S9 and particularly the OnePlus 6 is just as good, if not better, and costs up to £230 less – do the maths.

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You can also record footage at 4K resolution with HDR enabled, just like on the XZ2, and the XZ3 can capture super-slow motion Full HD video at 960fps. Videos look crisp with loads of detail and, although 4K HDR footage is capped at 30fps, we didn't notice any frame rate judder issues.

**UNDERCUTTING RETORT**

The Xperia XZ3 is a welcome return to form for Sony. Following an abundance of middling smartphone launches, the XZ3 gets everything right where it counts: top-tier performance, high screen quality and a wish redesign. Why, then, is it only getting four stars and no award? It's because £699 is a lot to ask for a phone which, as good as it is, doesn't significantly outperform any of its rivals (including cheaper alternatives) in any particular department. The OnePlus 6 is just as good, if not better, and costs up to £230 less – do the maths.

Nathan Spendelow
RAISING THE BAR(S)

COSMOS C700M

With Addressable RGB Lighting, Aluminum Panels, a Riser Cable, and Curved Tempered Glass

The COSMOS series is known for pushing the limits of Cooler Master’s case technology. The freedom in layout organization and the support for unique graphics card mounting make custom building accessible as soon as the COSMOS C700M is unboxed.
MOTOROLA Moto E5 Play

£89 • From www.amazon.co.uk

VERDICT
The Moto E5 Play has its flaws, but a low price and capable camera save it from the bin

MERCIFULLY, THERE ARE still smartphones aiming to be budget champions, even in this age of £1,000-plus handsets. Motorola’s Moto E5 Play, which launches at under £100, is one such smartphone.

There’s not much disguising its cheapness: the plain, all-plastic design quickly gives it away. Still, it feels sufficiently robust, and the removable plastic rear cover allows you to easily replace the 2,100mAh battery, access the microSD card slot (cards up to 128GB are supported) or swap out the nano SIM.

There’s a fast-charging Micro USB port on the bottom, and a 3.5mm headphone jack up top. The phone’s speaker sits above the display, which means you get forward-facing sound. It’s not especially loud, however, and it doesn’t sound particularly refined.

PIXEL PAUCITY
A fingerprint reader sits on the back – always nice to see on a budget phone – and it works remarkably well, too. There’s no IP-rated waterproofing, but the Moto E5 Play has been treated with a water-resistant coating, so it will survive the occasional splash. It also lacks NFC, unlike the similarly priced Vodafone Smart N9 – or, at the very least, a more practical one.

Outdoors, this is easily the best smartphone camera we’ve used at under £100

Smart N9 (Shopper 369).

The Smart N9 also has a higher-resolution 1440x720 screen, which makes the Moto E5 Play’s 5.3in, 960x480 display look even worse. Besides this low resolution, there’s also noticeable colour shift when the screen is tilted, so viewing angles are fairly narrow.

We only measured sRGB gamut coverage at 67.9%, and the 619:1 contrast ratio is equally unimpressive. Its peak brightness of 340cd/m², furthermore, is high enough for clear legibility under normal ambient light, but out in direct sunlight you’ll struggle to read the display.

Performance-wise, the Moto E5 Play scores extremely closely with other phones in its price range, including the Smart N9. It scored 590 in Geekbench 4’s single-core test, along with 1482 in the multicore test. However, it’s slower in practice, for one reason: it has only 1GB of RAM. The Smart N9, which has 2GB, is noticeably more fluid, especially when you’re switching between apps.

Despite its name, the Moto E5 Play isn’t cut out for games, either. You can run very basic apps such as Candy Crush or Temple Run, but decent-quality 3D games are out of the question, and it scored only 3fps in the GFXBench Manhattan 3 screen test.

That’s 1fps higher than the Smart N9, to be fair, although its seemingly high onscreen test result of 11fps is mainly down to the rock-bottom display resolution.

At least battery life is decent. The Moto E5 Play lasted 10h 9m in our video rundown test, outperforming the Smart N9 by nearly an hour. You can expect to eke out a full day from a complete charge, provided you stick to low or medium use.

As for software, the E5 Play comes with a largely clean install of Android 8.1 Oreo. It’s great to see Motorola sticking to a near stock experience – it’s how Android was designed to be. Of course, should you want to customise the launcher or download some funky widgets, you can always head over to the Google Play Store.

VICTORY SNAP
Our first impressions of the Moto E5 Play’s rear camera were misleading, because we were looking at them on the phone’s awful display. Once transferred to a PC, however, we were given a very pleasant surprise: despite it being a single-lens, 8-megapixel f/2.0 camera, it captures plenty of light and detail.

Even in overcast weather (which means less natural light), the Moto E5 Play picks out fine details that many of its competitors would reduce to a smeary mess. It also captures lifelike colours and doesn’t oversaturate the image, either.

Enabling HDR makes things even better: outlines become sharper, greys look less washed out and there’s even more detail on stationary objects. Outdoors, this is easily the best smartphone camera we’ve used at under £100.

In low light, it’s not quite so good; Vodafone’s camera in particular is better at keeping image noise low and colour accuracy high. With flash enabled, the Moto E5 Play suppresses noise better, but there’s still a relative shortage of colour accuracy.

The E5 Play is capable of shooting 1080p video at up to 30fps, the same as the Smart N9. Video quality is good, and the sensor captures plenty of light and detail. However, with no electronic image stabilisation (EIS), videos appear a little jittery, especially if you’re walking around while filming.

NEITHER HERE AUSTERE
While we wouldn’t go so far as actively recommending the Moto E5 Play – it’s too slow and has too poor a display, even for £100 – it’s not nearly as bad as it initially seems. The fingerprint reader is fast, the battery is both reasonably long-lasting and easily replaceable, and the camera performs very well indeed, provided you’ve got the right lighting. We’d even go as far as to say that it’s a better budget smartphone than the Smart N9 – or, at the very least, a more practical one.

Christopher Minasians

SPECIFICATIONS

| Processor | Quad-core 1.4GHz Snapdragon 425 |
| Screen size | 5.3in |
| Screen resolution | 960x480 |
| Rear camera | 8 megapixels |
| Storage | 16GB |
| Wireless data | 4G |
| Dimensions | 144x71x9.2mm |
| Weight | 150g |
| Operating system | Android 8.1 |
| Warranty | One year RTB + details on page 300 or 300GB |
| Part code | PACV04003GB |

Battery life: 10h 9m

See page 70 for performance details
Easy to learn, easy to master.

The new generation provides the perfect case for silence enthusiasts and those who want to master their PC build in the most convenient way. Silent Base case series makes it unbelievably easy to set up your new system, almost like a puzzle with just four pieces. Well-elaborated features like noise dampening vents, 10mm thick insulation mats and the convenient PSU shroud support the fast and simple installation of your whisper-quiet PC build.

**SILENT BASE 801**
- Three pre-installed Pure Wings 2 140mm fans
- Fan controller for up to six fans with PWM hub option
- Support of water cooling radiators up to 420mm length
- Offers space for eleven SSDs or five HDDs out of the box
- Invertible motherboard layout

**SILENT BASE 601**
- Two pre-installed Pure Wings 2 140mm fans
- Fan controller for up to three fans
- Support of water cooling radiators up to 360mm length
- Offers space for six SSDs or three HDDs out of the box

For more information visit bequiet.com

Available at: scan.co.uk · overclockers.co.uk · ebuyer.com · novatech.co.uk
aria.co.uk · cclonline.com · amazon.co.uk
**THE LATEST VERSION** of macOS is named after an arid desert, but the Mojave update is far from barren: it brings a decent set of new features that most Mac users will appreciate.

10.14 Mojave, to give it its full name, is a free download from the macOS App Store for anyone running a fairly recent Mac. You can install it on any mid-2012 or newer MacBook Air or Pro; any late 2012 or newer Mac mini or iMac; any 12in MacBook; or the recently released iMac Pro. It’s also available for the cylindrical 2013 Mac Pro, plus 2010 and 2012 tower models with AMD graphics.

**THE FUTURE IS THEN**

Although there have been rumours about Apple ending support for 32-bit apps, any application that works on macOS High Sierra will continue to run in Mojave. You’ll just get a warning message when opening 32-bit apps, advising you the program is “not optimised for your Mac”. Apple does plan to eventually ditch support for 32-bit apps, but this will be in the next release of macOS, which will probably come along in late 2019, so any developers who haven’t already made their code 64-bit native have a year to sort things out.

It may say something about Apple’s image that the Mojave feature that’s attracted the most attention is a purely aesthetic one. The new Dark Mode option is a simple toggle that switches the macOS interface into a tasteful black and grey palette.

That might sound like a gimmick, but it changes the feel of the interface to a surprising extent, much more so than the dark menu bar and dock option that was introduced in OS X 10.10 Yosemite. When you’re editing an image or assembling a video, the dark furniture seems to lend your work extra vibrancy and focus.

Blearily-eyed writers and editors who spend their days staring at the display, meanwhile, may prefer the new Dynamic Desktop feature, which automatically changes the tone of the interface – and the desktop wallpaper – according to the time of day. Your Mac looks bright and lively in the sunshine and subdued in the evening, with even the wallpaper gradually changing from a daytime scene to night.

There’s one disappointing shortcoming: it only works with two pre-rolled desktop themes, namely a rather bland desert dune and a simple sky-coloured gradient. Hopefully, it won’t be long before we get a wider range of options, or perhaps even support for user-created backdrops.

**STACKS OF FUN**

Even better than Dark Mode is the new Desktop Stacks feature. It’s a simple concept: when you turn it on, all files of the same type that you’ve saved to your desktop are collapsed into a single stack icon. In our case, this allowed us to instantly reduce 30-plus desktop icons to four, named Documents, Images, Music and Other. Clicking on a stack temporarily shows its contents on the desktop; another click instantly collapses them again. Alternatively, you can use a two-fingered swipe to scan through the files in a stack, causing each one, in turn, to appear in place of the stack icon, although this gets tedious and fiddly with stacks of more than a few files.

Our one complaint with stacks is that the automatic grouping is a bit of a blunt instrument. The Documents stack contains text files as well as Word documents, while InDesign files get lumped into Other, with no way to put them in Documents. If you prefer, you can group files by the date they were created, modified or opened, or by their tags, making it a breeze to create multiple stacks containing files relating to different projects. We just wish it worked in all Finder windows, rather than being limited to the desktop.

**QUICK FIX**

The Mojave Finder looks almost identical to High Sierra’s, but look carefully and you’ll notice Cover Flow has been replaced by a new Gallery view icon. Click this and the window switches to a filmstrip-type view, for browsing images and other documents. At first glance, it must be said, it looks similar to Cover Flow. Gallery view has two key advantages, however: first, a metadata pane at the right of the window exposes all sorts of information about the selected file, including EXIF data for photos. Second, at the bottom of this pane are icons for Rotate Left and Markup. These are Mojave’s new Quick Actions, which let you fix the orientation of an image, and annotate and crop it without having to open the Preview app. Click More… and you’ll also get the option to convert files to PDF, or to add more custom actions, which might be installed by third-party apps or created yourself using the macOS Automator tool.

That’s just as well, because while the default three Quick Actions are welcome, they feel like just a taster of the potential on hand. In time, we’re hoping to see Quick Actions for tasks such as converting file formats, sharing items and batch renaming.

Finally, the Mac’s screenshot function gets a big upgrade in Mojave. The old Shift-Command-3 and Shift-Command-4 shortcuts still work, but the new Shift-Command-5 shortcut practically makes them obsolete. This key combination opens a
While there are no plans to merge the desktop and mobile operating systems into a single platform, Apple is working on frameworks that will make it easier to develop apps across both. As if to show how this might work, Mojave imports some new apps from iOS. Apple News, Stocks and Voice Memos all seem rather unnecessary, but thankfully they’re joined by Apple Home, a long overdue addition. It’s not completely equivalent to the iPhone app: most notably, setting up new HomeKit devices still has to be done on iOS. But you can at last control your lights, thermostat and other smart home devices from your laptop. It works with Siri too, so next time you want to turn on the bedroom lights or open the pod bay doors, you can simply bark the command at your screen without having to lift your fingers from the keyboard.

Group FaceTime is also being ported across from iOS, allowing you to conduct video chats with up to 31 of your closest friends, although this is not in the initial Mojave release.

**AUTUMN CLEANING**

As well as these major updates, the new OS brings a few lesser tweaks and upgrades. iMac owners will be glad to learn that Mojave brings an updated version of APFS that works with Fusion Drives, and for those coming from Windows, the macOS migration utility has been souped up with the ability to import information from third-party Windows apps such as Microsoft Outlook.

Safari, meanwhile, now supports favicons – those little square graphics next to tab titles that don’t immediately appeal but are still very much worth having. A new security feature (borrowed from iOS) requires you to grant explicit authorisation before any app is permitted to operate your Mac’s camera or microphone, or to access personal information such as your location and data from your messages or emails.

Apple has also focused on making it harder for websites to track your online activity. The Mojave version of Safari provides only limited, generic information about you and your computer to remote servers, to prevent sites from ‘fingerprinting’ individual users and aggregating information across multiple services.

Finally, to protect you from yourself, Safari’s password manager can now automatically generate and store strong passwords for you, and warn you when you’re using the same password across multiple sites.

**FAMILY BONDING**

Apple likes to give iPhone users reasons to use a Mac, and vice versa. The new Continuity Camera feature is a neat idea along those lines, allowing you to use your iPhone or iPad’s camera as if it were directly connected to your Mac. Thus you can take a snap and immediately insert it in a Pages document or an email you’re composing. You can also use your iOS device to scan text by simply selecting the Scan Document menu option in Pages. The catch is application support: it remains to be seen whether this capability will make it into non-Apple applications such as Microsoft Word or Adobe Photoshop.

And if you were hoping for Mojave itself to be more similar to iOS, there’s good and bad news. While there are no plans to merge the desktop and mobile operating systems into a single platform, Apple is working on frameworks that will make it easier to develop apps across both.

As if to show how this might work, Mojave imports some new apps from iOS. Apple News, Stocks and Voice Memos all seem rather unnecessary, but thankfully they’re joined by Apple Home, a long overdue addition. It’s not completely equivalent to the iPhone app: most notably, setting up new HomeKit devices still has to be done on iOS. But you can at last control your lights, thermostat and other smart home devices from your laptop. It works with Siri too, so next time you want to turn on the bedroom lights or open the pod bay doors, you can simply bark the command at your screen without having to lift your fingers from the keyboard.

Group FaceTime is also being ported across from iOS, allowing you to conduct video chats with up to 31 of your closest friends, although this is not in the initial Mojave release.
Choosing a... **PC system**

01 A basic PC costing around £350 will be able to run everyday office, multimedia and education software and will easily cope with surfing the internet. It might even be able to run some modern games. Many PCs can be sold either with or without a monitor. If you don’t like the display the manufacturer is offering, you can always use your current one, or buy another one separately.

02 If you want to play games, you’ll have to upgrade the graphics card. Budget cards such as the Nvidia GeForce GTX 1050 will cope well with many 3D games, but to play the latest 3D games smoothly (and enjoy the best-quality graphics) it’s worth upgrading to a more powerful card such as the Nvidia GeForce GTX 1070.

03 All modern PCs come with at least a dual-core processor and are capable of most tasks. Anyone who regularly undertakes demanding tasks such as video editing and encoding should consider a hexa-core or even an octa-core processor.

04 There are plenty of good reasons to upgrade the PC’s memory or hard disk. If you’ll use your PC for gaming, video editing or other demanding tasks, you’ll need at least 8GB of RAM and a large hard disk; 1TB should suffice. Many new PCs have an SSD, which speeds up the time it takes for your PC to boot and for programs to load.

05 Having plenty of USB ports is always useful, as most computer peripherals attach to these ports. Most new PCs come with USB3 or the latest USB3.1 ports, which provide faster data transfers when used with supported devices than the older USB2 standard.

06 Most new PCs now come with Windows 10 pre-installed. Don't be too easily swayed by the inclusion of other software, though, as it may be that you’ll never use it.

07 While most PCs come in cases of a similar size, some have more compact mini tower or mini PC cases. These smaller PCs will fit under your TV or on your desk more easily, but bear in mind that they’re significantly harder to upgrade than full-size machines.

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### PCs

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<th><strong>RASPBERRY PI</strong></th>
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**The ultimate micro PC gets even better with faster CPU clock speeds and dramatically improved Wi-Fi performance. The differences between this and the standard Pi Model 3 probably won’t be enough to be worth a direct upgrade, but since this is no more expensive, it’s the best choice for new projects.**

**PROCESSOR**: Quad-core 1.4GHz Broadcom BCM2837 • RAM: 1GB • USB PORTS: 1x Micro USB (power), 4x USB2 • TOTAL STORAGE: MicroSD card slot • DISPLAY: None • OPERATING SYSTEM: Raspbian • WARRANTY: One year RTB • DETAILS: www.raspberrypi.org • PART CODE: Pi 3 Model B+ • FULL REVIEW: Jun 2018

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<th><strong>CHILLBLAST</strong> Fusion Ryzen 2700X Custom</th>
<th><strong>PALICOMP</strong> i5 Cosmos</th>
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<td>£1,500   • <a href="http://www.chillblast.com">www.chillblast.com</a></td>
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**With AMD’s most powerful octa-core chip and a dedicated GPU for easier video work, the Fusion Ryzen 2700X Custom is a highly adept media-editing PC even if it doesn’t have the RAM or CPU core count of a top-end workstation. The case is sound-damped as well.**

**PROCESSOR**: Octa-core 3.7GHz AMD Ryzen 7 2700X • RAM: 16GB • FRONT USB PORTS: 2x USB2, 2x USB3 • REAR USB PORTS: 2x USB2, 2x USB3, 2x USB3.1, 1x USB Type-C • TOTAL STORAGE: 256GB SSD, 4TB hard disk • GRAPHICS CARD: 16GB Gigabyte GeForce GTX 1070/Windforce OC 3G • OPERATING SYSTEM: Windows 10 Home • WARRANTY: Two years collect and return, five years Labour • DETAILS: www.chillblast.com • PART CODE: Fusion Ryzen 2700X Custom Video/Photo Editing PC • FULL REVIEW: Nov 2018

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**PROCESSOR**: Quad-core 3.7GHz Intel Core i5-8600K • RAM: 8GB • FRONT USB PORTS: 2x USB3 • REAR USB PORTS: 2x USB2, 4x USB3 • TOTAL STORAGE: 256GB SSD, 2TB hard disk • GRAPHICS CARD: 8GB EVGA GeForce GTX 1070 SC Gaming OC 3.0 • OPERATING SYSTEM: Windows 10 Home • WARRANTY: Three years RTB • DETAILS: palicomp.co.uk • PART CODE: CP3F • FULL REVIEW: Aug 2018
Choosing a… Laptop

01 A basic laptop costing around £300 will run everyday office, multimedia and education software, but it won’t be suitable for 3D gaming or processor-intensive tasks such as video editing. Many laptops at this price have a 15.6in screen and weigh over 2kg, so they’re best used around the house and for occasional journeys.

02 If you want to play modern games, you’ll need a laptop with a dedicated graphics chip such as the Nvidia GeForce GTX 1060M. Good gaming laptops tend to have large 15.6 or 17in screens and weigh around 3kg, so they’re best suited to use at home.

03 If you want a laptop that you can take everywhere, look for a model that weighs less than 2kg. For the best portability, buy one that has a 13.3in or 14in screen. In general, the smaller and lighter the laptop, the more expensive it is, especially if it has plenty of processing power.

04 Battery life is extremely important for a laptop, particularly if you’re carrying it around. We’d expect all but the biggest and heaviest to last for at least five hours on a single charge, but for an ultraportable that you carry everywhere, eight hours and above is more desirable.

05 Laptops use mobile versions of processors to conserve power, and these lag behind desktop chips when it comes to performance. For a budget Windows laptop, an Intel Core i3 processor will do the job, but if you want better performance, you should look for an Intel Core i5 or Core i7 model instead. We recommend a minimum of 4GB of RAM, although 8GB is better for multitasking.

06 Most budget and mid-range laptops use a mechanical hard disk for storage. You’ll want at least 500GB, but 1TB or more is better. Solid-state drives (SSDs) have faster performance, making your computer quicker to boot and more responsive. They have lower capacities, though. You’ll need at least 128GB.

07 Convertibles and 2-in-1 laptops can change from laptop mode to tablet mode. We’ve listed our favourite models later on in this guide in the Tablets section.

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**APPLE** MacBook Pro 13in (2018)

£3,599 • www.apple.com/uk

Just like its bigger 15in brother, the latest MacBook Pro is as expensive as it is powerful, but powerful it most certainly is. This is an incredibly potent laptop, with an excellent display and blazingly fast storage, all within a thin and attractive chassis.

**PROCESSOR** Quad-core 2.7GHz Intel Core i7-8559U • RAM 16GB • DIMENSIONS 304x212x14.9mm
**WEIGHT** 2.3kg • SCREEN SIZE 13.3in • SCREEN RESOLUTION 2560x1600 • GRAPHICS Adaptive Intel Iris Plus 655 • TOTAL STORAGE 1TB SSD • OPERATING SYSTEM macOS 10.14 • WARRANTY One year RTB • DETAILS www.apple.com/buy • PART CODE MacBook Pro 13in

**FULL REVIEW**

Dec 2018

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**ACER** Aspire 5

£630 • www.amzn.to/2M5Slqc

The Aspire 5 is the epitome of the sensible mid-range laptop. It’s not ultra-stylish and it doesn’t have a professional-quality display, but for the price it offers reliable performance in a variety of workloads, and it will last a full day on battery power without much trouble.

**PROCESSOR** Quad-core 1.6GHz Intel Core i5-8250U • RAM 8GB • DIMENSIONS 382x263x21mm • WEIGHT 2.2kg • SCREEN SIZE 15.6in • SCREEN RESOLUTION 1920x1080 • TOTAL STORAGE 256GB SSD • OPERATING SYSTEM Windows 10 Home • WARRANTY One year RTB • DETAILS www.acer.com • PART CODE AS15-51-50YS • FULL REVIEW Oct 2018

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**ASUS** ROG Zephyrus

£2,749 • www.box.co.uk

Tumbling prices mean the Core i7-7700HQ version of this slimline gaming laptop is, despite costing well over £2,000, a bit of a bargain; notebooks with Nvidia’s GTX 1080 graphics card inside are usually even more expensive. The ROG Zephyrus is a lot more portable than most gaming laptops, too.

**PROCESSOR** Quad-core 2.8GHz Intel Core i7-7700HQ • RAM 16GB • DIMENSIONS 379x275x17.9mm • WEIGHT 3kg • SCREEN SIZE 15.6in • SCREEN RESOLUTION 1920x1080 • GRAPHICS ADAPTOR Nvidia GeForce GTX 1080 • TOTAL STORAGE 512GB SSD • OPERATING SYSTEM Windows 10 Home • WARRANTY One year RTB • DETAILS www.asus.com • PART CODE ROG G501 • FULL REVIEW Oct 2018

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**DELL** XPS 15 2-in-1

£1,699 • www.dell.com/uk

This is everything that’s great about the XPS series – the massive power, the lengthy battery life, the sleek design – given even more flexibility with a fully rotatable hinge and touchscreen. That’s not the only improvement, either: this is the first XPS laptop with Dell’s ‘maglev’ keyboard design, which gives the keys a lovely pseudo-mechanical feel.

**PROCESSOR** Quad-core 2.8GHz Intel Core i7-8350U • RAM 8GB • DIMENSIONS 364x235x16mm • WEIGHT 3kg • SCREEN SIZE 15.6in • SCREEN RESOLUTION 1920x1080 • GRAPHICS ADAPTOR Radeon RX Vega M GL Graphics • TOTAL STORAGE 256GB SSD • OPERATING SYSTEM Windows 10 Home • WARRANTY One year on site • DETAILS www.dell.co.uk • PART CODE XPS15 9570 • FULL REVIEW Oct 2018
Choosing a... Smartphone

01 A smartphone’s operating system (OS) dictates its basic features and which third-party software you can install. There are three main contenders: Apple’s iOS, which is found on the iPhone, Google’s Android, which is used by various handset manufacturers, and Windows Phone, which has few options, especially since Microsoft has discontinued support for its OS. Apple iOS and Google Android both have thousands of apps available.

02 All smartphones have colour screens, but their resolutions vary. Basic models have 1,280x720 pixels, but text can be indistinct. Look for a display that has at least 1,920x1,080 pixels so it’s easier to read text and watch Full HD videos. Don’t worry too much about built-in media players or Office document editors; you can always install apps to replace these with better versions later.

03 Very few modern smartphones have a physical keyboard for entering text; they almost exclusively use touchscreens now. Physical keyboards can aid heavy emailing, but today’s touchscreen keyboards work just as well. Android smartphones and iPhones running iOS 9 or above allow you to install a variety of custom onscreen keyboards so you can find one that suits you.

04 Be careful when choosing a contract. Look for one that includes a large data allowance if you want to use the internet regularly or you’ve set your phone to synchronise your contacts, calendar and email through online services.

Built-in Wi-Fi can help you avoid high data charges by connecting to the internet through wireless hotspots when you’re out, or your router when you’re at home. Android and iPhone handsets can operate as wireless hotspots, letting you connect your laptop to the web over your mobile data connection. There may be an extra charge for this.

SMARTPHONES

**MOTOROLA** Moto G6 ★★★★★
£199 SIM-free; £24-per-month contract • www.amzn.to/2P8P9AN (SIM-free); shop.vodafone.co.uk (contract)

The Moto G series gets back on form with the Moto G6, a fast, fingerprint sensor-equipped budget marvel. Of particular note are the dual rear cameras, which can take shots that rival far more expensive handsets on overall quality.

**PROCESSOR** Octa-core 1.6GHz Qualcomm Snapdragon 450 • **SCREEN SIZE** 5.7" • **SCREEN RESOLUTION** 1920x1080 • **REAR CAMERA** Dual 12 megapixels, 5 megapixels • **STORAGE** 32GB • **WIRELESS DATA** 4G • **DIMENSIONS** 149x70x8mm • **WEIGHT** 149g • **OPERATING SYSTEM** Android 8.0 • **WARRANTY** One year RTB • **DETAILS** www.motorola.co.uk

**SAMSUNG** Galaxy S8 ★★★★★
£375 SIM-free; £27-per-month contract • www.amzn.to/2qNy2fT (SIM-free); www.carphonewarehouse.com (contract)

The most powerful Android phone ever. The camera is superb, the display is dazzling, and even the base model comes in a beautiful, almost completely bezel-free, design.

**PROCESSOR** Quad-core 2.3GHz Samsung Exynos 8895 • **SCREEN SIZE** 5.8" • **SCREEN RESOLUTION** 2960x1440 • **REAR CAMERA** 12 megapixels, 12 megapixels • **STORAGE** 64GB • **WIRELESS DATA** 4G • **DIMENSIONS** 148x70x8mm • **WEIGHT** 153g • **OPERATING SYSTEM** Android 7.0 • **WARRANTY** One-year RTB • **DETAILS** www.samsung.com

**HONOR 7X** ★★★★★
£200 SIM-free; £27-per-month contract • www.amzn.to/2khTkgX (SIM-free); www.three.co.uk (contract)

Don’t fancy paying tons of cash for an edge-to-edge, 18:9 display? The Honor 7X is affordable but has a vast, vibrant screen, and comes with a great dual-camera array.

**PROCESSOR** Octa-core 2.36GHz HiSilicon Kirin 659 • **SCREEN SIZE** 5.9" • **SCREEN RESOLUTION** 2160x1080 • **REAR CAMERA** Dual 16 megapixels • **STORAGE** 64GB • **WIRELESS DATA** 4G • **DIMENSIONS** 157x75x7.6mm • **WEIGHT** 160g • **OPERATING SYSTEM** Android 7.0 • **WARRANTY** One year RTB • **DETAILS** www.hihonor.com • **PART CODE** PAAJ0004GB • **FULL REVIEW** Sep 2018

**ONEPLUS 6** ★★★★★
£469 SIM-free; £10 up front plus £41-per-month contract • www.amzn.com (SIM-free); www.02.co.uk (contract)

This is OnePlus’ finest work yet: it’s almost as powerful as any Android handset around and has a great battery lifespan, but costs much less than its rivals.

**PROCESSOR** Quad-core 2.8GHz Qualcomm Snapdragon 845 • **SCREEN SIZE** 6.3" • **SCREEN RESOLUTION** 2960x1440 • **REAR CAMERA** 12 megapixels, 8 megapixels • **STORAGE** 128GB • **WIRELESS DATA** 4G • **DIMENSIONS** 153x74x7.8mm • **WEIGHT** 180g • **OPERATING SYSTEM** Android 8.1 • **WARRANTY** One year RTB • **DETAILS** www.oneplus.net • **PART CODE** OnePlus 6 • **FULL REVIEW** Jul 2017

**SAMSUNG** Galaxy J5 (2017) ★★★★
£129 SIM-free; £14-per-month contract • www.amzn.to/2B6fPjS (SIM-free); www.three.co.uk (contract)

The new Galaxy J5 performs well, takes great photos, has an incredibly vibrant screen and looks stylish, but it’s the battery life—over 18 hours in our tests—that really impresses.

**PROCESSOR** Octa-core 1.6GHz Exynos 7770 • **SCREEN SIZE** 5.2" • **SCREEN RESOLUTION** 1280x720 • **REAR CAMERA** 13 megapixels • **STORAGE** 16GB • **WIRELESS DATA** 4G • **DIMENSIONS** 144x72x8mm • **WEIGHT** 166g • **OPERATING SYSTEM** Android 7.0 • **WARRANTY** One year RTB • **DETAILS** www.samsung.com/uk • **PART CODE** SM-J500FZKABTU • **FULL REVIEW** Dec 2017

**HUAWEI** P20 Pro ★★★★★
£799 SIM-free; £10 up front plus £48-per-month contract • www.carphonewarehouse.com

The P20 Pro competes with the best on performance and display quality, but its greatest strength lies in its unique triple-lens camera setup, which helps to provide exceptional picture quality.

**PROCESSOR** Octa-core 2.4GHz HiSilicon Kirin 970 • **SCREEN SIZE** 5.1" • **SCREEN RESOLUTION** 2244x1080 • **REAR CAMERA** 40 megapixels, 20 megapixels, 8 megapixels • **STORAGE** 128GB • **WIRELESS DATA** 4G • **DIMENSIONS** 155x74x7.8mm • **WEIGHT** 177g • **OPERATING SYSTEM** Android 8.1 • **DETAILS** consumer.huawei.com • **PART CODE** 51092FG • **FULL REVIEW** Aug 2018
Choosing a... Tablet

01 All tablets rely on an operating system (OS) to run apps. You have three main choices: Apple’s iOS, which runs on the iPad, Android, which Google licenses to various manufacturers; and Windows 10, which has become common in hybrid tablets and convertibles. If you own an Apple or Google smartphone, you can download your apps, music and so on to a tablet that runs the same OS, so it makes sense to stick with a compatible device.

02 It’s important to pick a tablet that has a good-quality, high-resolution screen. Many budget tablets have 1,280x800-resolution displays, but better tablets have Full HD 1,920x1,080 panels, and we’re starting to see tablets that have even higher screen resolutions. Some are as high as 2,560x1,600 or even 4K. Entry-level tablets typically use TN panels, which don’t have particularly good viewing angles. The viewing angles of IPS panels are much better.

03 If you want to listen to music, watch films and play games, make sure your tablet has plenty of storage. Many tablets come with 8GB or 16GB of internal storage, although some budget models have less. You’ll typically pay more for a higher storage capacity. Many tablets also have microSD slots that let you add extra storage, although you won’t find one on an iPad. This is a cheap way of boosting storage capacity.

04 Tablets rarely include a SIM card slot. This means you’ll have to rely on Wi-Fi to get online, although some tablets let you access the internet through your smartphone. If you want mobile access to the internet, look for 3G- and 4G-ready devices. These almost always cost more than Wi-Fi-only models, but they’re great if you use your tablet while commuting or travelling.

05 Your choice of tablet determines the apps you can use on it. You may find that some of the apps you want are available on OS but not Android, and vice versa. Windows 10, meanwhile, runs traditional desktop applications.

TABLETS

SAMSUNG Galaxy Book 10.6in
£649 • www.amzn.to/2AHjihJ

Good budget 2-in-1s are rare, but Samsung hits the mark with its 10.6in Galaxy Book. The Full HD touchscreen display looks great and, unlike with the iPad Pro or Surface Pro ranges, the excellent keyboard and stylus peripherals come included in the box.

PROCESSOR Dual-core Intel Core m3-7Y30 • SCREEN SIZE 10.6in • SCREEN RESOLUTION 1920x1280 • REAR CAMERA None • STORAGE 64GB • WIRELESS DATA No • DIMENSIONS 261x179x8.9mm • WEIGHT 450g • OPERATING SYSTEM Windows 10 Home • WARRANTY Two years RTB • DETAILS www.samsung.com/uk • PART CODE SM-W620NZKAXAR • FULL REVIEW Nov 2017

APPLE iPad (2018)
£319 • www.apple.com/uk

Apple has recalibrated its focus for the latest iPad, keeping the existing design but turning it into an education aid with Apple Pencil support and the Smart Annotation software feature. Even if you’re not a teacher or in education, it’s still a powerful tablet at a decent price.

PROCESSOR Quad-core Apple A10X Fusion • SCREEN SIZE 9.7in • SCREEN RESOLUTION 2048x1536 • REAR CAMERA 8 megapixels • STORAGE 32GB • WIRELESS DATA None • DIMENSIONS 238x163x7.5mm • WEIGHT 469g • OPERATING SYSTEM iOS 11 • WARRANTY One year RTB • DETAILS www.apple.com/uk • PART CODE iPad • FULL REVIEW Aug 2018

MICROSOFT Surface Pro (2017)
£1,599 • www.microsoft.com

This pricey 2-in-1 earns every penny, with its colourful, pin-sharp display, best-in-class app performance, lengthy battery life and quality keyboard cover. It’s been given welcome design tweaks too, like a more durable hinge and smoothed-off edges.

PROCESSOR Dual-core 2.4GHz Intel Core i7-660U • SCREEN SIZE 12.3in • SCREEN RESOLUTION 2256x1504 • REAR CAMERA 8 megapixels • STORAGE 256GB • WIRELESS DATA No • DIMENSIONS 292x201x8.5mm • WEIGHT 764g • OPERATING SYSTEM Windows 10 Pro • WARRANTY One year RTB • DETAILS www.microsoft.com • PART CODE 10H1-D00002 • FULL REVIEW Aug 2017

AMAZON Kindle Oasis (2017)
£230 • www.amzn.to/2iz8Cqe

The premium installment of Amazon’s eReader line is back with a bigger screen, ambient light sensor and IPX8 waterproofing, though its most interesting improvement is the ability to play Audible Audibooks.

PROCESSOR Not stated • SCREEN SIZE 7in • SCREEN RESOLUTION 300dpi • REAR CAMERA None • STORAGE 8GB • WIRELESS DATA Optional 3G • DIMENSIONS 167x114x3mm • WEIGHT 179g • OPERATING SYSTEM Kindle OS • WARRANTY One year RTB • DETAILS www.amazon.co.uk • PART CODE Kindle Oasis (2017) • FULL REVIEW Mar 2018

SAMSUNG Galaxy Tab S3
£469 • www.amzn.to/2EJB810

Yes, it’s incredibly expensive for an Android slate, but the Galaxy Tab S3 is pure luxury: the AMOLED display looks exquisite, the stereo speakers sound great, and Samsung’s S Pen stylus is included as standard.

PROCESSOR Quad-core 2.2GHz Qualcomm Snapdragon 820 • SCREEN SIZE 9.7in • SCREEN RESOLUTION 2048x1536 • REAR CAMERA 13 megapixels • STORAGE 32GB • WIRELESS DATA None (4G optional) • DIMENSIONS 257x175x8mm • WEIGHT 429g • OPERATING SYSTEM Android 7.0 • WARRANTY One year RTB • DETAILS www.samsung.com/uk • PART CODE SM-T820 • FULL REVIEW Aug 2017

GOOD BUSINESS

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Your choice of tablet determines the apps you can use on it. You may find that some of the apps you want are available on iOS but not Android, and vice versa. Windows 10, meanwhile, runs traditional desktop applications.
Choosing a Compact System Camera

If you're ready to step beyond the basic controls of a compact camera, or want greater flexibility than an ultra-zoom can offer, a compact system camera (CSC) is the next logical upgrade. With interchangeable lenses, manual controls and stellar image quality, these cameras give proper digital SLRs a run for their money.

There are three competing types of CSC mount, and the one you buy determines the number of compatible lenses and accessories you have available. Samsung's NX-mount is arguably the most limited in terms of lens selection, and the company has confirmed that it’s shutting down its European camera business, so it’s best to avoid these altogether if possible.

Sony’s E-Mount has a slightly wider range, but Micro Four Thirds offers the widest variety. Both Panasonic and Olympus cameras use this mount, and the lenses are interchangeable between manufacturers.

Micro Four Thirds cameras are typically more compact than other types of CSC because the image sensor is physically smaller — with a 22mm diagonal, it’s roughly 30% smaller than an APS-C sensor. The APS-C sensors that Sony and Samsung use in their CSCs are the same size as those in traditional digital SLRs.

Like digital SLRs, CSCs come at a wide range of prices. Available from as little as £200, there’s a CSC to suit every budget. Most come with at least one kit lens, but if you already have lenses for a particular CSC mount, you can buy the body on its own and save money.

Once you’ve settled on a particular mount, you should pay attention to a camera’s features. Articulating screens and integrated viewfinders will help you compose shots, while extra physical controls and a hotshoe mount will give you flexibility for manual shooting.

Touchscreens are great, but they’re no replacement for physical dials when it comes to changing shutter speed and aperture. An integrated flash is much more convenient than a detachable one, as you can never forget to take it with you.

### PHOTOGRAPHY

**SONY RX100 V**

£699 • www.slrhut.co.uk

**FUJIFILM X-T2**

£1,249 • www.jessops.com

**NIKON D3400**

£355 • www.johnlewis.com

**POLAROID Originals OneStep 2**

£95 • www.jessops.com

**PANASONIC Lumix GH5**

£1,599 • www.wxphotographic.com

**PANASONIC Lumix DMC-G80**

£749 • www.jessops.com

It may be small, but the RX100 IV is seriously fast, and because it also captures a surprising amount of light, image and video quality are both top-notch.

A collection of minor improvements to battery life, shooting speed and stills quality add up to make the D3400 the best entry-level DSLR available.

The X-T2 is a mirrorless CSC capable of shooting high-quality images at incredibly high burst speeds, making it ideal for wildlife and sports photography.

A collection of minor improvements to battery life, shooting speed and stills quality add up to make the D3400 the best entry-level DSLR available.

The OneStep 2 brings back the simple joys of instant photography. Although the stock can get quite pricey, your shots will look just as they would on a classic Polaroid – perfect for sharing or simply sticking to the fridge.

This update to the brilliant GH5s can take great photos, but it’s video capture where the GH5 truly excels. Its 4K, 60fps footage is crisp enough for serious indie filmmaking, and it supports 10-bit recording and an optional flat colour profile as well.

The G80 is ahead of the pack when it comes to video quality, and its stills look great as well. It’s more expensive than the preceding G7, but includes a superior 12-60mm kit lens, among other improvements.
Choosing a... Display

01 A basic 24in LCD monitor costs around £100. It will be fine for typical Windows work but is likely to have poor viewing angles, so you'll need to sit straight on for the best picture quality. Its colour accuracy may not be very good, either.

02 A VGA input lets you use the monitor with any PC, but the quality may not be as good as it is over DVI or HDMI. Both are digital connections and require a compatible graphics card but they avoid the need for digital-to-analog or analog-to-digital conversions, which can reduce image quality. A digital connection achieves the best picture automatically, so you won't have to adjust clock or phase settings as you do with analogue connections.

03 A larger monitor will be easier on the eye and may have a higher resolution. Most monitors have a resolution of at least 1,920x1,080 (1080p), which provides lots of room for working with multiple windows at the same time. For even higher resolutions, you'll need a larger display. Some 27in and 30in screens have 2,560x1,600 or even 4K resolutions. You’ll need a graphics card with a dual-link DVI output and a dual-link DVI cable or either HDMI or DisplayPort to use a monitor at these resolutions.

04 If you want better picture quality, look for a monitor with a high contrast ratio. The higher the ratio, the whiter the whites and the blacker the blacks. You'll also be able to see more fine detail in images with high contrast levels. Viewing angles are important, as wider angles mean you don’t have to sit directly in front of the monitor to get the best picture. Wider viewing angles also allow more people to view the screen at the same time.

Fast response times reduce ghosting, but don’t be dazzled by the numbers. A response time of 25ms or quicker is fine for all applications.

**DISPLAYS**

**AOC G2460VQ6**

£126 • www.pworldbusiness.co.uk

Once you switch it to sRGB mode, this is one very good low-cost gaming monitor. Its 75Hz refresh rate means you’ll benefit from higher frame rates more effectively than on a standard 60Hz screen.

SCREEN SIZE: 24in • RESOLUTION: 1920x1080 • SCREEN TECHNOLOGY: TN • VIDEO INPUTS: VGA, HDMI, DisplayPort • WARRANTY: Three years parts and labour • PART CODE: G2460VQ6 • FULL REVIEW: Jul 2018

**BENQ SW2700PT**

£249 • www.amzn.to/2BjxUxG

We never thought you could get so much monitor for this little cash: a vast 31.5in MVA panel, with Quad HD resolution, good colour accuracy and high contrast. That’s not to mention its 75Hz refresh rate and AMD FreeSync support.

SCREEN SIZE: 31.5in • RESOLUTION: 2560x1440 • SCREEN TECHNOLOGY: MVA • REFRESH RATE: 75Hz • VIDEO INPUTS: HDMI, DisplayPort, VESA • WARRANTY: Three years parts and labour • PART CODE: SW2700PT • FULL REVIEW: Mar 2018

**VIEWSONIC XG2700-4K**

£30 • www.amzn.to/28jXUGC

Even if this isn’t the most cutting-edge monitor, its 4K gaming capability still holds up, with a responsive and colourful IPS panel and almost a complete lack of ghosting. AMD graphics card owners can also eliminate tearing with FreeSync.

SCREEN SIZE: 27in • RESOLUTION: 3840x2160 • SCREEN TECHNOLOGY: IPS • VIDEO INPUTS: VGA, HDMI x3, DisplayPort • WARRANTY: Three years parts and labour • PART CODE: XG2700-4K • FULL REVIEW: Jan 2018

**PHILIPS Brilliance 241B7QPJKEB**

£749 • www.uk.insight.com

IPS monitors generally look great, but it’s hard to find one at a low price. Enter the Brilliance 241B7QPJKEB: a colour-accurate IPS display for well under £200. It’s well designed, too, with a collapsible webcam and a greatly adjustable stand.

SCREEN SIZE: 24in • RESOLUTION: 1920x1080 • SCREEN TECHNOLOGY: IPS • REFRESH RATE: 60Hz • VIDEO INPUTS: HDMI, DisplayPort, VGA • WARRANTY: Three years parts and labour • PART CODE: 241B7QPJKEB • FULL REVIEW: Jun 2018

**SAMSUNG C34F791**

£700 • www.ebuyer.com

With its Quantum Dot display, the C34F791 can achieve pristine colour coverage and superp accuracy. Its Ultra HD resolution and 34in curved screen make it ideal for multitasking, but a 100Hz refresh rate and AMD FreeSync support ensure it’s even better for 4K gaming.

SCREEN SIZE: 34in • RESOLUTION: 3440x1440 • SCREEN TECHNOLOGY: VA • REFRESH RATE: 100Hz • VIDEO INPUTS: DisplayPort, HDMI • WARRANTY: Two years RTB • PART CODE: C34F791 • FULL REVIEW: Oct 2017
Choosing a... TV

01 A 32in Full HD TV costs around £200, but premium larger 4K models can be closer to £2,000. TVs look much smaller in the shop than in your home, so measure the space available before you buy.

Curved TVs are becoming increasingly more common, but bear in mind that these typically take up more floor space than a traditional flat set.

02 A 1,920x1,080-resolution TV can display a 1080p image. You can still buy TVs with a 720p (1,366x768) resolution, but they’re no cheaper and the image won’t be as sharp. 3,840x2,560 Ultra HD resolution, or 4K, TVs are finally available at reasonable prices, although you’ll still pay a premium for one over a 1080p model.

03 Consider the number of inputs you’ll need to connect the rest of your equipment. Two HDMI ports should be the bare minimum, but many TV sets come with four HDMI connectors. You’ll need HDMI 2.0 if you want a future-proof 4K TV, as this is the only way to get 60fps video playback from external sources at such a high resolution.

If you want to plug a PC into your TV, you’ll need to use either HDMI or VGA inputs. Be aware that some TVs only let you use a PC on an analogue input, and others won’t display the Windows desktop at the TV’s highest resolution.

04 The contrast ratio tells you the difference between the darkest and the brightest shades that the screen will be able to display. The higher the number, the darker the blacks and the brighter the whites. Buy a TV with High Dynamic Range (HDR) support for the best picture from supported services.

05 HD content is now becoming fairly widespread, but if you want Ultra HD content your options are more limited. Most Ultra HD TVs have Netflix built into their smart TV systems, but only BT is currently providing live Ultra HD video, with BT Sport Ultra HD.

Ultra HD Blu-ray players give you an amazing picture, and Amazon’s Fire TV set-top box will stream its Prime Video service and Netflix at Ultra HD resolutions.

HOME CINEMA

PHILIPS 55PUS6753/12 ★★★★★
£549 • www.amzn.to/2R0cWjP

This Philips set doesn’t have the best implementation of HDR we’ve seen on a TV, but otherwise, the 55PUS6753/12 is a fantastic 4K screen for a relatively low price.

SCREEN SIZE 55in • NATIVE RESOLUTION 3,840x2,160 • VIDEO INPUTS 3x HDMI, 5x component • TUNER Freesat HD • DIMENSIONS 778x1,244x266mm • WARRANTY One year RTB • DETAILS www.philips.co.uk • PART CODE 55PUS6753/12 • FULL REVIEW Oct 2018

SAMSUNG HW-MS750 ★★★★★★
£649 • www.currys.co.uk

The HW-MS750 doesn’t need a dedicated subwoofer; it puts out a thunderous amount of bass all by itself, and its massive soundstage is perfect for films. It’s the best standalone soundbar around, although you will need to pay a premium for it.

SPEAKERS 11 • RMS POWER OUTPUT 450W • WEIGHT 6.3kg • NETWORKING Bluetooth • WARRANTY One year RTB • DETAILS www.samsung.co.uk • PART CODE HW-MS750 • FULL REVIEW May 2018

SONY KD-55XF9005 ★★★★★
£1,299 • www.currys.co.uk

Direct-lit backlighting, excellent upsampling and beautifully smooth motion make the KD-55XF9005 a worthy alternative to high-end OLED TVs, even though it only has a VA panel.

SCREEN SIZE 55in • NATIVE RESOLUTION 3,840x2,160 • VIDEO INPUTS 5x HDMI • TUNER Freesat HD • DIMENSIONS 1113x213x538mm • WARRANTY One year RTB • DETAILS www.sony.co.uk • PART CODE KD-55XF9005 • FULL REVIEW Aug 2018

PANASONIC DMP-UB900 ★★★★★
£319 • www.hifonix.co.uk

Together with the Samsung UBD-K8500, this forms the vanguard of a new breed of Ultra HD Blu-ray players. Samsung’s model is cheaper, but the DMP-UB900 has superior features, particularly where audio delivery is concerned.

BLU-RAY PROFILE 6.0 • 3D CAPABLE Yes • DIMENSIONS 455x30x326mm • NETWORKING Ethernet, 802.11ac Wi-Fi • WARRANTY One year RTB • DETAILS www.panasonic.co.uk • PART CODE DMP-UB900EB • FULL REVIEW Aug 2016

CAMBRIDGE AUDIO TV2 (v2) ★★★★★
£200 • shop.cambridgeaudio.co.uk

The TV2 (v2) is a simple, clean-looking soundbase. What it lacks in multiroom capability, due to its lack of Wi-Fi, it more than makes up in exquisite sound quality, especially with an integrated subwoofer producing strong but controlled bass.

SPEAKERS 1 • RMS POWER OUTPUT 150W • DIMENSIONS 100x500x333mm • WEIGHT Not stated • DOCK CONNECTOR None • NETWORKING Bluetooth (aptX) • WARRANTY Two years repair and replace • DETAILS www.cambridgeaudio.co.uk • PART CODE TV2 (v2) • FULL REVIEW Jul 2017

POLK Audio MagniFi Mini ★★★★★
£245 • www.amzn.to/2fts0Rf

A tiny soundbar with big sound, the MagniFi Mini takes up hardly any space under your TV but is capable of filling the living room with crystal-clear music and dialogue. Best of all, it comes with a standalone subwoofer, empowering bass booms with an extra kick.

SPEAKERS 3 • RMS POWER OUTPUT 150W • DIMENSIONS 813x340x101mm (soundbar), 366x71x386mm (subwoofer) • WEIGHT 3.6kg (soundbar), 3.6kg (subwoofer) • DOCK CONNECTOR None • NETWORKING Bluetooth • WARRANTY One year repair and replace • DETAILS www.polkaudio.com • PART CODE MagniFi Mini • FULL REVIEW Sep 2017
Choosing a... Bluetooth speaker

01 Bluetooth speakers come in all shapes and sizes, so you’ll need to decide what you want to do with the speaker before you buy. If you don’t plan to take your music outdoors or around the house, look for a wired speaker. These are typically cheaper than speakers with built-in batteries.

If you do want a portable speaker, however, pay particular attention to how much it weighs. Ruggedised models should be able to survive accidental drops, water spills and unexpected rain showers.

02 Many of the cheapest Bluetooth speakers use the lossy A2DP Bluetooth protocol, which is prone to compressing your music and discarding detail compared with the original recording.

It’s hard to tell the difference when listening to pocket-sized speakers, but if you’re looking for a speaker to fill a room, an aptX-compatible device is a better option. This Bluetooth protocol retains more detail than the A2DP profile, although you’ll need to use it with a compatible smartphone in order to get the benefits.

03 As with any audio product, the number and size of speaker drivers can have a significant impact on the quality of sound you get from a Bluetooth speaker. Typically, the presence of multiple drivers enables the manufacturer to tune each one for specific frequencies, directing high-end sounds towards a tweeter and sending the mid-range frequencies to the main driver.

Single-driver speakers with larger driver cones can be just as capable of producing fantastic audio, however.

04 Most Bluetooth speakers have at least one auxiliary input for a wired 3.5mm audio jack, in case you want to listen to music from a device that doesn’t have Bluetooth. There are other extra features to look out for, though. Speakers with built-in batteries may have a USB port for charging your smartphone, or a built-in microphone to turn it into a speakerphone when a paired smartphone receives a call. Not all speakers have physical controls; many rely on your paired device’s controls for adjusting the volume or muting playback.

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**SENSHEISER HD 660 S**

★★★★  £360 • www.hifix.co.uk

While they’re inspired by classic Sennheiser headphones such as the HD 580 Precision, the HD 660 S bring a more modern, bassy sound of their own. Being open-back, they’re best used at home.

HEADPHONES SUBTYPE Over-ear headset  •  PLUG TYPE 3.5mm jack plug  •  WEIGHT 266g  •  WARRANTY One year RTB  •  DETAILS en-uk.sennheiser.com • PART CODE 500775  •  FULL REVIEW Oct 2018

**CREATIVE Muvo 2c**

★  £30 • www.amzn.to/2wzSxB8

Considering it’s both pocket-sized and dirt cheap, the Muvo 2c’s bass presence and sheer loudness come as a pleasant surprise, and it’s water- and dust-resistant as well.

HEADPHONES SUBTYPE Over-ear headset  •  PLUG TYPE 3.5mm jack plug (optional)  •  WEIGHT 310g  •  CABLE LENGTH 3m  •  WARRANTY Two years RTB  •  DETAILS www.sonicdirect.co.uk • PART CODE 984-000923  •  FULL REVIEW Jul 2018

**Q ACOUSTICS 3010i**

★★★☆  £199 • www.amzn.to/2xi4CsE

Louder and more precise than the 3010, these bookshelf speakers are worth the money. You’ll just need to plug them into an external amplifier, like a hi-fi amp or AV receiver.

HEADPHONES SUBTYPE Stereo  •  PLUG TYPE 3.5mm jack plug  •  CABLE LENGTH 2m  •  PART CODE 50100  •  FULL REVIEW Nov 2018

**BOSE QuietComfort 35 II**

★★★★★  £289 • www.sonicdirect.co.uk

The world’s best ANC headphones get a Google Assistant upgrade: you can search for songs, select playlists and set reminders all via the built-in microphone. And, of course, they sound splendid.

HEADPHONES SUBTYPE Over-ear headset  •  PLUG TYPE 3.5mm jack plug  •  CABLE LENGTH 1.2m  •  WARRANTY Two years RTB  •  DETAILS www.bose.co.uk • PART CODE 79564-00010  •  FULL REVIEW Apr 2018

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★★★☆  £199 • www.amzn.to/2xi4CsE

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Choosing an... Action camera

01 Action cameras are typically much smaller than a regular camcorder, as they are designed primarily for shooting action footage, but because of their small size they are ideal for strapping on to your pet’s collar or your children’s toys for a different perspective.

02 Even basic action cameras will shoot Full HD video, and many will even shoot 4K, but frame rate is arguably more important than resolution when it comes to action video. Higher frame rates mean smoother clips, and super-high frame rate videos can be played in slow motion to emphasise exciting shots.

03 Most action cameras rely on flash memory for storing your video, letting you swap out memory cards on the fly when you fill one up with clips. More expensive devices can have integrated flash memory as well as a card slot, but it’s typically cheaper to buy the basic version of a camera and pick up memory cards separately.

04 Not all action cameras have LCD displays; in fact, many don’t include a screen in order to extend battery life.

05 Action cameras typically have a huge range of accessories, with specific mounts and harnesses for different activities and sports. If the camera itself isn’t water resistant, a weatherproof case will protect it from the elements, while a tripod mount will let you lock it firmly in place. Spare batteries are essential for longer shoots, and some decent video-editing software will help you to produce a more polished result.

VIDEO

AMAZON Fire TV with 4K Ultra HD (2017)

£70 • www.amzn.to/2B72FTN

Despite shrinking from a set-top box to an HDMI dongle, this is packed with new features, including a remote that works with Alexa voice commands.

VIDEO OUTPUTS: HDMI 2.0 • NETWORKING: 802.11ac Wi-Fi • DIMENSIONS: 64x165x15mm • STREAMING FORMATS: 4K H.265, AirPlay, DLNA, Plex • INTERNET STREAMING SERVICES: Amazon Video, Netflix, BBC iPlayer, ITV Hub, All 4, My5 • WARRANTY: One year RTB • DETAILS: www.amazon.co.uk • PART CODE: Fire TV with 4K UHD (2017) • FULL REVIEW: Feb 2018

AMAZON Fire TV Stick

£40 • www.amzn.to/2s4qrKp

Don’t have a 4K TV? No worries – the standard Fire TV Stick is a wonderful little streamer in its own right. The 2017 model has added Alexa, Amazon’s digital assistant, so searching through the vast library is easier than ever.

VIDEO OUTPUTS: HDMI 2.0 • NETWORKING: 802.11ac Wi-Fi • DIMENSIONS: 66x33x32mm • STREAMING FORMATS: AirPlay (via apps) • INTERNET STREAMING SERVICES: iPlayer, ITV Hub, All 4, My5 • WARRANTY: One year RTB • DETAILS: www.amazon.co.uk • PART CODE: FIRE TV STICK • FULL REVIEW: Aug 2017

NVIDIA Shield TV

£190 • www.johnlewisis.com

A good media streamer/Android games console hybrid made even better by a more comfortable controller, a wider range of streaming sources and smart home integration.

VIDEO OUTPUTS: HDMI 1.4 • NETWORKING: 802.11ac Wi-Fi, 10/100/1,000 Ethernet, Bluetooth 4.1 • DIMENSIONS: 199x96x26mm • STREAMING FORMATS: Plex, Kodi • INTERNET STREAMING SERVICES: Netflix, Amazon Instant Video, Google Play Movies and TV, Google Play Music, YouTube, BBC iPlayer • WARRANTY: Two years repair and replace • DETAILS: www.nvidia.co.uk • PART CODE: 945-12879-0400-000 • FULL REVIEW: May 2017

YI 4K+

£260 • www.amzn.to/2qLlqoK

At last, a 4K action camera that not only rivals the GoPro Hero range, but surpasses it. The YI 4K+ is well priced considering its high video quality, wealth of shooting options and responsive UI, and it has electronic image stabilisation too.

SENSOR: 1.3cm CMOS • SENSOR PIXELS: 12 megapixels • MAXIMUM RECORDING RESOLUTION: 4K (60fps) • AV CONNECTIONS: USB Type C • DIMENSIONS: 42x55x20mm • WEIGHT: 96g • WARRANTY: One year RTB • DETAILS: www.yitechnology.com • PART CODE: 9107 • FULL REVIEW: Jun 2018

APPLE TV 4K

£179 • www.apple.com/uk

This big update adds 4K content (including, for the first time, Amazon Video support). The best part is that if there’s a 4K version of content you’ve previously purchased in HD, Apple will upgrade it free of charge.

VIDEO OUTPUTS: HDMI 2.0a • NETWORKING: 802.11ac Wi-Fi, 10/100/1,000 Ethernet • DIMENSIONS: 35x88x19mm • STREAMING FORMATS: AirPlay, others via apps • INTERNET STREAMING SERVICES: iTunes, Apple Music, Netflix, Amazon Instant Video, Now TV, BBC iPlayer, ITV Hub, All 4 • WARRANTY: One year RTB • DETAILS: www.apple.com/uk • PART CODE: Apple TV 4K • FULL REVIEW: Jan 2018

SAMSUNG Gear 360 (2017)

£118 • www.amzn.to/2wesOMX

Samsung’s updated 360° camera improves on the original in every way: it’s more portable, supports live video stream, and is no longer limited to Samsung Galaxy phones. Best of all, it’s cheaper than the previous model was at launch.

SENSOR RESOLUTION: Dual 8.4 megapixels • SENSOR SIZE: Not disclosed • VIEWFINDER: None • LCD SCREEN: 0.56in, 122880 pixels, 1280x640mm • WEIGHT: 96g • WARRANTY: One year RTB • DETAILS: www.samsung.com/uk • PART CODE: SM-R20NZWABTU • FULL REVIEW: Oct 2017
Choosing a... Wearable

Wearable tech can include anything from chest-strap heart-rate monitors to augmented reality glasses, but the two most common types are smartwatches and fitness trackers. Both are designed to sit unassumingly on your wrist, and are almost always meant to be used in tandem with a paired smartphone.

Smartwatches are typically more complex and expensive, though more closely resemble a traditional wristwatch. You can use them to receive and reply to text messages and emails, quickly check maps and even play games – like a smartphone, most smartwatches allow you to install your own choice of apps.

Fitness trackers are much more dedicated to healthy pursuits. Stop counters, heart-rate monitors and even sleep tracking are all common, and the data collected is fed back to you so you can see how your workout routine or calorie intake is going. Many smartwatches also contain health-tracking features, but fitness-specific wearables tend to be cheaper, smaller and lighter.

When it comes to battery life, it’s important for any wearable to last a full day, but if it’s a smartwatch then you can get away with having to charge it overnight. With fitness trackers, it’s better if it lasts for several days off a single charge, so you can wear it to bed and benefit from sleep tracking.

Look out for waterproofing as well. Wearables that don’t mind a few lengths of the pool can be used for swimming or just timekeeping, and at the very least we expect a fitness tracker to be able to deal with rain or sweat.

Different smartwatches use different operating systems, which determine which apps you can install on your device, as well as compatibility with smartphones. Android Wear and Tizen smartwatches will work with both Android and iOS phones, but Apple’s watchOS will only pair with an iOS handset.

WEARABLES

SAMSUNG Gear S3

£220 • www.amzn.to/2ssXHV4

The Gear S3 isn’t the cheapest smartwatch, but it is one of the best. It’s ripe with both everyday and serious fitness features, and its rotating bezel is hands-down our favourite method for navigating menus on a wearable.

PEDOMETER Yes • HEART-RATE MONITOR Yes • DISPLAY SIZE 1.3in • RESOLUTION 360x360 • OS SUPPORT Android, iOS • BATTERY LIFE 5 days • WARRANTY Two years RTB • DETAILS www.samsung.com/uk • PART CODE M-R760NDAABTU • FULL REVIEW Apr 2017

APPLE Watch Series 3

£279 • www.johnlewis.com

Much-improved fitness-tracking capabilities, together with Apple’s knack for physical design, make this easily the most versatile Apple Watch yet. It’s just a shame it will still only work with Apple’s own iPhones.

PEDOMETER Yes • HEART-RATE MONITOR Yes • DISPLAY SIZE 1.65in • RESOLUTION 312x390 • OS SUPPORT iOS • BATTERY LIFE 18 hours • WARRANTY One year RTB • DETAILS www.apple.com/uk • PART CODE Apple-Watch-Series-3 • FULL REVIEW May 2018

HUAWEI Watch 2 Sport

£190 • www.amzn.to/2qLo7qo

It’s worth shelling out for the premium version of this sporty Android Wear smartwatch: it includes built-in 4G connectivity, which when combined with GPS tracking means you can safely leave your smartphone at home.

PEDOMETER Yes • HEART-RATE MONITOR Yes • DISPLAY SIZE 1.6in • RESOLUTION N/A • OS SUPPORT Android, iOS • BATTERY LIFE Six months • WARRANTY Two years RTB • DETAILS www.huawei.com • PART CODE HM5000 • FULL REVIEW Jun 2017

FITBIT Versa

£200 • www.currys.co.uk

The Versa is a much more successful smartwatch/fitness tracker hybrid than Fitbit’s previous attempt, the Ionic: this is pleasantly lightweight, highly customisable and backed up by an active (and competitive) community of Fitbit users.

PEDOMETER Yes • HEART-RATE MONITOR Yes • DISPLAY SIZE 1.3in • RESOLUTION 300x300 • OS SUPPORT Android, iOS • BATTERY LIFE Four days • WARRANTY One year RTB • DETAILS www.fitbit.com • PART CODE FB505RGP-EU • FULL REVIEW Jul 2018

SAMSUNG Gear Fit2

£145 • www.amzn.to/2IWodDs

There’s much to like about this Tizen-powered fitness tracker. GPS is a very welcome inclusion, and you can add widgets to the touchscreen, just like on a smartphone.

PEDOMETER Yes • HEART-RATE MONITOR Yes • DISPLAY SIZE 1.3in • RESOLUTION 290x42 • OS SUPPORT Android, iOS • BATTERY LIFE Four days • WARRANTY Two years • DETAILS www.samsung.com/uk • PART CODE SM-R3600DAABTU • FULL REVIEW Sep 2017
Choosing a... Smart thermostat

01. A smart thermostat can save you a lot of money by intelligently controlling your heating. Most smart heating devices are designed to be used with hot water central heating systems, with the boiler directly controlled by the system. These typically require a relay to be wired into your boiler, with a wireless thermostat giving you direct control. Smartphone apps then tie into the system to give you remote control. While it's possible to fit controls yourself, you may want to pay an experienced plumber to do the job, expect to pay around £150 for a typical installation.

If you have electric heating, there are very few choices, and the big names (Nest, Honeywell and so on) do not directly support these systems.

02. Want smart hot water control? If you want to remotely set schedules and disable hot water while you’re away, choose your smart system carefully, as many don’t have this option. Hot water control usually requires a second relay to be wired into the boiler.

03. What kind of heating system do you want? There are two main choices: a central system and one with individual radiator controls. The former replaces your existing thermostat, and lets you set one temperature for your entire house. The latter requires each radiator valve to be replaced with a smart valve so that each room and radiator can have its own individual control.

This option is more expensive to install but will provide you with greater savings.

04. Do you use a smart personal assistant? Make sure that your smart thermostat supports the one that you use. Amazon Alexa, powered by the Echo and Echo Dot, is the best-supported system; Apple’s HomeKit, powered by Siri, isn’t so well supported; Google Assistant, built into Google Home, is just gaining traction and supports Nest only.

05. If you want your smart heating system to do more, look for IFTTT support. With this handy system, you can set automatic rules, such as turning the heating off if the outside temperature rises.

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**SMART HOME**

**AMAZON** Echo 2nd Generation

★★★★☆

£90 • www.amazon.co.uk/2DxFEuQ

**TADO** Smart Thermostat

£200 • www.tado.com

**NEST** Cam IQ Outdoor

£329 • nest.com/uk

**HONEYWELL** Evohome Security

£286 • www.theevohomeshop.co.uk

**GOOGLE** Home

£129 • store.google.com

**RING** Video Doorbell 2

£149 • www.johnlewis.com

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**Video Doorbell 2**

This is the best of the new breed of smart, camera-equipped doorbells: it’s easy to install, comes with a bundled chime, and has fairly low subscription costs for storing footage in the cloud.

**HD smart alarm system** will notify you of a break-in, and its motion sensors can even take a picture of an intruder so that you can quickly rule out false alarms. A great range of sensors and full app control make this a top choice.

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If you have electric heating, there are very few choices, and the big names (Nest, Honeywell and so on) do not directly support these systems.
Choosing an... Inkjet printer

01 You should be able to buy a decent inkjet printer for less than £40. High-quality printing is possible on such a printer, but it will be slow. The actual print speed of an inkjet can be half the quoted (maximum) speed for text documents, and even slower when printing graphics. Budget inkjet printers such as these are designed only for light use and can be expensive to run.

02 For £80 to £90 you can buy a more capable printer that’s either faster and better built or better at reproducing photos. If documents are your priority, you’ll want a high minimum speed and low print costs. Look for inkjets that can handle all your office media, such as envelopes and labels.

03 If photos are your priority, speed is less important. Choose a printer that reproduces subtle tones well. You can’t determine this by looking at the specifications – only hands-on testing will do, so remember to check our reviews before you buy.

04 Heavy-duty office inkjets can cost up to £1,000 and their build quality is improving. They use large individual ink tanks, which can cut running costs. Printers with automatic duplex (double-sided) printing or A3 capabilities are now much more affordable.

05 Pricier photo printers let you print from memory cards plugged straight into the printer, so you don’t need to use a PC. An LCD preview screen offers greater control for this method of printing. Many inkjet printers now have a PictBridge USB port, which you can use to print images directly from most digital cameras.

06 If you’re really serious about photography, consider buying an inkjet that can produce borderless prints up to A3 size. The best devices can print photos that look nearly as good as those from professional labs.

PRINTERS & SCANNERS

EPSON WorkForce WF-7710DWF

£175 • www.ebuyer.com

The WorkForce WF-7710DWF allows you to print at the larger A3+ paper size, as well as fax and scan at A3, so it’s great for home office users who require a bit more flexibility from their MFP.

TECHNOLOGY: Piezo inkjet • MAXIMUM PRINT RESOLUTION: 4,800x2,400dpi • DIMENSIONS: 340x567x452mm • WEIGHT: 35kg • MAXIMUM PAPER SIZE A3+ • WARRANTY: One year RTB • DETAILS: www.epson.co.uk • PART CODE: C11CG16401CE • FULL REVIEW: Jan 2019

HP OfficeJet Pro 7720

£107 • www.ebuyer.com

The OfficeJet Pro 7720 strikes a fine balance between price, performance and features, making it ideal for home offices and small businesses – especially those that could use A3 printing.

TECHNOLOGY: Thermal inkjet • MAXIMUM PRINT RESOLUTION: 4,800x1,200dpi • SCANNER RESOLUTION: 1200x1,200dpi • MAXIMUM PAPER SIZE A3+ (print only) • WARRANTY: Three years RTB • DETAILS: www.hp.co.uk • PART CODE: V501A8 • FULL REVIEW: Jan 2019

EPSON imageFormula DR-C230

£323 • www.ebuyer.com

This sheet-fed document scanner is perfect for getting through stacks of documents without having to manually scan each page. It’s pleasantly fast and pairs with Canon’s powerful CaptureOnTouch Pro software, which does a fine job of processing your scans.

TECHNOLOGY: Dual CIS sheet-fed scanner • SCANNER RESOLUTION: 600x600dpi • MAXIMUM PAPER SIZE A3+ • WEIGHT: 2.8kg • WARRANTY: One year RTB • DETAILS: www.canon.co.uk • PART CODE: 2646C003 • FULL REVIEW: Feb 2018

EPSON EcoTank ET-7750

£550 • www.jessops.com

Like all EcoTank MFPS, the ET-7750 offsets its high price with low running costs, and this specific model delivers sharp, solid colours that suit photo printing well.

TECHNOLOGY: Piezo inkjet • MAXIMUM PRINT RESOLUTION: 5,760x1,440 • SCANNER RESOLUTION: 1,200x2,400dpi • MAXIMUM PAPER SIZE A3+ • WEIGHT: 10.5kg • DETAILS: www.epson.co.uk • PART CODE: C11CG16401CE • FULL REVIEW: Sep 2018

XYZPRINTING da Vinci Minimaker

£145 • www.icubes.co.uk

It’s not as fully featured as the da Vinci Jr 1.0w, but the Minimaker prints at identical speed and quality, and costs much, much less. In fact, it’s the most affordable 3D printer we’ve ever used.

TECHNOLOGY: Fused Filament Fabrication • MAXIMUM PRINT RESOLUTION: 100 micros • MAXIMUM BUILD SIZE: 150x150x150mm • DIMENSIONS: 290x360x335mm • WEIGHT: 11.5kg • FILAMENT: 1.75mm PLA • WARRANTY: One year RTB • DETAILS: eu.xyzprinting.com • PART CODE: 3FMIXC1EU00 • FULL REVIEW: Apr 2017

CANON Pixma TS3150

£36 • www.ebuyer.com

If you only print or scan infrequently, you probably don’t need a load of fancy features. The Pixma TS3150 does the job for hardly any money – it’s a bit slow, but the results are of a higher quality than we’d expect from a budget MFP.

TECHNOLOGY: Thermal inkjet • MAXIMUM PRINT RESOLUTION: 4,800x1,200dpi • SCANNER RESOLUTION: 600x1,200dpi • DIMENSIONS: 426x373x315mm • WEIGHT: 3.9kg • DETAILS: www.canon.co.uk • PART CODE: 2226C008 • FULL REVIEW: Jan 2018
Choosing a… Wireless router

**01** Wireless routers each use a number of Wi-Fi standards, so you shouldn’t have any trouble connecting your computer or phone directly if you get an 802.11n or 802.11ac router. Nearly all routers support 802.11n, so even a cheap model should provide decent performance.

You can expect a transfer speed of around 40 Mbit/s at a distance of 10m from any modern 802.11n router. The very latest routers use the 802.11ac standard, which provides tremendously fast transfer speeds. Some devices still don’t support the 802.11ac standard, so check the specifications before you buy.

**02** If you subscribe to an ADSL broadband service, you should buy a wireless router that has a built-in ADSL modem. This will cost more than the equivalent cable router, but it allows you to connect your router directly to your broadband connection without having to use a separate modem.

Alternatively, a high-gain antenna can boost signals and improve ranges and throughputs to the entire house. You can also add a high-gain antenna to a PC’s network adapter. If wired network speeds are a priority, you should look for a router with a Gigabit Ethernet connection.

**03** Most 802.11n wireless routers use the 2.4GHz frequency band. This has good range but it can be prone to interference if it’s positioned close to a lot of other 2.4GHz devices, such as other routers and baby monitors. If you have trouble getting a consistent signal or you want faster speeds for video streaming, for example, it’s worth buying a dual-band router that can use both the 2.4GHz and 5GHz bands.

Many routers come with built-in USB ports that let you connect a USB drive and use the router as a network storage device. If you want to share a USB printer over your network, look for a wireless router that has a USB print server.

Finally, if you’re interested in making voice calls over the internet, buy a router with built-in VoIP support (and phone sockets) because this can save you money.

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**NETWORKS**

**D-LINK DIR-842**

- **Price**: £50 • [www.amazon.co.uk/2AYE8G6](http://www.amazon.co.uk/2AYE8G6)
- **This budget dual-band router is fast enough to serve as an affordable upgrade to your ISP router, and it’s easy to set up, too.**
- **Wi-Fi Standard**: 802.11ac • **Stated Speed**: 4x4 867 Mbit/s (5GHz), 1x1 300 Mbit/s (2.4GHz)
- **USB Ports**: None • **Warranty**: Two years RTB • **Part Code**: DIR-842 • **Full Review**: Jan 2018

**YUBICO YubiKey 4**

- **Price**: £39 • [www.amazon.co.uk/2vQhtC](http://www.amazon.co.uk/2vQhtC)
- **This isn’t your standard networking device: it’s a USB key that stores the cryptographic data required to log into your devices and services via two-factor authentication. This adds a secure and convenient second layer of protection, wherever you are.**
- **USB Type**: Type-A • **Supported Services**: Google, Facebook, Dropbox, Windows, macOS, Samsung, LastPass, Dashlane • **Warranty**: One year RTB • **Details**: www.yubico.com • **Part Code**: Yubikey4 • **Full Review**: Aug 2017

**D-LINK DIR-895L**

- **Price**: £349 • [www.dlink-direct.co.uk](http://www.dlink-direct.co.uk)
- **If you can stomach the price, D-Link’s DIR-895L will make it worth your while with staggeringly fast speeds and exceptionally long range. It also lets you connect to your home network remotely, via an L2TP VPN.**
- **Modem**: Gigabit Ethernet • **Wi-Fi Standard**: 802.11ac • **Stated Speed**: 2x 2,166 Mbit/s (5GHz), 1,000 Mbit/s (2.4GHz) • **USB Ports**: 1x USB2, 1x USB3 • **Warranty**: Two years RTB • **Part Code**: DIR-895L • **Full Review**: Dec 2017

**TP-LINK Archer C5400**

- **Price**: £230 • [www.currys.co.uk](http://www.currys.co.uk)
- **Although this isn’t the fastest £200-plus router, it’s still speedy, and comes with an impressive array of features, from parental controls and filters to BT YouView support and smart home integration.**
- **Modem**: Gigabit Ethernet • **Wi-Fi Standard**: 802.11ac • **Stated Speed**: 2x 2,166 Mbit/s (5GHz), 2x 1,000 Mbit/s (2.4GHz) • **USB Ports**: 1x USB2, 1x USB3 • **Warranty**: One year RTB • **Part Code**: C5400 • **Full Review**: May 2018

**YUBICO YubiKey 4**

- **Price**: £230 (triple pack) • [www.currys.co.uk](http://www.currys.co.uk)
- **Provided you’re willing to tinker with a few settings, the Deco M5 is the most feature-rich mesh Wi-Fi system around, even if it’s not strictly the fastest. Get the triple pack for the best coverage throughout the house.**
- **Modem**: Gigabit Ethernet • **Wi-Fi Standard**: 802.11ac • **Stated Speed**: 867 Mbit/s (5GHz), 400 Mbit/s (2.4GHz) • **USB Ports**: 3 • **Warranty**: Three years RTB • **Details**: www.tp-link.com • **Part Code**: DecoM5 • **Full Review**: Dec 2017

**TP-LINK Deco M5**

- **Price**: £189 (twin pack) • [store.google.com](http://store.google.com)
- **Arguably the most user-friendly mesh networking system yet, Google Wifi trades long-range speed for supreme ease of use and excellent configuration tools.**
- **Modem**: N/A • **Wi-Fi Standard**: 802.11ac • **Stated Speed**: 2,400 Mbit/s • **USB Ports**: 0 • **Warranty**: One year RTB • **Details**: google.com • **Part Code**: Wifi • **Full Review**: Jul 2017

**GOOGLE Google Wifi**

- **Price**: N/A • [www.google.com](http://www.google.com)
- **This isn’t your standard networking device: it’s a USB key that stores the cryptographic data required to log into your devices and services via two-factor authentication. This adds a secure and convenient second layer of protection, wherever you are.**
- **USB Type**: Type-A • **Supported Services**: Google, Facebook, Dropbox, Windows, macOS, Samsung, LastPass, Dashlane • **Warranty**: One year RTB • **Details**: Quadpack • **Part Code**: Google Wifi • **Full Review**: Apr 2018

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Choosing an... Internal hard disk

01 A basic 1TB internal hard disk should cost around £40. This will be fast enough for general use and will provide enough storage for most users. Make sure the hard disk you choose has the appropriate interface type for your PC. Most hard disks and solid-state drives (SSDs) use the SATA3 interface, which enables faster speeds than the older SATA2. Pretty much every motherboard released in recent years will have multiple SATA3 ports, allowing you to connect several storage drives at once.

02 SSDs can make the most of SATA3’s high bandwidth for fast file transfers. They use flash memory similar to that found in USB flash drives, and although they tend to provide less capacity than mechanical hard disks, they’re significantly faster. More expensive SSDs use the NVMe standard, which is even faster than SATA3, but require an M.2 slot on the motherboard.

03 Buy a hard disk that provides more capacity than you think you need, as your storage requirements are likely to grow. A 2TB disk strikes the best balance between capacity and low cost per gigabyte.

04 If you want more disk space or you want to protect your data against disk failure, think about buying several hard disks to create a RAID array. These use multiple hard disks to create one large logical disk with better performance, or to duplicate your data for better protection. RAID arrays require hard disks of the same size. In theory, they can be from different manufacturers, but it’s better to buy identical disks if you can.

05 A hard disk’s spindle speed determines how quickly it can transfer data. A spindle speed of 7,200rpm is common in desktop drives and is fast enough for most purposes. Desktop hard disks with 5,400rpm spindle speeds are quite slow but use less power and generate less heat and noise. To strike the best balance between speed and storage capacity, use an SSD as your system disk and store your files on a larger mechanical disk.

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**STORAGE**

**SYNOLOGY** DiskStation DS418j

£281 • www broadbandbuyer.com

When a tiny two-bay NAS won’t cut it, the fast, high-capacity DiskStation DS418j is an excellent upgrade, especially as it can automatically convert old hard disks to be compatible with this NAS’s hardware and features.

- 3.5in HARD DISK BAYS (FREE) 4 x 6
- NETWORKING 1x 10/100/1000 Ethernet
- DLNA MEDIA SERVER Yes
- PRINT SERVER Yes
- DIMENSIONS 184x168x230mm
- WEIGHT 2.1kg
- WARRANTY Two years RTB • DETAILS www.synology.com • PART CODE (DS418j) • FULL REVIEW Jan 2018

**SAMSUNG** 860 Evo 250GB

£88 • www.scan.co.uk

The 860 Evo, fittingly, replaces the old 850 Evo as the best 2.5in SSD around. Its read and write speeds push the limits of what SATA drives can do, and it’s had a big upgrade to endurance, meaning you can write far more data to this SSD before it wears out.

CAPACITY 250GB • COST PER GIGABYTE £0.39p • INTERFACE SATA3 • WARRANTY Five years RTB • DETAILS www.samsung.com/uk • PART CODE MZ-76E250BW • FULL REVIEW June 2018

**INTEL** Optane Memory 32GB

£44 • www.scan.co.uk

An interesting twist on M.2 SSDs, Optane Memory isn’t so much a dedicated storage drive as a large cache for your existing hard disk, accelerating its read speeds to NVMe levels at a much lower price.

CAPACITY 32GB • PRICE PER GIGABYTE £1.38 • INTERFACE M.2/NVMe • WARRANTY Five years RTB • DETAILS www.intel.com • PART CODE MEMPEK1W032GAXT • FULL REVIEW Sep 2017

**SAMSUNG** Portable SSD X5 1TB

£86 • www.cclonline.com

For when you absolutely need to shift files as quickly as possible, there’s the X5. Its use of the Thunderbolt 3 interface makes it the fastest external SSD ever.

CAPACITY 1TB • COST PER GIGABYTE 59p • INTERFACE Thunderbolt 3 • WARRANTY Three years RTB • DETAILS www.samsung.com/uk • PART CODE MUX-PB1T0B/WW • FULL REVIEW Dec 2018

**WD** Red 6TB

£173 • www.amazon.co.uk/2nEZIAQ

This is pricier than most 6TB hard disks, even those created specifically for NAS drives, but the WD Red’s performance makes it a worthwhile investment. Despite its 5,400rpm spin speed it manages to outperform 7,200rpm drives such as the Toshiba N300 in read/write tests.

CAPACITY 6TB • COST PER GIGABYTE £0.39p • INTERFACE SATA3 • CLAIMED READ 530MB/s • CLAIMED WRITE 310MB/s • WARRANTY Three years RTB • DETAILS www.wdc.com • PART CODE WD60EFAX • FULL REVIEW Nov 2017

**SAMSUNG** 960 Evo 250GB

£70 • www.scan.co.uk

While it’s not quite as quick as the 960 Pro, the 960 Evo is still the second-fastest NVMe SSD we’ve ever tested, and since it’s much more affordable, it’s the one most people should go for.

CAPACITY 250GB • COST PER GIGABYTE £0.39p • INTERFACE M.2/NVMe • CLAIMED READ 3,500MB/s • CLAIMED WRITE 1,700MB/s • WARRANTY Five years RTB • DETAILS www.samsung.com/uk • PART CODE MZ-V6E250BW • FULL REVIEW Mar 2017

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Choosing a... Graphics card

01 You don’t have to spend much to buy a decent graphics card that can drive multiple monitors. The AMD Radeon RX 550 costs about £100, for example, and while it isn’t suited to playing the latest games in Full HD, it is perfect for watching videos, browsing the web and playing basic games.

02 You’ll need to spend more money if you want to play the latest games. A good mid-range gaming graphics card is the Nvidia GeForce GTX 1060, which is powerful enough to play all modern games at Full HD resolution.

High-powered cards tend to be more expensive, so expect to pay over £400 if you want to play games in Ultra HD at the highest quality settings.

03 Check that your chosen card has the graphics outputs you need. Only low-end cards now have VGA outputs, but many come with a DVI-to-VGA adaptor. Depending on your monitor, you may also want an HDMI output or even DisplayPort connection.

Bear in mind that AMD’s Eyefinity triple-monitor gaming mode requires at least one DisplayPort monitor, which means your AMD graphics card must have at least one DisplayPort output. Nvidia’s Surround three-monitor mode needs only DVI and HDMI ports.

04 The amount of memory a card has is important if you want games to look their best at high resolutions. Unless you’re on a tight budget, get a card with 4GB of RAM, as this should allow you to select the highest-quality textures in games.

05 A card’s size, noise output and power requirements are the final considerations. Make sure your PC’s case has enough room to accommodate your chosen card. Double-slot cards with large fans tend to be quieter than single-slot cards with small fans but will block other expansion slots on your motherboard.

Also check that your power supply can provide the power the card needs and that it has the right connectors. Many cards require a six-pin PCI Express power connector, and some also need an additional eight-pin connector.

COMMENTS

THERMALTAKE Versa H18

★ ★ ★ ★ ★ £60 • www.scan.co.uk

Budget PC cases are often lacking in both features and capacity for upgrades. The Versa H18 isn’t entirely exempt, and is limited to smaller motherboards, but it can easily cope with basic components and ambitious water-cooled builds alike.

CASE TYPE Mini-tower • MOTHERBOARD TYPE MicroATX, Mini-ITX • SUPPLIED FANS 1x 120mm • MAX DRIVE BAYS 2x 3.5in, 2x 2.5in • DIMENSIONS 390x205x380mm • WEIGHT 4.8kg • WARRANTY Three years RTB • DETAILS www.thermaltake.com • PART CODE CA-1J4-00M1WN-00 • FULL REVIEW Nov 2018

AMD Ryzen 7 2700X

★ ★ ★ ★ ★ £300 • www.scan.co.uk

AMD’s second generation of Ryzen processors gets off to an auspicious start with the mighty Ryzen 7 2700X. It’s faster than Intel’s equivalent Core i7-8700K at stock speeds, despite being cheaper, and temperatures stay low even when overclocking.

SOCKET AM4 • CORES 8 • FREQUENCY 3.7GHz • INTEGRATED GRAPHICS None • WARRANTY Two year RTB • DETAILS www.amd.com • PART CODE YD270XBGAFBOX • FULL REVIEW Aug 2018

HYPERX Alloy Elite

£96 • www.currys.co.uk

This is a brilliant do-it-all gaming keyboard: the agile Cherry MX Red key switches provide a strong foundation, upon which HyperX has built a comfortable, detachable wrist rest, dedicated media keys and customisable red backlighting. The USB pass-through port is handy, too.

KEYBOARD SHAPE Full size • NUMBER PAD Yes • CONNECTION 2x USB2 • MEDIA KEYS Pause/play, mute, skip, volume • USB PORTS 1x USB2 • WARRANTY Two years repair and replace • DETAILS www.hyperxgaming.com • PART CODE HX-KB2RD1-UK/R1 • FULL REVIEW Mar 2018

MSI B350M Mortar

£73 • www.scan.co.uk

A near-perfect motherboard for AMD Ryzen-based, microATX systems. It’s remarkably well equipped for connectivity and upgradability, and comes close to much more expensive mobos in performance benchmarks.

PROCESSOR SOCKET AM4 • DIMENSIONS 244x244mm • CHIPSET AMD B350 • MEMORY SLOTS • PCI-E x16 SLOTS 1 • PCI-E x8 SLOTS 2 • PCI-E x4 SLOTS 2 • PCI-E x1 SLOTS 3 • USB PORTS 2x USB3, 2x USB2, 1x USB3 • VIDEO OUTPUTS 1x HDMI, 1x DisplayPort, 1x DVI-D • WARRANTY One year RTB • DETAILS www.msi.com • PART CODE B350M Mortar • FULL REVIEW Aug 2017

NVIDIA GeForce GTX 1060

★ ★ ★ ★ ★ £249 • www.geforce.co.uk

Based on the same Pascal architecture as the fearsome GTX 1080 and GTX 1070, the mid-range GTX 1060 is unmatched when it comes to marrying price with 4K and VR-readiness. It’s surprisingly power-efficient, too.

GPU Nvidia GeForce GTX 1060 • MEMORY 6GB GDDR5 • GRAPHICS CARD LENGTH 250mm • WARRANTY Three years repair and replace • DETAILS www.geforce.co.uk • PART CODE GTX 1060 Founder’s Edition • FULL REVIEW Nov 2016

THERMALTAKE View 37

£103 • www.scan.co.uk

A spacious, feature-rich choice for both ATX- and EATX-based builds, the View 37 comes with a gull-wing side window that’s perfect for showing off your handiwork.

CASE TYPE Mid-tower • MOTHERBOARD TYPE ATX, EATX, microATX, Mini-ITX • SUPPLIED FANS 2x 140mm • MAX DRIVE BAYS 7x 3.5in, 1x 2.5in • DIMENSIONS 525x265x583mm • WEIGHT 11.8kg • WARRANTY Three years RTB • DETAILS www.thermaltake.com • PART CODE CA-1J7-00M1WN-00 • FULL REVIEW Nov 2018

VERSACE H18

★ ★ ★ ★ ★ £60 • www.scan.co.uk

Budget PC cases are often lacking in both features and capacity for upgrades. The Versa H18 isn’t entirely exempt, and is limited to smaller motherboards, but it can easily cope with basic components and ambitious water-cooled builds alike.

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SOFTWARE

**ADOBE** Premiere Pro CC 2018
★★★★★
£20 per month ✽ www.adobe.com

There’s a lot to love in this update, especially the improved support for collaborative editing and a host of new tools for producing VR-ready 360° content.

**OS SUPPORT** Windows 7/8/10, OS X 10.11, macOS 10.12 and later ✽ **MINIMUM GPU** Multicore ✽ **MINIMUM RAM** 1GB (32-bit), 2 GB (64-bit) ✽ **HARD DISK SPACE** 8GB ✽

**DETAILS** www.adobe.com ✽ **FULL REVIEW** Jun 2018

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**KASPERSKY** Security Cloud
★★★★★
£50 ✽ www.kaspersky.co.uk

It’s just as effective as Kaspersky Total Security, but Security Cloud goes a step further by learning your bad security habits and warning you about them.

**OS SUPPORT** Windows 7/8/10, OS 10.11/macOS 10.12, Android 4.1 and later, iOS 10/11 ✽ **MINIMUM CPU** 1GHz ✽ **MINIMUM GPU** None ✽ **MINIMUM RAM** 1GB (32-bit), 2GB (64-bit) ✽ **HARD DISK SPACE** 1GB (Windows), 1.5GB (Mac) ✽

**DETAILS** www.kaspersky.co.uk ✽ **FULL REVIEW** Jan 2018

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**NORDVPN**
★★★★★
£9 per month ✽ www.nordvpn.com

There are cheaper VPN services available, but none has the flexibility and multi-level security features of NordVPN. It’s become much faster than previous versions, too.

**OS SUPPORT** Windows, macOS, iOS, Android, DD-WRT router ✽ **PRODUCT CODE** NordVPN ✽ **FULL REVIEW** Sep 2018

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**ABBYY** FineReader 14
★★★★★
£249 ✽ www.abbYY.com

The more feature-rich Corporate edition is expensive, but FineReader 14 is perfect for turning paper notes and documents into digital, editable files using optical character recognition (OCR).

**OS SUPPORT** Windows 7/8/8.1/10 ✽ **MINIMUM CPU** 1GHz ✽ **MINIMUM GPU** DirectX 10 ✽ **MINIMUM RAM** 4GB plus 512MB per additional CPU core ✽ **HARD DISK SPACE** 2.4GB ✽

**DETAILS** www.abbYY.com ✽ **PRODUCT CODE** FineReader 14 ✽ **FULL REVIEW** May 2017

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**MICROSOFT** Windows 10
April 2018 Update
Free ✽ www.microsoft.com

Besides some subtle visual tweaks, the latest major update for Windows adds some genuinely useful features, such as Focus Assist and Timeline.

**OS SUPPORT** Windows 10 ✽ **MINIMUM CPU** GHz or faster ✽ **MINIMUM GPU** Direct 9 or later with WDDM 1.0 driver ✽ **MINIMUM RAM** 1GB (32-bit), 2GB (64-bit) ✽ **HARD DISK SPACE** 16GB (32-bit), 20GB (64-bit) ✽

**DETAILS** www.microsoft.com ✽ **FULL REVIEW** Aug 2018

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**MAILBIRD** Mailbird Pro 2.0
£9 per year or £28 lifetime ✽ www.getmailbird.com

While the free version of this email client is good, upgrading to Pro is even better – you get a unified view of all your mailboxes, loads of themes and extensive integration with other apps and productivity software.

**OS SUPPORT** Windows XP/7/8/8.1/10 ✽ **MINIMUM CPU** N/A ✽ **MINIMUM GPU** N/A ✽ **MINIMUM RAM** N/A ✽ **HARD DISK SPACE** 50MB ✽

**DETAILS** www.getmailbird.com ✽ **FULL REVIEW** Nov 2016

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**GAMING**

**XBOX** One S
★★★★★
£222 ✽ www.amzn.to/2yWNCv

HDR support is great, but it’s the 4K Blu-ray player that makes this sleeker, smaller Xbox One really stand out against the competing PS4 Slim.

**PROCESSOR** Octa-core 1.75GHz Jaguar ✽ **RAM** 8GB DDR3 ✽ **FRONT USB PORTS** 4x USB2 ✽ **REAR USB PORTS** 2x USB2 ✽ **STORAGE** 500GB/1TB/2TB ✽ **WARRANTY** One year RTB

**DETAILS** www.xbox.com ✽ **PART CODE** Xbox One S ✽ **FULL REVIEW** Dec 2016

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**OCULUS** Go
★★★★★
£199 ✽ www.amzn.to/2L4s5wx

No longer do you need a decked-out PC or premium smartphone to enjoy VR. The Oculus Go cram all the hardware you need into the headset itself, making virtual reality entertainment as immediate and accessible as it’s ever been.

**DISPLAY** LCD ✽ **RESOLUTION** 2,560x1,440 ✽ **REFRESH RATE** 72Hz ✽ **PROCESSOR** Octa-core 2x 2.4GHz Qualcomm Snapdragon 821 ✽ **RAM** 3GB ✽ **WEIGHT** 450g ✽

**DETAILS** www.oculus.com/go ✽ **PART CODE** Go 3GB ✽ **FULL REVIEW** Sep 2018

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**SONY** PS4 Slim
★★★★★
£260 ✽ www.argos.co.uk

Sony has made the PlayStation 4 even better with a slimmer, newer chassis and superior power efficiency. It’s as cheap as the PS4 has ever been before.

**PROCESSOR** Octa-core 1.6GHz AMD Jaguar ✽ **RAM** 8GB DDR3 ✽ **FRONT USB PORTS** 4x USB2 ✽ **REAR USB PORTS** None ✽ **STORAGE** 500GB/1TB/2TB ✽ **WARRANTY** One year RTB

**DETAILS** www.playstation.com ✽ **PART CODE** B01GVQVQH2 ✽ **FULL REVIEW** Jan 2017

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**NINTENDO** Labo
★★★★★
£60 ✽ www.very.co.uk

Nintendo’s Labo almost defies explanation: it’s a combination of video game, cardboard model kit and children’s educational tool. What we do know is that it’s incredibly innovative, rewarding and great fun.

**AVAILABLE FORMATS** Nintendo Switch ✽ **DISK SPACE** Not stated ✽ **DETAILS** labo.nintendo.com ✽ **PART CODE** Nintendo Labo ✽ **FULL REVIEW** Aug 2018

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How we test

Find out how well products perform with the help of Computer Shopper’s comprehensive tests

**COMPUTER SHOPPER’S REVIEWS** use some of the most exhaustive testing procedures you'll find in any PC magazine. Every product is subjected to qualitative and quantitative tests that show how it performs in practical use. Graphs for performance, battery-life scores and costs are used in the Reviews section, as shown on the right. Look in the ‘Summary of tests’ table (below) for details of each test we run.

For PCs and laptops, we evaluate performance using our own custom benchmarking suite. See below right for a brief description of our benchmarking software and game tests.

**SUMMARY OF TESTS**

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**BENCHMARKS**

**SHOPPER BENCHMARKS**

Our benchmark suite uses open-source software that runs on Windows, Mac OS X and Linux systems. This lets us use objective results to compare PCs and laptops, no matter which operating system they run. It’s designed to test each computer to its limit, using a combination of intensive image-editing, video-encoding and multitasking tests.

We ran the tests on our reference PC, which has an Intel Core i5-4670K processor, 8GB of DDR3 RAM and an AMD Radeon R7 260X graphics card. We normalised our results so this PC had a score of 100. This makes it easy to draw comparisons between test systems.

The resulting overall score is shown at the bottom of every PC and laptop review. As we use the same tests in our standalone and group test reviews, you can compare the performance of any computer, whether it's a hybrid, laptop or desktop, from both sections of the magazine.

**3D BENCHMARKS**

**DIRT SHOWDOWN**

Dirt Showdown is a cracking racing game that makes good use of DirectX 11’s fancy graphical effects. You'll want at least 30fps for smooth racing.

**TOMB RAIDER**

With the ultra-demanding Super-Sampling Anti-Aliasing (SSAA) enabled, 2013’s Tomb Raider reboot is a great indicator of mid-range performance.

**METRO: LAST LIGHT REDUX**

Our most demanding graphics test uses tessellation, SSAA and massive textures to give even high-end cards a thorough workout.
The easiest way to buy your next car

Skip the forecourt - great deals from the comfort of your home

With over 40,000 new and used cars to choose from across the country, buyacar.co.uk makes it simple to find the car you want and will deliver it straight to your door.

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Choose from thousands of cars, apply for finance online with us and value your existing car - all from the comfort of your home.

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Whether buying outright or taking one of our affordable monthly payment plans, we’ve travelled the UK for the best deals - so you don’t have to.

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All our cars come from UK main dealers and go through rigorous checks and tests before they arrive at your door.

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Find out more at buyacar.co.uk

100% would recommend!
All members of staff are lovely and willing to help.

Pleased with service
The process of getting the car was very easy and secure.

Easy Peasy!
No trawling garage showrooms! Already recommending to friends & family.

Purchased VW Golf
I was nervous about buying on the internet. Needn’t have worried.

READ MORE REVIEWS ON TRUSTPILOT

Dennis Buyacar Ltd, 31-32 Alfred Place, London, WC1E 7DP (GB09151058) (FRN 667368) is Authorised And Regulated By The Financial Conduct Authority. Buyacar is a credit broker and not a lender.
Product Reviews

Our guide to all the products reviewed in this month’s Computer Shopper

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Free software guide

It’s easy to access your free software. Just go to www.shopperdownload.co.uk/371 and register with the code from the card insert. Please be aware that you need to have bought the ‘Free Software Edition’ and not the ‘£4.50 Edition’ to access the downloads.

SoftMaker Office NX Home

OFFICE NX HOME is a powerful productivity suite, providing an alternative to Microsoft Office while keeping compatibility with its key file types.

The package includes a word processor (TextMaker), a spreadsheet (PlanMaker) and a presentation tool (SoftMaker), and each of these can open both the old-style and Office 365/2010 files for their equivalent Microsoft application (DOC and DOCX, XLS and XLSX, PPT and PPTX, and so on). Conversion is reasonably accurate, too, although there are occasional problems with more complex documents.

If you’re not a fan of the Microsoft Office UI, then the SoftMaker Office interface may appeal, as it offers a classic style (a ribbon is available as an option) to the more conventional menus and toolbars. You also get the standard Microsoft Office flat-designed theme interface if you prefer this instead. There’s even a dark UI to match Windows 10’s ‘dark mode’.

The suite also has lots of useful extras, including a handy Export to PDF option on every File menu, and the ability to be installed on a USB flash drive.

The commercial version of Office NX Home gives you a whole host of additional features in comparison to the Free version. We’re offering you a whole year’s subscription to Office NX Home to take advantage of the additional content.

Steganos Safe 19

STEGANOS SAFE IS a versatile tool that aims to protect your most important files in a secure encrypted vault. You could create this vault on a system drive, but it’s also possible to use an external drive or USB key, enabling you to keep your files safe as you carry them around.

The vault is protected by a password, and Steganos Safe will warn you if your chosen password isn’t secure. Alternatively, you could use the built-in password generator to automatically create one that’s truly tough to crack.

Once your vault is generated, it’s available in Windows Explorer, and acts like any other folder. The key difference is that your data is encrypted as it’s saved, ensuring only someone with the password can gain access.

If that’s still not enough, you can even create a ‘hidden safe’, where a small safe (less than 3GB) is hidden inside an audio or video file. Snoopers might see an MPEG on your USB drive, for example, and be able to play it as usual, but only you will also be able to access the data it contains.

Cloud storage support enables you to use Safes with your Dropbox, Microsoft OneDrive or Google Drive accounts. Set this up and your data is encrypted in the cloud, so even if the provider gets hacked there’s still no way anyone can access your files.

Steganos Safe completes its feature set with a comprehensive shredder, securely deleting any remnants of confidential files on your hard disk to ensure they can’t be recovered later.
**WiseCare365 Pro**

**KEEPING YOUR COMPUTER**

Running smoothly can take a lot of work, but WiseCare365 offloads most of it with tools to easily check your system for problems or clean up the Registry and drives.

The interface is broken down into a number of sections, the first housing the PC Checkup tool, which can be used to scan your system for problems as well as identifying possible areas for optimisation. The System Cleaner section includes Registry and hard disk cleanup options, such as the ability to remove unnecessary files and Windows components. The System Tuneup section is where most people should head first: it offers the ability to make many small tweaks, which could add up to faster boot speeds and better overall performance.

Several other, more general tools are included, such as a password generator, a file shredder and a disk shredder. While these aren’t as developed as the system care aspect, it is handy to have so many tools all available in one place.

The Pro version unlocks access to a number of extra features, mainly focused on maintaining privacy and protecting against malware, but if you’re looking for a simple clean-up and tweaking tool, the free edition will more than suffice.

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**Abelssoft EasyBackup 2019**

**BACKING UP IMPORTANT data** is such a chore that we often forget until it’s too late and we’ve lost our files.

With the rise of cloud-based storage, we can sometimes over-rely on keeping our files stored away, safe and secure. The problem with cloud backups is that they rely on the same content on your computer. Cloud storage simply mirrors the files you’ve stored locally. If you remove files from your cloud folder or they become corrupted, you might find that these actions are replicated online.

With this in mind, we’d recommend a dedicated backup tool such as EasyBackup. Designed to be simple for novice users, you simply have to select the files you want to back up and the destination, and the software will do the rest.

Choose the files you want to back up from locations such as your pictures, documents and music folders, manually choose individual files and folders stored elsewhere on your computer, then plug in your USB stick or an external drive and your files will be backed up automatically.

If you need to recover data, you can simply load EasyBackup, choose a restore date and retrieve your data from the drive.
**iolo System Mechanic 17.5**

**SYSTEM MECHANIC 17** is an amazingly comprehensive tool that provides everything you’ll need to clean and speed up your PC, fix system problems and protect your privacy.

If your PC isn’t performing, for instance, System Mechanic will help you defragment your hard disk, optimise your internet connection for faster downloads, defragment and compact the Registry, optimise the boot process by removing unnecessary startup programs, and provide a temporary performance boost by closing selected background processes.

Each of these functions in turn delivers far more than you might expect. For one thing, you don’t just get a defrag module: System Mechanic also uses the Program Accelerator, optimising applications by grouping related files together, while enhanced AccelleWrite technology helps to improve the efficiency of your drives, and the SSD Accelerator keeps solid-state drives running at their optimum performance levels.

It’s the same across the suite, with powerful features and functionality everywhere you look. There are tools here to defragment and compact the Registry, repair hard drive problems, enhance system security, locate unnecessary duplicate files, or recover from disaster if Windows won’t boot. A Windows tweaking tool provides easy access to more than 100 key Windows settings, and an Advanced Uninstaller completely removes apps to free up hard disk space – and you could still create a very capable maintenance suite from the other tools we haven’t got space to mention.

---

**Auslogics BoostSpeed 10**

**AUSLOGICS BOOSTSPEED** is a comprehensive suite of tools that will improve performance in just about every area of your PC’s operations.

If your system is slow to boot, for instance, the Startup Manager can locate and disable unnecessary Windows startup programs, Explorer extensions and more. BoostSpeed can highlight ‘dangerous’ items, programs it believes may be spyware, for an additional security benefit.

BoostSpeed also makes it easy to speed up a sluggish hard disk. There are tools to remove junk and leftover files, clear your web, Windows and application histories, and explore your drive to see which folders are consuming the most space. The excellent Auslogics Disk Defrag will then rearrange your files to deliver the best possible performance.

There are plenty of useful bonus functions, too. These include modules to undelete files, discover and fix hard disk problems, view system information, securely shred data or wipe entire disks to make sure any personal data they contained has gone forever.

If browsing all these modules sounds too much like hard work, you can simply launch a System Scan and BoostSpeed will automatically and quickly identify Registry problems, leftover hard disk junk, file fragmentation and more, fixing all identified problems with a single click.

Alternatively, System Advisor can scan your PC for unwanted programs, surplus services and misconfigured settings, recommending tweaks and automatically applying them on demand.

This latest build also brings a host of smaller improvements to enhance the program’s effectiveness, fix bugs and improve configurability, and generally ensure it does an even better job of helping your PC run at its best.

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**REQUIREMENTS** Windows XP, Vista, 7, 8, 10 
32/64-bit, 50MB hard disk space 
**WEBSITE** www.iolo.com 
**NOTES** Get your registration code at sm17.disc.computershopper.co.uk. Includes a six-month licence.

**REQUIREMENTS** Windows XP, Vista, 7, 8, 10, 75MB hard disk space 
**WEBSITE** www.auslogics.com 
**NOTES** Get your registration code at boostspeed10.disc.computershopper.co.uk.
Resources

Chat and Communication

**Updated** Evernote 6.15.4.7934  Store your notes, ideas and plans in the cloud, and synchronise them between computers.

**Updated** Mailbird 2.5.20.0  A free desktop email client for Windows.

**Updated** Miranda IM 0.10.80  Chat with friends across multiple messaging platforms, including AIM, Facebook, IRC and MSN, all from one simple interface.

**Updated** Skype for Windows 8.31.0.92  Make internet voice and video calls for free, and buy credit to make calls to mobiles and landlines.

**Updated** Telegram 14.0  This free IM app synchronises your conversations across multiple devices, and can spruce up chats with stickers and GIFs.

**Updated** WhatsApp Desktop 0.3.557  A free PC and Mac version of the popular messaging app, letting you chat from your desktop.

Customisation

**New Version** iolo System Mechanic Free 18.0.1  Speed up your system with iolo’s PC optimisation suite.

Rainmeter 4.2  Customise the desktop with your choice of tools and shortcuts.

Windows 8 Transformation Pack 9.1  Emulate the look of Windows 8 on an earlier version of the operating system.

**Updated** Cyberduck 6.8.0.28825  A powerful but easy-to-use FTP client for uploading and downloading your files.

**Updated** Glasswire 2.0.123  Keep tabs on your network usage with this simple monitor.

**Updated** SUMo 5.8.2.404  Quickly scan your PC’s installed applications and find any updates that are available for them.

**Updated** FileZilla 3.37.4  A fast and reliable FTP client with lots of useful features.

**Updated** NetBalancer 9.12.5  Make the most of your internet connection by assigning download and upload priorities to web applications.

**Updated** TeamViewer 13.2.26558  Remote-control your computer from anywhere in the world.

General

**Updated** Screenshot Captor 4.29  Create and manage screenshots the easy way.

**Updated** iolo System Mechanic Free 18.0.1  Speed up your system with iolo’s PC optimisation suite.

**Updated** Skype for Windows 8.31.0.92  Make internet voice and video calls for free, and buy credit to make calls to mobiles and landlines.

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**Updated** TeamViewer 13.2.26558  Remote-control your computer from anywhere in the world.

Internet and Network

**Updated** CarotDAV 1.15.5  Manage all your online storage services with one simple application.

**Updated** Cyberduck 6.8.0.28825  A powerful but easy-to-use FTP client for uploading and downloading your files.

**Updated** Glasswire 2.0.123  Keep tabs on your network usage with this simple monitor.

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**Updated** CCleaner 5.47  Remove unwanted information, temporary files, browsing history, huge log files and even the settings that uninstalled software leaves behind.

**Updated** Defraggler 2.22  Ensure that your system is defragmented properly and improve its performance.

**Updated** Finestra Virtual Desktops 2.5.4501  Set up four or more virtual desktops on your PC.

**Updated** Cyberduck 6.8.0.28825  A powerful but easy-to-use FTP client for uploading and downloading your files.

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FRAME WORKS
PC cases

A custom PC requires suitable accommodation, so be sure you choose the right chassis for your build with our buying guide and hands-on tests.

**THE WORST MISTAKE** to make when buying a PC case is to treat it as merely a vessel; something that only exists to hold all the more exciting parts in place.

In reality, no other component in a PC build exerts so much influence on the rest. The case determines what kind of motherboard you can use, whether a graphics card will fit, how many storage drives you can install and even how cool the finished system can run. On top of all this, it has key duties of its own: a good case should be easy and practical to build into, and should at least look good enough on the outside that you don’t get sick of the sight of it.

In other words, a lot rests on the humble case, as well as your ability to find one that suits your needs. We can help with that: in addition to the following buying guide, where we break down the desirable and not-so-desirable qualities of chassis design, we’ve reviewed a diverse mix of seven recently launched cases. Read on to make sure you don’t end up building yourself into a corner.

**VANITY PROJECT**

It’s easier to build a great PC if the case itself has been constructed well. Indeed, while your desktop is unlikely to be going anywhere in a hurry, durability and robust materials are just as welcome qualities here as they would be on a smartphone or laptop.

That means looking out for tough, strong metals, which don’t flex or bend when
pressure is applied. At the same time, a case needs to be aesthetically pleasing, something that may be in the eye of the beholder but is no less important all the same. For home office or living room PCs, more tasteful, understated designs make the most sense, while gaming systems can get away with far more ostentatious looks. That’s not to say that ugly, over-designed models get a free pass, but it is possible to integrate things such as full glass side panels and RGB lighting in ways that still look sufficiently grown-up.

Above all else, you should only part with your cash for something that you personally like the look of – after all, you’re the one who’ll be seeing it in your house every day. There’s nothing wrong with passing over a better-featured rival if you’re not keen on its styling.

FITTING IMAGE
That said, you should pay close attention to a case’s compatibility with internal components, since, as we say, not every case will be able to fit every component. Case sizes are often linked to the largest motherboard form factor they can hold, so EATX-compatible cases tend to be the biggest, with ATX-compatible cases usually in the middle. Smaller models will likely only be able to hold microATX and/or Mini-ITX boards, so if you want to install, say, multiple PCI-E devices, you’re better off with a case that can fit an ATX or EATX motherboard.

It’s worth noting that cases will usually also be able to hold smaller motherboard sizes, so an ATX-compatible case could also take a microATX or Mini-ITX board, although this wouldn’t be a very efficient use of space. Storage drive capacity won’t be a concern to everyone, as most users can get by with just one or two drives. However, PCs built for media editing, photography, videography or gaming can greatly benefit from multiple SSDs and hard disks, so the more trays, bays and mounting points, the more flexible a case can be.

Before speccing your PC with a graphics card or CPU cooler, you should also check a case’s clearances. A GPU clearance below 300mm, for instance, will mean that the largest graphics cards will simply be too long to fit inside. CPU cooler clearance refers to the maximum allowed height of a tower-style CPU air cooler; 160mm will be enough for most. If you want watercooling, you should also make sure there’s room to install the radiator, which will need to be fitted to the case’s fan mounts.

GENERATION VENT
This brings us to cooling support. All tower-style cases should have a few different places to install fans, and more is definitely better in this regard. Even if you don’t have to fill every single slot, your PC should be able to benefit from a cyclical airflow (where cold air is drawn in and hot air is pushed out) covering as many of the internals as possible.

Above all else, you should only part with your cash for something that you personally like the look of – after all, you’re the one who’ll be seeing it in your house every day.

Of course, it’s even better if all of this is done for you, so pre-installed fans are a massive bonus. Ideally, there should be at least one fan at the front and one fan – the exhaust – at the back, although cases such as the NZXT H500 provide an acceptable alternative of a roof-mounted fan.

FIT TO BE TIED
The best cases don’t just enable a PC to run well once it’s been completed: they also take steps to ensure that the building process itself goes smoothly. This can be as simple a thing as providing a spacious, airy main chamber that doesn’t make it difficult to use your hands or see what you’re doing, but there are other tools as well.

Many of these are focused around cable management – the process of tidying up the myriad cables and wires that run between PC components. Being able to get these organised and out of the way won’t just make your PC prettier (it’s definitely worth doing if your case has a side window), it can also improve airflow by preventing thicker cables acting as obstructions. Therefore, watch out for things such as fabric straps, routing channels, large routing holes and rubber grommets, all of which can help you keep the cabling neat.

THE BEST PC CASES FOR...

BUDGET BUILDS

THERMALTAKE Versa H18
Sometimes a microATX motherboard is all you need, especially when you’re trying to save on component costs – and if that sounds like you, you might just love the Versa H18. This compact case is fantastically affordable, at just £40, but manages to stand up to bigger mid-towers on many of its features. That doesn’t stretch to ATX motherboard support, but storage capacity is good (either two 3.5in drives and two 2.5in drives, or four of the latter), and there are plenty of fan slots, too. It’s also big enough for easy building while still being small enough to tuck away neatly.

MID-RANGE GAMING

COOLER MASTER Masterbox K500
This mid-tower is a fine example of how to pull off a bold exterior design without it coming off as obnoxious or infantile. Despite looking a bit like a sci-fi cyborg’s chestplate, the front of the Masterbox K500 has a sharp, clean quality, which isn’t remotely compromised by the RGB lighting of the included fans.

PC gamers will appreciate the healthy airflow these fans provide, as well as the generous 600mm GPU clearance and reasonable £74 price, which frees up your budget to go towards more performance-oriented components. Storage capacity isn’t the best, but with space for two large hard disks as well as a fast 2.5in SSD, it’s still enough for plenty of games.

PREMIUM PCS

THERMALTAKE View 37
The Cooler Master Cosmos C700M is a better chassis on a technical level, but the View 37 packs in lots of premium features at a fraction of the price. A superbly high storage capacity and EATX compatibility make it suitable for more serious workstation-type builds, while the massive ‘gull-wing’ window and excellent cooling lend themselves to a top-of-the-line gaming rig as well.

Regardless of what kind of PC you want, the View 37’s distinctive curved panel isn’t just for show. Removing it clears away both the side and top panels at once, so the interior chamber is opened up far more than on any other tower. This makes tinkering even easier; perfect if you’ve got the budget to stuff the whole thing full of components.
AS WITH ANY type of PC component, there’s inevitably a case designed to be as big, brash and expensive as the format would allow. Enter the Cosmos C700M: a huge, RGB-laden, EATX-compatible tower that costs more than the other six models in this test put together. That statistic alone will be enough to make most potential buyers run. Yet the Cosmos C700M is overtly and proudly intended for those to whom money is no object, and has the features and build quality to prove it.

COLD HEARTED Cooling support is outstanding throughout. Four 140mm fans come pre-installed – one at the back, three at the front – and you can positively stuff the Cosmos C700M with extras. Both the front and the top mounts support radiators up to 420mm long, naturally alongside tripled-up 140mm or 120mm fan setups, while the bottom can – if only with a sold-separately bracket – hold up to two 120mm or 140mm fans plus a 240mm radiator. The rear can be fitted with a 140mm radiator as well, and removing the two 3.5in trays makes room to mount an open-loop reservoir. It’s a wonderfully comprehensive collection.

Speaking of drive trays, these are the only two dedicated 3.5in mounts in the case, though a third is included in the accessory box. Five modular 2.5in brackets are also pre-installed, with one home to a combined fan and RGB controller, giving you four to stick SSDs on. This is one area where we were expecting slightly more from the Cosmos C700M, as it only offers a couple of 2.5in bays more than the Phanteks Eclipse P350X or NZXT H500, despite both of these being much smaller mid-range cases. The Cosmos C700M has the additional advantage of a 5.25in tray, but you’d need to replace the entire front panel to one with a cut-out if you wanted to use it for an optical drive instead of storage.

AS WOULD ANY type of PC component, there’s inevitably a case designed to be as big, brash and expensive as the format would allow. Enter the Cosmos C700M: a huge, RGB-laden, EATX-compatible tower that costs more than the other six models in this test put together. That statistic alone will be enough to make most potential buyers run. Yet the Cosmos C700M is overtly and proudly intended for those to whom money is no object, and has the features and build quality to prove it.

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COOLER MASTER Masterbox K500

VERDICT
This mid-tower’s striking looks will grab your attention; cooling and ease of use will keep it

NORMALLY WHEN WE’RE sent a Cooler Master case for review, it’s some enormous thing like the Cosmos C700M or the MasterCase H500P Mesh White (Shopper 364), so it’s nice to see something as mainstream-friendly as the Masterbox K500.

It’s a mid-tower case capable of holding motherboard sizes up to ATX, so it hits the sweet spot where it’s not so big that it takes over your desk or floor but is still spacious enough for a multitude of hardware.

SPIN DOCTOR
On that note, cooling gets off to an excellent start, with dual 120mm intake fans and one 120mm rear exhaust fan; there’s certainly no pressing need to buy more. The intakes are equipped with RGB lighting, too, and while pressing need to buy more. The intakes are RGB lighting of its own, it still feels pretty cheap in places and lacks a pre-installed exhaust fan.

Cooling support is better, even discounting the included fans. At the front are a total of three 120mm slots or two 140mm slots, with more than enough space for a 280mm radiator or smaller (unfortunately, 360mm radiators are just a tiny bit too tall). The roof of the case provides an additional two 120mm slots, along with a convenient magnetic dust filter on the top, which is easy to remove and clean. There’s not enough clearance from the motherboard to also make room for a radiator up here, but if you’ve got a 120mm AIO watercooler, you could alternatively unscrew the rear fan, install the radiator in the same place, then reattach the fan on top of it.

You could get more extensive cooling support from a larger, more enthusiast-leaning chassis such as the Thermaltake View 37, but the K500 still manages to offer decent scope for future upgrades while granting users a very respectable three-fan setup right from the start.

FILLING TIME
Further building-friendliness comes in the form of a wide, deep main chamber, which is almost completely devoid of sharp edges and annoying little nooks for screws to get lost in. More importantly, it allows for graphics cards to be a generous 400mm long, the same as the Eclipse P350X. The NZXT H500’s equivalent clearance of 381mm doesn’t seem like that much behind, but it could wind up making the difference if you end up with one of the new GeForce RTX cards, which use Nvidia’s largest GPUs yet.

CPU cooler clearance, conversely, goes to NZXT: the H500 has the space for heatsinks and fans to reach up to 165mm tall, whereas the K500 (and P350X) can only claim 160mm. But the K500 still manages to offer a very respectable three-fan setup right from the start.

Storage-wise, the K500 includes two 3.5in trays, which can also hold one 2.5in drive each instead. In addition, there’s one spare 2.5in mounting bracket, which can be placed either on the vertical wall of the main chamber or on top of the PSU shroud. Unfortunately, this still means you can only install a total of three storage drives out of the box (one less than the NZXT H500 or the Phanteks Eclipse P350X, both mid-towers within the £60-£70 range). If Cooler Master had been less stingy with the mounting brackets, including one for every possible position, this could have been doubled to six.

Cooling support is better, even discounting the included fans. At the front are a total of three 120mm slots or two 140mm slots, with more than
KOLINK Satellite Plus

£45 • From www.overclockers.co.uk

VERDICT
It won't suit more performance-based setups, but the Satellite Plus is a handsome candidate for living room PCs

CUBE-STYLE CASES are a fitting alternative to towers whenever you want to save space. This could be just to make room on your desk, but compact designs such as the Kolink Satellite Plus also excel as part of a home cinema PC build, as cube cases tend to fit more easily into AV cabinets. The fact that they don’t look like the archetypal tower PC also helps maintain your living room aesthetic.

The Satellite Plus is particularly mindful of looks, as compared to the standard Kolink Satellite, it has exactly the same specs – drive capacity, motherboard support, dimensions – but has dropped the Satellite’s plain, mesh-fronted design for a more tasteful brushed aluminium finish. The resulting chassis mesh-fronted design is far more stylish than the Satellite. We deck – small as it is, it’s still 190mm tall – but is far more stylish than the Satellite. We especially like how the I/O panel is positioned on the right, affording a clean front that’s only accented by a circular power button.

BOX OF TRICKS
Naturally, a PC chassis isn’t all about appearances, and compact cube cases in particular need to be smart about how they use their limited internal space. Happily, that’s exactly what Kolink has done here.

For instance, removing the top panel (this and both side panels can be popped off once their fastening screws have been removed from the back) doesn’t just reveal empty space: stretching across the gap is a metal bar for attaching two 3.5in drives, two 2.5in drives, or one of each. This saves the need for a more space-hogging drive cage elsewhere, and what’s more, there’s another bar on the right-hand side, which can hold an additional two 2.5in drives or one extra 3.5in drive.

That gives the Satellite Plus a total storage capacity of four drives, the same as the Thermaltake Versa H18, Phanteks Eclipse P350X and NZXT H500 – not bad considering these are all larger tower-style cases.

You’re still more or less limited to tiny Mini-ITX motherboards – the product description lists support for microATX boards ‘up to 226x180mm’, but the only ones we can find that use this obscure form factor are ancient AM3+ boards, which you shouldn’t really be considering in 2018. Since standard, 244x244mm microATX motherboards won’t fit, this is essentially a Mini-ITX chassis.

That’s fine, of course, for a range of builds, from simple home media PCs to gaming systems. There are two PCI-E slots at the back, enough for the vast majority of modern graphics cards, although GPU clearance is a relatively modest 280mm, so a lot of high-end cards won’t fit. CPU cooler clearance, on the other hand, is on a par with a good tower, reaching 165mm.

WARM FEELINGS
Cooling won’t be something to skimp on when it comes to components, as in the airflow department there isn’t much to be done with the Satellite Plus itself. Drilled holes in both side panels allow a certain amount of ventilation, and the pre-installed 120mm fan will help prevent hot air building up, but this is not the kind of case you can stuff with large fans and larger water-cooling radiators.

Indeed, that 120mm fan mount is the only one in the case; it would be possible to add a 120mm AIO radiator, although this would reduce its effectiveness as an exhaust for the rest of the internal chamber. In other words, if you’re ambitiously going to get huge PC power into a small case, it might be wiser to go with the Versa H18, where the components have a bit more room to breathe.

First-time builders might also have an easier time in general with a tower-style case, as there are a few idiosyncrasies when it comes to working with a cube chassis such as this.

For one thing, the top storage-mounting bar – as glad as we are to have it – gets in the way somewhat when installing the motherboard and graphics card, and because the PSU gets enclosed at the front – rather than sitting at the back with its rear panel exposed, like on towers – you don’t have easy access to its power switch. Therefore, you must either leave it permanently switched on, or be willing to remove the right side panel every time you want to turn it off, or even just to perform a hard reset.

Cable management, as a concept, also doesn’t really exist within the Satellite Plus. You can zip-tie the front I/O wires together, but there aren’t any dedicated bars, clips or straps to keep them fully out of the way of other components. At least there’s no see-through window, so you can at least ignore the cables until it’s time to open up the case and start shoving them aside again.

SQUARE DEAL
In fairness, limited cooling, odd layouts and wayward cables are all common trade-offs for the compact convenience of a cube chassis – it’s unfortunate that they apply to the Satellite Plus, but they’re not specific to this single case. Even so, these niggles steer the Satellite Plus even further toward basic, air-cooled PC configurations and away from more powerful premium systems.

Which, frankly, is fair enough. The £45 price already makes this a lower-end proposition, and while the Versa H18 is even cheaper – as well as better for a wider range of builds – the Satellite Plus is an ideal candidate for a home media PC, where having the mightiest CPU and graphics card isn’t as important as space-saving, classy design, and scope to add more storage if necessary.
**NZXT H500**

★★★★☆

£70 • From www.scan.co.uk

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**VERDICT**

It’s better value than most H-series cases, but the H500 still isn’t NZXT’s best work

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**IS SOMEONE AT NZXT a Shopper reader?**

We’ve previously complained that the component maker’s H700i (Shopper 361) and H400i (Shopper 363) PC cases had limited their appeal by massively inflating prices via the inclusion of dubiously useful ‘smart devices’ – essentially souped-up fan hubs with RGB lighting and built-in cooling controls. In practice, the smart device doesn’t do much a decent piece of system monitoring software can’t do, leaving you with an otherwise good case that costs more than it should.

At least someone who’s aired this grievance is being listened to, as you can now buy NZXT’s latest H-series mid-tower either with the smart device (the £100 H500i) or without, hence the much cheaper H500. With support for motherboards ranging from Mini-ITX to full-sized ATX, and an even lower price than the microATX-focused H400i, this chassis might be the star all-rounder of the H family.

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**A TOUCH OF GLASS**

Unfortunately, a serious of follies gets in the way, but first let’s consider the H500’s strengths. It’s a good-looking case, simultaneously sharp and understated; a PSU shroud runs down the full length of the interior, hiding the majority of any cables, while a tempered glass side panel lets you admire the handiwork of your finished rig.

This is removed by pulling it down vertically, which is slightly more practical than on most cases (including NZXT’s), where they need to slide backwards – something that can be difficult if your PC is positioned up against a wall.

The main chamber isn’t massive, having a fairly middling CPU height clearance of 165mm, but its GPU length clearance of 381mm is great, and NZXT has devised a clever new method for installing intake fans and water-cooling radiators: a 280mm bracket at the front. This can be removed so you can screw on the components outside the case, then simply replace the bracket with everything attached – a bit like how, when building a PC, you’d install the CPU and RAM on the motherboard outside the case before adding it all in at once. It’s just a little something that makes putting it all together that bit easier.

Although storage capacity is nothing special – you can have either two 2.5in drives plus three 3.5in drives, or three 2.5in drives plus two 3.5in drives – the H500 does have the H700i’s nifty movable 2.5in trays, which can be repositioned on top of the PSU shroud or behind the motherboard tray with relative ease. Fan support is reasonable for the case’s size, too, with room for single 120mm fans at the back and in the roof as well as either two 120mm or two 140mm fans at the front. Bonus points are also earned for having the rear and roof mounts already filled with pre-installed fans; a lot of sub-£100 cases only include a single exhaust fan.

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**WEARING THIN**

On the subject of pricing, it’s worth reiterating that the H500 is £30 cheaper than the H500i, as well as less than half the price of the flagship H700i (which is, to be fair, a much larger EATX chassis). What, then, could prevent it from being the H-series case to buy?

The first issue is build quality. To be clear, the H500 is structurally sound, but its all-steel construction feels somewhat basic compared to previous NZXT cases. It rattles when you tap it, almost every part of the interior is thin enough to flex, and the plain, grainy finish isn’t remotely as nice as, say, the smoother matt panelling of the NZXT S340 Elite (Shopper 351). The Cooler Master Masterbox K500 is similar in this regard, but better disguises its non-premium materials with a more futuristic, eye-grabbing look.

Cable management has also taken a big step back from the H700i. The concealing vertical bar in the main chamber is still there, albeit noticeably slimmer, but behind the motherboard there’s a measly two plastic routing channels with just a couple of Velcro straps. The cut-out routing holes are thinner, too, and it’s particularly tricky to squeeze a 12V motherboard power cable through the uppermost hole compared to the H700i.

What’s more, as generous as it is to include the 120mm roof fan, it would have been even better for that fan – or a couple of them – to come at the front, for a more efficient cyclical airflow. Surprisingly, the front panel can’t be removed, and the only points of air intake are a strip of dots down the front edge of the right side panel and a tiny vent on the underside. Most disappointing of all is the lack of an easily removable dust filter at the front, one of our favourite (and most-used) features on NZXT cases spanning the past few years.

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**THIRD-PLACE CASE**

This brings us back to not just the H700i, but the Source 340 Elite. This older case costs £10 more than the H500, but besides it being put together a little more solidly, it also has one more 2.5in drive bay, two more USB2 ports (the H500 only has two USB3 connectors) and our beloved magnetic dust guard. If that still doesn’t appeal, the Masterbox K500 costs about the same and has similar features, but includes more fans and has room for larger graphics cards.

There’s nothing stopping you from building a quality PC setup with the H500 – as we say, it has its strengths. It’s just not a very compelling purchase when these other two cases are around, regardless of whether it has the smart device or not.
PHANTEKS Eclipse P350X
★★★★☆
£65 • From www.overclockers.co.uk

VERDICT
It needs an extra fan, but otherwise the Eclipse P350X is a good-value chassis for ATX builds

PHANTEKS IS NOT a blockbuster name like NZXT or Cooler Master, but just because it’s a less famous brand doesn’t mean it can’t put out some great kit; the Eclipse P400S (Shopper 351), for instance, is a great mid-tower. The P350X is ostensibly a slightly lower-end chassis, though it takes the Eclipse line in an even more modern direction than the P400 and P400S, thanks to the addition of built-in RGB lighting. Unlike on, say, the Cooler Master Masterbox K500, the lighting doesn’t originate from removable fans but is part of the chassis itself. Thin, light-up strips run along the top edge of the PSU shroud, as well as down either side of the front panel; an altogether more subtle implementation than many RGB-equipped cases go for.

Regardless, it’s impressively flexible, and can either be controlled directly from a button on the front I/O panel (cycling through colours and effects with each press) or made to sync with Asus Aura and MSI Mystic Light. As long as you’ve got the compatible Asus or MSI components, this could be a good way to compensate for the lack of lighting inside the main chamber proper, where you’d really want to show off your build through the tempered glass side window.

EXTENDED CUT
Oddly, Phanteks claims the Eclipse P350X can support EATX motherboards, but only those up to 280mm wide – the standard width for EATX boards being 305mm, which will not fit in the case’s motherboard tray. However, there’s more than enough room for a full-size ATX board, as well as microATX and Mini-ITX. It’s simply a case of moving the standoffs to line up with your motherboard’s screw holes.

Of the three mid-range ATX cases we’ve got here, the other two being the NZXT H500 and the Masterbox K500, the Eclipse P350X is arguably the best for helping keep things neat and tidy. All three have a full-length PSU shroud, but the Eclipse P350X also has a deep, wide channel behind the main chamber for stashing the front I/O cables and most of the motherboard-connecting cables too. Because these emerge from cutouts on the side of the channel, it serves the same purpose as the H500’s ‘cable management bar’, obscuring most of the unsightly wires, and a pair of Velcro straps make it very easy to bundle cables, adjust their slack or add new cabled components; with the other two, you’d have to snap off and replace single-use zip ties to make these kinds of adjustments.

MISSING PIECES
Out of the box, storage capacity tops out at two 3.5in drives and two 2.5in drives, although both 3.5in trays can hold a 2.5in drive instead. This puts the Eclipse P350X dead even with the H500 and one ahead of the Masterbox K500. It could have been even further ahead, as a third 2.5in mounting point exists next to the other two (positioned on the rear of the motherboard tray), but Phanteks just hasn’t seen fit to include the required bracket for it.

As with the K500, which similarly withholds mounting brackets, it’s a strangely miserly design choice (surely tossing in one more little piece of metal wouldn’t raise costs that much?) but its omission foists on to users both the expense and hassle of having to order and install the bracket if they want to add another SSD.

Speaking of omissions, there’s a surprising lack of any rear exhaust fan on the Eclipse P350X. There’s a single 120mm unit at the front, so at least some cool air gets introduced, but it’s just as important, if not more so, to get rid of the hot air produced by the processor, motherboard and graphics card. Until you buy and install another 120mm fan to act as the exhaust, most of that hot air will just sit around inside the case.

The good news is that overall cooling support, for those who have no issue with customising their own fan configurations, meets expectations for a mid-tower. The front of the case doesn’t stretch to triple 120mm fans like the Masterbox K500 can, but can still handle two 120mm or two 240mm fans, as well as water-cooling radiators up to 280mm long. The top will also take doubled-up 120mm or 140mm fans, albeit without room for a radiator, while the empty rear 120mm slot will accommodate a single fan or a fan/radiator combo.

HEAD-ON APPROACH
However, while it is inconvenient to have to provide your own rear fan, these can be found very cheaply, and the price difference between this and the H500 and K500 will cover a good chunk of the cost.

Also, while we’re not massive fans of the Eclipse P350X’s plastic front panel – even with the lighting strips, it’s plasticky in a way that its two rival cases aren’t – we like how the two 3.5in trays are accessible via removing it. This is much quicker than having to unscrew and slide off the right side panel, like most tower-style cases require to access their drive trays.

The Eclipse P350X is a good case, then, with some cool tricks. The Masterbox K500, however, is slightly better – even with its lower drive capacity and a higher price, it’s just more nicely made in general, with a less monolithic look and three times as many fans, two of which are RGB.
**VERDICT**

While it doesn’t entirely escape budget limitations, the Versa H18 is very capable for something so cheap.

**IF YOU WANT** a small PC but perhaps aren’t so comfortable building into a truly compact case like the Kolink Satellite Plus, the Versa H18 is a great compromise. Besides adopting a more traditional tower form factor, it’s nice and wide, almost entirely built out of metal, includes a PSU shroud for tidiness, and can be fitted with a good-sized side window: almost immediately, the Versa H18 positions itself as a PC case for those who want more from their budget components than the usual basic, plasticky fare.

Being a mini-tower, it’s still limited to builds based around either microATX or Mini-ITX motherboards, but it’s not so tight inside that only the base essentials will fit. CPU cooler cooler comes in at a very respectable 155mm, and you can use graphics cards up to 350mm in length. That’s assuming you don’t have any fans or radiators installed at the front, but even if you do – knocking off a few centimetres – that would still leave room for all but the longest of high-end GPUs.

**CHILL OUT**

Fan support is also decent for the form factor. The top and rear of the Versa H18 can both hold a 120mm fan (the only pre-installed fan is, in fact, attached to this backmost mount), while the front can be maxed out with either three 120mm fans or two 140mm fans – and that means 240mm, 280mm and 360mm radiators will fit as well. A rectangular hole is cut into the PSU shroud so that the whole of the front panel is accessible for such upgrades, and we didn’t have any problems getting the radiator and attached fans of a Cooler Master MasterLiquid ML240R RGB to slip inside.

In other words, it quickly becomes apparent that despite this being an entry-level case, it’s very possible to construct a potent, potentially liquid-cooled system in the Versa H18. There are, however, some issues – or, perhaps more accurately, omissions – to be wary of.

For one, it’s a shame that only a single 120mm fan is included. Granted, it’s not as though there’s a huge cavern of space for this one fan to keep cool all by itself, but particularly for first-time builders it would have been extremely handy to have at least one intake fan at the front as well. This could create an in-out airflow effect that cools much more effectively than a single exhaust.

Second, there’s no storage drive cage as such. All 2.5in and 3.5in drives must instead be screwed directly on to the chassis itself, which isn’t unheard of but is generally more of a hassle than simply being able to drop them into a removable tray. This is especially true of the 3.5in mounts, which are hidden underneath the PSU shroud. Capacity is also modest, at two 2.5in and two 3.5in mounts, although this is perfectly acceptable for a mini-tower system, as microATX and Mini-ITX motherboards don’t often come with more than four SATA ports anyway.

**LOOPS, I DID IT AGAIN**

There’s not much in the way of cable management, however: just a few tiny loops through which to thread cable ties. The essential routing holes are all there, if a bit small, and without anything like rubber grommets to keep cables held in place.

Still, even if the Versa H18 is lacking many of the comforts a more expensive PC case would provide, it’s all ultimately workable, and there are some nice extra touches, too. The front I/O panel, for instance, includes a relatively generous three USB connectors (split between two USB2 ports and one USB3 port), plus separate 3.5mm microphone and headphone jacks. What’s more, almost the entire front side of the Versa H18 is a layered combination of perforated steel and mesh, so even without an intake fan, there’s plenty of space for air to pass through.

The fact that the ports are placed on the removable panel section (not the underlying chassis) means that when you take it off, either to clean the mesh of dust or to install fans and radiators at the front, you also end up pulling on a bundle of wires. It’s therefore best to leave a bit of slack on these rather than cable-tying them as tightly as possible, otherwise the panel simply won’t come away.

**SMALL REWARD**

This design hiccup is at least made up for by the Versa H18’s appreciably grown-up looks. Boxly in a good way, it’s neither tacky nor dull – like a lot of entry-level cases – and the window/shroud combo allows for a clean build you can admire any time. Thermaltake also makes a version with a full tempered glass side panel, although besides being more expensive, we can currently only find this at US retailers.

Regardless, this acrylic-windowed model ends up easy to recommend to budget buyers. Many of its problems are part and parcel of getting a tower case for such little cash, and the Versa H18 nails the fundamentals, resulting in a smart-looking little case that’s easy to build a well-specced system inside.
THERMALTAKE View 37

WE STILL REMEMBER the View 27 catching our eye a whole two years ago, when the Cyberpower Ultra Elite FX system (Shopper 3/4/7) arrived within it. It was hard not be taken with its distinctive ‘gull-wing’ side panel, which wrapped a curved acrylic window around the top left edge of the PC so you could peer in from the top as well as from the left.

The new View 37 isn’t so much a refinement of this idea as an expansion of it. The entirety of the curvy panel is now acrylic, rather than being a partially metal panel with a window, so you can see all the way down to the PSU bay. It’s also significantly larger than the View 27, measuring 525x261x538mm – that’s 22mm taller, 60mm wider and 59mm deeper. As a result, the View 37 can now accept EATX motherboards, as well as ATX, microATX and Mini-ITX boards.

ANOTHER ONE OPENS

This bulking-up hasn’t spoiled the View 37’s style. Even if it’s mostly made of what is essentially plastic, to our eyes this is easily one of the most interesting-looking PC cases around, and not in the way that might make you feel embarrassed to show to non-enthusiast friends.

The best thing about the panel, however, is the practical benefit. Functionally, removing it also removes the PC’s roof, which on most tower builds can be an obstruction, both to light and your hands, especially when tinkering with things near the top of the motherboard such as power pins and the CPU cooler. On the View 37, this obstruction is gone completely, so it’s easier to see what you’re doing without a torch and easier to get your hands into those little nooks and crannies.

This comes at the cost of not being able to install any fans or radiators in the roof, but – unlike on the View 27 – this is compensated for by a series of mounts on the right side. This is an excellent addition, with support for 360mm and 420mm radiators and up to three 120mm or 140mm fans. What’s more, this is matched by the front panel mounts, and surpassed with space for up to two 200mm fans, although out of the box, only two 140mm fans are installed, one at the front and one at the back. These are lit up in blue; an RGB Edition is also available, and includes a couple of RGB controllers, but this adds an unappealing £60 to the price.

Stuffing in larger radiators and more fans might force you to remove the three-bay drive cage, but such modularity is hardly a fault. The vertical graphics card riser can also be taken out, should you be happy with a single GPU. Speaking of which, one upside of the View 37’s considerable proportions is that it can fit monster graphics cards up to 410mm long, as well as large tower-style CPU fans up to 180mm in height. Liquid cooling is also welcomed; again, the drive cage must be removed if you’re going to be installing the pipes and reservoir of an open-loop system, but AIO watercoolers can be installed easily.

TRAYS ON END

The potential loss of this cage wouldn’t even cripple the View 37’s ability to hold hard disks. In addition to these three trays (which can alternatively hold 2.5in drives), the rear side of the motherboard tray is covered in mounting brackets: four in total, each of which could hold either one 3.5in drive or two 2.5in drives apiece. That’s an enviable potential total of 11 drives, even more than the gigantic Cooler Master Cosmos C700M. There are no 5.25in slots, which you get on Cooler Master’s ultra-high-end chassis, but the I/O panel is still decent: Thermaltake includes two USB2 and two USB3 ports, more than enough for most users. The front panel is solid plastic, but vents have been cut down either side to allow air to reach the intake fan.

DOWN TO THE WIRES

The only real disappointment is a lack of high-end cable management features. Not that this has been ignored: there are grommeted routing holes to keep cables in place, with three sets of two positioned side by side. This helps the cables thread through as close to the motherboard as possible, even if you’re using a tiny Mini-ITX board. Larger ATX boards will cover the first column of holes, leaving the second available. What this system lacks, however, is any kind of channelling to contain the cables before they go through to the main chamber. All you can really do is zip-tie them together and hope they stay put.

In practice this is a minor letdown among a wealth of thoughtful design. Far from just being an aesthetically minded show-off, the View 37 cleverly enables some painless PC building while delivering fully on cooling and storage support. It’s also a lot cheaper than the Cosmos C700M, proving that you don’t need to spend silly amounts of money for a top-quality EATX chassis.

VERDICT

Bigger and better equipped than its predecessor, the View 37 is a supremely practical EATX chassis.
It’s been encouraging to see good cases at such a wide range of prices. The Thermaltake Versa H18 and Kolink Satellite Plus both offer high value for less than £50, while the Cooler Master Masterbox K500 and Phanteks Eclipse P350X confidently represent the mid-range.

Our favourite chassis – the Thermaltake View 37 – is a bit more expensive, but not to the extent of the Cosmos C700M. In fact, part of what makes the View 37 so desirable is that it has the features of an even pricier PC case, particularly its massive drive capacity, EATX motherboard support and heavy-duty fan slot supply. We could rave plenty more about its curvy, surprisingly practical side window, but the View 37 is far more than a transparent piece of plastic.

For those who can’t stretch beyond the £100 mark, the Masterbox K500 and Versa H18 are our more affordable picks. Cooler Master’s mid-tower is an all-rounder with a lot more visual pizzazz than these types of cases tend to have, and the Versa H18, although not without its shortcomings, delivers bang for your buck that the Satellite Plus just can’t match. That’s not to say Kolink’s cube lacks appeal; stick to simple internals, and it makes a lovely little living room system.

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**Award**

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<thead>
<tr>
<th>Manufacturer</th>
<th>RECOMMENDED</th>
<th>BEST BUY</th>
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<tr>
<td>COOLER MASTER</td>
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<td>THERMALTAKE</td>
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<td>KOLINK</td>
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<td>PHANTEKS</td>
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**Model**

| Model | Cosmos C700M | Masterbox K500 | Satellite Plus | H500 | Eclipse P350X | Versa H18 | View 37 |

**Rating**

| Rating | ★★★☆☆ | ★★★☆☆ | ★★★☆☆ | ★★★☆☆ | ★★★☆☆ | ★★★☆☆ | ★★★☆☆ |

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**HARDWARE**

| USB2 ports | 0 | 0 | 0 | 0 | 0 | 2 | 2 |
| USB3 ports | 4 + 1 USB Type-C | 2 | 2 | 2 | 2 | 1 | 2 |
| Mic and headphone jacks | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Front panel extras | RGB controls, fan controls, reset button | Reset button | Reset button | Reset button | RGB controls, reset button | Reset button | Reset button |
| Case type | Full tower | Mid-tower | Cube | Mid-tower | Mid-tower | Mini-tower | Mid-tower |
| Motherboard compatibility | EATX, ATX, microATX, Mini-ITX | ATX, microATX, Mini-ITX | Mini-ITX | ATX, microATX, Mini-ITX | ATX, microATX, Mini-ITX | MicroATX, Mini-ITX | ATX, ATX, microATX, Mini-ITX |
| Fan mounts | 7x 120mm, 7x 140mm | 6x 120mm, 2x 140mm | 1x 120mm | 4x 120mm, 2x 140mm | 5x 120mm, 3x 140mm | 5x 120mm, 7x 140mm, 2x 200mm |
| Supplied fans | 4x 140mm | 3x 120mm | 1x 120mm | 2x 120mm | 1x 120mm | 2x 120mm |
| Max 2.5in drive bays | 6 | 3 | 4 | 4 | 4 | 4 | 7 |
| Max 3.5in drive bays | 2 | 2 | 3 | 2 | 2 | 2 | 11 |
| Max 5.25in drive bays | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| PCI slots | 7 | 2 | 9 (inc 2 vertical) | 7 | 4 | 10 (inc 2 vertical) |
| PSU size | ATX | ATX | ATX | ATX | ATX | ATX |
| Max CPU cooler height | 198mm | 160mm | 165mm | 165mm | 160mm | 155mm | 180mm |
| Max graphics card length | 490mm | 400mm | 280mm | 381mm | 400mm | 350mm | 410mm |
| Dimensions | 651x306x650mm | 455x210x491mm | 190x260x280mm | 460x210x428mm | 450x200x455mm | 390x205x380mm | 525x261x538mm |
| Weight | 23kg | 6.2kg | 2.1kg | 7kg | 6.4kg | 4.3kg | 11.8kg |

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**BUYING INFORMATION**

| Price | £415 | £74 | £45 | £70 | £65 | £40 | £103 |
| Warranty | Two years RTB | Two years RTB | One year RTB | Two years RTB | Five years repair and replace | Three years RTB | Three years RTB |
| Supplier | www.cclonline.com | www.scan.co.uk | www.overclockers.co.uk | www.scan.co.uk | www.overclockers.co.uk | www.scan.co.uk | www.scan.co.uk |
| Part code | MCB-C700M-MG5N-500 | MCB-K500D-KGNN-500 | CA-02F-KK | CA-H500B-B1 | PH-E3150PTG_DBK | CA-146-00ST1WN-00 | CA-17F-00ST1WN-00 |

*Prices correct at time of going to press*
In this group test, we’re examining eight different options, ranging from the premium Apple Watch Series 4 to the dirt-cheap, screenless Moov Now. All have been subjected to days of use, including plenty of activity tracking, so you can reliably see how these wearables stack up. If, however, you want even more help with choosing a smartwatch or fitness tracker, read on for our buying guide.

ONE OF THE best things about new types of tech products — as opposed to older ones such as laptops and smartphones — is seeing how quickly they develop. Smartwatches and dedicated fitness trackers only entered the mainstream a few years ago, but we’re already witnessing big improvements to things such as physical design, software capability and battery life.

As such, the wearables market is the best it’s ever been, though that’s not to say some duds haven’t found their way through as well. Avoiding these is important, especially if you’re looking for a device to entrust with your health, be it for helping you to lose weight, training you for competitive events or just helping you sleep better.

In this group test, we’re examining eight different options, ranging from the premium Apple Watch Series 4 to the dirt-cheap, screenless Moov Now. All have been subjected to days of use, including plenty of activity tracking, so you can reliably see how these wearables stack up. If, however, you want even more help with choosing a smartwatch or fitness tracker, read on for our buying guide.

BRAINS OR BRAWn
One of the aforementioned improvements in recent wearable design has been a blurring of the line between smartwatches and fitness trackers: many watches may look prim and proper, for instance, but they’re almost certain to contain a lot of activity-tracking hardware.
Likewise, fitness tracker manufacturers have begun producing devices which borrow more from smartwatches, such as the Fitbit Versa – a tracker that can be loaded with apps, play music and, of course, tell you the time. ‘Pure’ fitness trackers still exist, however, and can be a good choice, as the lack of ‘smart’ features can help them stay light, cheap and long-lasting. If you’re specifically looking for something to wear while exercising, and not something to act as your everyday watch, it’s still perfectly fine to go with a more specialised wearable.

Regardless of how it can be categorised, a wearable should always strive to be thin and light. We find anything that weighs more than about 60g can produce an annoying weighing-down sensation when exercising, and even when you’re idle, it’s not nice to be distracted by the lump of metal on your wrist.

Comfort is also affected by things such as strap design and clasp mechanisms. Soft, flexible straps made from rubber or fabric tend to be the most comfortable; metal bands look better but don’t bend or breathe as well. We’ll mention in the review if a product has an uncomfortable design or a fiddly clasp.

Another design trait worth focusing on is waterproofing. You should never settle for a fitness tracker or smartwatch that isn’t at least splash- and sweat-proof, and all the products featured here are fully waterproof to varying depths. This is obviously an essential feature for swim tracking, but it’s good to have the peace of mind that a sudden rain shower won’t ruin your new toy.

GLOBAL REACH
With a few exceptions – such as the Garmin Forerunner 235, which focuses on running – smartwatches and fitness trackers will aim to cover a variety of activities, and will also track more general data such as the number of steps you’ve taken and your heart rate.

Both general and activity-specific data will be useful for improving your performance and maintaining your health, but both are reliant on certain sensing hardware, which not all wearables will share. The most common is a pedometer, which measures steps taken and distance travelled, while altimeters (which measure vertical travel, often indicated by an equivalent number of stairs) and heart-rate monitors are likely – but not guaranteed – inclusions. The latter in particular is good to have if your goals revolve around improving your general health.

Built-in GPS is another feature worth having. Smartwatches and fitness trackers use GPS to more accurately measure distance, as well as map your running, walking or cycling routes. If one doesn’t have integrated support, it can usually piggyback off the GPS capabilities of a paired smartphone, but this requires you to be carrying your phone when you go out exercising, not ideal, as you don’t want it bouncing around (or out of) your pocket.

Onboard GPS solves this problem, although not all GPS tracking works equally well. If it appears inaccurate, as is often the case with the Forerunner 235, then you might find it worth biting the bullet and just using your phone to provide GPS instead.

CELL OF THE BALL
As with any battery-powered kit, the longevity of a smartwatch or fitness tracker will vary wildly depending on how you use it, with GPS being a particular drain. The good news is that most will last for several days of mixed use before needing to recharge, and the Moov Now – which uses replaceable CR2032 batteries – can keep going for up to six months, with the drawback of you needing to buy fresh ones.

To be fair, even with shorter-lasting wearables, anything that lasts for a day or so will suffice for exercising or simple watch use, as you can just recharge overnight. The exception would be if you want to try sleep tracking, which naturally requires that the watch or tracker be worn and powered on while you slumber. In this case, only devices with a multi-day battery life make sense.

THE BEST WEARABLES FOR...

APPS

APPLE Watch Series 4
While its fitness-tracking capabilities are formidable, the Apple Watch Series 4 truly excels as a versatile smartwatch. This is partly down to its good looks and highly customisable watch face design, but mainly thanks to it being especially well supported on the apps front.

Much of the good stuff comes from Apple itself, such as the Music app that lets you sync iTunes playlists with other devices, but there’s also a wealth of third-party apps. Email, fitness, to-do lists, sound recording and even Rosetta Stone language tuition, among many others, can be found on your wrist with just a few taps.

SLEEP TRACKING

MOOV Now
What makes the Now such an attractive choice for keeping tabs on your sleeping patterns isn’t insights provided by the mobile app; the data provided is helpful, but in terms of fine details it’s nothing special compared to most other sleep-tracking apps.

Instead, it’s all about the hardware. For one thing, the Now itself is never going to get in the way of a snooze: it weighs almost nothing, and there’s no screen to accidentally wake up and shine light in your face.

Best of all is the battery life, which allows for months and months of uninterrupted data-gathering during the hours when most other trackers would be sitting on a charger.

GENERAL FITNESS

FITBIT Versa
This is a tricky one: the Apple Watch, Garmin Forerunner 235 and Samsung Galaxy Watch all have a similarly comprehensive set of tracking tools but with the added benefit of GPS, while the Versa needs to be tethered to a smartphone. However, Apple’s and Samsung’s smartwatches are heavier, more expensive and less singularly minded on fitness, while the Forerunner 235 is primarily a running watch, and its GPS integration could be much better.

Besides, buying a Fitbit device also means access to the thriving Fitbit user community, giving you plenty of sources for support (or friendly competition) during your exercising efforts.
Interestingly, there’s no difference in weight between the GPS-only and GPS/cellular versions of 30.1g and 36.7g without a strap. However, both the app launcher are made easier, such as selecting an icon from the Grid View Series 3, measuring 10.7mm to the older their Series3 counterparts, respectively.

The Series 4 is also thinner than the Series 3, measuring 10.7mm to the older version’s 11.4mm. However, both the 40mm and 44mm models are heavier than their Series 3 counterparts, respectively weighing 30.1g and 36.7g without a strap. Interestingly, there’s no difference in weight between the GPS-only and GPS/cellular models this time around.

SOME GOOD BUZZ
The other headline design change is that the Watch 4’s digital crown now has haptic feedback, which makes scrolling through menus and zooming in and out in the Maps app feel much more precise than before. As you’d expect, there’s a single, subtle vibration every time you jump from one item or page to another, which makes a drastic difference from only having visual cues on screen.

There would be one other big feature to talk about, but it’s not ready yet. The Apple Watch Series 4 is in theory able to perform an ECG test from your wrist, thanks to its new electrical heart-rate sensor. However, Apple needs government approval from each country the watch is being sold in before the feature can be unlocked, and there’s no telling when that might be granted in the UK. Technically, this will be very impressive if it works, but you shouldn’t be buying the Apple Watch for ECG functionality alone.

One health feature that is enabled out of the box is fall detection. The idea is that the Apple Watch’s improved accelerometer and gyroscope can help it sense if you’ve taken a bad fall, and can even call the emergency services directly from your wrist. To avoid false positives, fall detection is left off by default and can be toggled manually. However, our testing proved inconclusive: several times we tried simulating a fall with the aid of a mattress, but never managed to trigger the system. That either means it can’t reliably detect an adult falling over, or that it’s sophisticated enough to know we were safely falling on to something soft.

Even if the new health features aren’t much use, Apple has made some great additions to watchOS 5, some of which have a strong fitness focus. One of our favourites is activity competitions, where you can challenge a friend to a week-long competition to see who can close the most activity rings.

LITTLE HELPER
Finally, there’s also automatic exercise detection, which detects when you’ve started or finished working out, and can open the Workout app so you can log your exercise in its entirety.

This sprung into action when we forgot to end a recorded session after a walk, prompting us after we’d been seated for a few minutes. It’s very convenient, though not infallible: it didn’t ask us if we wanted to log a bike ride, even an hour and a half into it.

There are more advanced workout features now, too. Yoga and hiking have been added to the existing workout modes and, during a run, you can set pace targets and also track your cadence (steps per minute) for the very first time on an Apple Watch. The Series 4 is a good fitness tracker, but it’s an even better smartwatch.

You can listen to podcasts directly from the device, make voice calls to other Series 4 owners with a single tap, and add more complications (in other words, widgets) to the home screen than ever before.

This last point is thanks to the new watch faces. Taking advantage of the larger screen, these new designs put all manner of data (including world clocks, weather, calendar, activity and heart-rate information) front and centre, along with useful app shortcuts, in a way we’ve not seen on any other smartwatch. It’s supremely functional and customisable.

The Series 4 employs a 64-bit, dual-core S4 processor that Apple claims is up to two times faster than the S3 chip in the Series 3. We’re not so sure that applies to everyday use – if this Series 4 is twice as fast, it doesn’t feel it – but either way, navigating the UI is quick and smooth.

As for battery life, we routinely surpassed the 18-hour figure given by Apple itself, sometimes going 36 or even 48 hours between charges. Of course, this will vary depending on how you use the Apple Watch, but it’s good that you can count on it to last a day and night before needing to top up.

TIME MASTER
It’s disappointing that the Apple Watch Series 4’s most groundbreaking feature won’t be usable any time soon, but even without it, this is a smartwatch that improves on its forebears in almost every way – and those were among the best to begin with.

As usual, the new Apple Watch will only work with iOS devices, so Android owners in search of a high-end smartwatch should check out the Samsung Galaxy Watch instead. Otherwise, the only reason to be put off the Apple Watch is its typically high price.
FITBIT Versa

VERDICT
A versatile smartwatch with four-day battery life and a compact design, all backed up by the Fitbit community

THE VERSA HAS a lot of hopes and expectations riding on it, even if most of them are Fitbit’s own. It’s the firm’s second attempt to break into smashwatches, following the Fitbit Ionic (Shopper 360), and strips away many of the non-essentials from this precursor to create a smaller and more affordable wearable. Fitbit is hoping this will, in turn, broaden the Versa’s appeal beyond the usual, male-dominated smartwatch crowd.

The obvious benefit is the size of the watch on your wrist. If you’re used to wearing something bulky like a Garmin Fenix, the Versa will feel ridiculously compact and lightweight in comparison. It’s still far off the kind of featherlight designs you can find in conventional watches, however, so in terms of attracting new adopters it might not be entirely successful.

SWAP TEAM
The Versa loses out to designer watches for style as well, despite Fitbit softening the corners with a rounding effect. You can choose between three colours – grey, rose gold and black – but the greatest degree of customisation comes from downloadable watch faces and a choice of straps. A silicone strap comes in the box, and you can (for instance) buy a designer leather strap for £50 or a mesh metal one for a rather excessive £70. Fitbit is doing its best to create the versatile black dress of watches, transformed by accessories, and make a bit of cash on the side.

One inevitable consequence of dropping down in size is a smaller battery, which is why the Versa lasts just over four days on a single charge compared to the Ionic’s five days. That seems a sensible compromise, not least because Fitbit’s battery life claims are true – judging by our week with the Versa – and that it recharges in under two hours. There’s even a neat charging station you can slip the Versa onto, although this is (yet another) proprietary charger from Fitbit and incompatible with the Ionic.

To keep the battery life high, the screen is off most of the time. You can activate it with a vigorous flick of the wrist, but we found this only worked about half of the time; often, we had to press a button to check the time instead. The 300x300 screen is lovely and bright, however, when you do manage to activate it.

As the lack of GPS indicates, this isn’t a bona fide fitness watch. If you want to track your run or bike ride down to the last metre, you’ll need to bring your phone with you so the Versa can ‘borrow’ its GPS chip.

Without a phone in the vicinity it still attempts to track how far you’ve been but, naturally, it isn’t as accurate. The good news is that it’s waterproof to 50m, so will track laps, calories burned and so on in the pool.

MOTIVATIONAL TALK
While it has many elements of a fitness watch, the Versa is best thought of as a lifestyle watch: one that not only fits in with your lifestyle, but also aims to improve it. For instance, by default it nags you every hour to get up and do some steps. In that same spirit of life improvement, there’s a Relax app that’s suspiciously reminiscent of the Apple Breathe app, and you’re encouraged via the Fitbit phone app to join its community of users for encouragement and support.

The watch’s Fitbit OS is incredibly easy to use. It supports all the usual smartwatch notifications – emails, texts, phone calls – and it’s obvious what action you need to take. Navigation is mainly performed via swiping and pressing the big Home button on the left of the screen, but there are also two physical buttons on the right that can be used in certain situations.

You shouldn’t expect a huge app store to rival Apple’s. Fitbit only opened up its SDK to developers last year, and there are still fewer than 100 apps from which to choose. There’s a handful of big names – Strava, New York Times, Hue Lights, Yelp – but in the main the third-party apps are from individual developers. Most developers’ focus appears to be watch faces, with hundreds on offer to suit everyone from the data obsessed to the minimalist.

The other app of note is for the music-subscription service Deezer. This allows you to synchronise playlists to your watch, and with room on the watch for up to 300 songs you should have enough variety for several workouts. Deezer costs £10 per month, however, so you may prefer to take manual control and download your own tracks to the device instead.

KEEPING IT CASUAL
One premium-grade feature that hasn’t been jettisoned is the NFC chip, which enables the Fitbit Pay app for contactless payments. But don’t get excited: currently, only two minor banks support it in the UK.

While some small gripes mean it isn’t as slick as the Apple Watch, the Fitbit Versa comes surprisingly close. Keen runners and cyclists will be better served by a GPS-equipped tracker, but the Versa is something you can wear every day without being conscious of the lump of silicon, glass and plastic on your wrist. With Fitbit’s community to back it up, it’s a great buy at £200.
WEARABLES

FOSSIL Q Control

★★★★★

£179 • From www.fossil.com

VERDICT

The Q Control is Fossil’s first fitness-focused smartwatch, but it lacks several key tracking features.

MAINLY BY VIRTUE of including a heart-rate monitor, the Q Control is Fossil’s first Android Wear device to be described as a ‘Sports Smartwatch’. How, then, does it compare to other fitness-minded wearables such as the Apple Watch?

For one, it’s no less nice-looking. The chunky steel casing exudes a certain degree of style and sophistication, just as you’d expect from a brand that’s associated with fashion accessories. Once it’s on your wrist, however, you might become less enthusiastic about the chunky design as it’s quite weighty, which isn’t ideal when you’re taking it out on a run. The optical heart-rate sensor does at least sit flush with the back of the casing, meaning it won’t become any more uncomfortable when you leave it on your wrist for hours at a time.

WHAT GOES AROUND

To control the watch, there’s a 1.4in full-colour OLED touchscreen and one button on the right side, which lets you hop between the app drawer and the home screen. The screen’s 450x450-pixel resolution looks good, but an air gap between the front glass panel and the display means that it falls short of greatness.

Another method of navigation comes via the watch’s ‘virtual touch bezel’, which lets you scroll through apps, notifications or emails without swiping up and down on the touchscreen. However, we rarely found ourselves using it, as in practice it doesn’t actually prevent errant fingers covering the screen. Notably, Garmin found an excellent workaround for this problem with the Vivoactive 3 (Shopper 362), placing a touch panel on the side of the casing.

The Q Control uses a 20mm black silicone strap, so you can easily swap it out when it wears out or if you want to add a bit more character. We found the strap comfortable, and there are plenty of notches for both bigger and smaller wrists.

Fossil’s website claims that the Q Control uses wireless charging, but in reality what you get is a small four-pin magnetic charging pad, on top of which you perch the Q Control. We ended up wishing for a traditional charging cable: on three separate occasions, we thought we’d left the device charging, only to come back and find its battery still totally empty.

Like most smartwatches today, the Q Control automatically logs metrics including step count and heart rate. These can be easily viewed via the Google Fit app, where you can also set specific fitness goals.

When you want to log a workout manually, you just open the aptly named Fit Workout, which lets you choose from an enormous list of activities, from cycling and running to strength training and downhill skiing. Unfortunately, because there’s no built-in GPS, you’ll need to have your phone if you want to track your movements precisely. This is a slightly less galling omission now that the Q Control’s price has plummeted from £270 to £179, but it’s still saddening when the Forerunner 235 offers GPS tracking for similar cash, even if it is prone to inaccuracies.

CHECKING YOUR HEART RATE can also feel like a chore, as you need to go all the way into the Google Fit app instead of just consulting a widget. One of the few points in the Q Control’s favour is that it’s waterproof to SATM, or approximately 50m. There’s no swimming mode in the Fit app, but you can keep track of your pool workouts with the third-party app MySwimPro.

The Q Control’s Snapdragon Wear 2100 chip and 768MB of RAM is speedy enough to keep everything running smoothly, but unfortunately, battery life was another letdown. Fossil estimates it lasting ‘all day’, and this is pretty much spot on; if you charge it overnight, the battery should last until the following evening, but there’s no way it will make it through the night.

On the bright side, Android Wear is a pretty good OS, though there’s no NFC for wireless payments, as you get on many other Wear smartwatches. Agenda, Contacts, Fit, Keep Reminders and Weather are useful preinstalled apps that help you keep on top of daily tasks without having to always reach for your phone. The Android Wear Play Store is also much better stocked with third-party apps than Samsung’s Galaxy Apps store, so you can install Telegram, Messenger, Strava and Runtastic, among many others.

Google Assistant is another boon. Just long-press the watch’s button and you can send a message, get directions with Google Maps or start tracking your heart rate or run.

LOST CONTROL

That’s not to say that Android Wear is perfect. The music controls worked really well when playing Spotify from a phone, but whenever we tried playing a song directly from the watch, the Spotify app simply wouldn’t play ball. The Q Control’s 4GB of built-in storage will let you store music offline, but only using Google Play Music.

The Q Control is a great-looking watch, but unfortunately, that’s where our endorsements end. It’s a minimally featured and often unreliable fitness aid, and a flawed everyday smartwatch as well. Android Wear offers plenty of great smart features and a strong range of third-party apps, but to really compete with the current crop of sporty smartwatches, the Fossil Q needs to offer much, much more.
**GARMIN Forerunner 235**

★★★★☆

£175 • From www.amazon.co.uk

**VERDICT**
The Forerunner 235 offers oodles of options, but accuracy can be off the mark.

**THE FORERUNNER 235** serves to demonstrate not just why Garmin's reputation for quality running watches is so richly deserved, but also how tenuous this position at the top actually is.

Combining a decent-sized 1.77in screen and a circular frame, it's somewhat chunky and definitely resembles a fitness aid more than a fashion item, but it's smart enough to wear most of the time. Instead of a touchscreen, there are five buttons for navigation through menus. If you've ever tried using a touchscreen with sweaty hands, you'll know this is a sensible move in a running watch, although five buttons does feel a bit like overkill. It could quite feasibly get by with two.

The screen is technically a colour one, but it uses colour so sparingly that it may as well be black and white. As a result, the battery life is pretty decent, running to well over a week even if you use the onboard GPS a bit, which is just as well, as it has a bulldog-clip style bespoke charger that you're unlikely to find lying around if you need to top up the charge in a pinch.

**STOP THE CLOCK**

In general, it's a well designed wearable, but there are moments where it's too clever for its own good. For example, take the way it exclusively uses GPS to set the time: to get a GPS lock, you need both a clear view of the sky and to start a running activity, so you could end up as we did, stuck in a foreign airport with no way to accurately set the local time.

Still, that's likely to be a rare occurrence, and mostly the Forerunner 235 delivers an excellent running experience. Unlike cheaper wearables, which offer a set number of stats across a selection of screens, the Forerunner 235 offers a dizzying array of options as to how you display your data. You can set up to four metrics per screen, and each slot can be individually tailored to what you want to track for each activity.

Of course, the brilliant way data is displayed is irrelevant if you can't trust the numbers and, unfortunately, the Forerunner 235 is a little iffy on this score. While the watch would often correct itself before we'd completed a run, for the most part the numbers didn't correspond with what was going on in real time.

For instance, we wore the Forerunner 235 on multiple 5km runs (mapped precisely to that distance) and, while the Garmin Connect app came close to accurately measuring how far we'd run by the end, reporting between 4.88km and 4.96km, the watch invariably claimed we were running at too slow a pace to end up with the times we did. On one run we averaged 4m 52s per kilometre, but the Forerunner 235 insisted we'd managed only 5m 10s. Even for something that costs less than £200, that's a disappointing degree of inaccuracy.

**ON THE BEAT**

At least it's fine for more basic tracking, and since it's designed for everyday wear, it will be diligently tracking steps and heart rate even when you're not breaking into a sweat. This translates into your standard range of fitness tracker essentials, such as telling you when to move if you're sedentary for a long time, and tracking your sleep.

Rather neatly, the heart-rate tracking can be seen in a handy graph for the last four hours with a single click of the watch's buttons. It will also send through notifications and connect with your phone's calendar.

Elsewhere, the Forerunner 235 does more than simply track runs and steps, and its talents are expandable through Garmin's app store. A word of warning here: despite having a 5ATM waterproofing rating, this isn't a swimmer's watch. The best you can do is install one of several third-party apps that can roughly track swims with the compass.

The Garmin Connect app itself is a highlight, just for how fully featured it is. Besides tracking a huge array of metrics, it displays – like the Forerunner 235 – all the details in a welcomingly accessible manner.

When you do head out on a run, all this data is accompanied by a nice map of your route and a description of the weather that day. Personal bests are recorded in a special segment of the app, and there's even room for you to enter details on your running gear, so you know when it's time to replace an old pair of shoes.

**ALL IN ONE**

There's more to the app than just tracking rides and runs, and it's a mixture of what's automatically detected from the watch (such as sleep, heart rate and VO2 max) and stuff for you to enter manually (such as calories consumed, weight and so on). If we were to be hyper-critical, we'd say the list of apps that Garmin Connect can be connected to could be a little more comprehensive, but with Strava, MyFitnessPal and, bafflingly, Office 365 in the mix, the main contenders are present and correct. Given how in-depth Garmin Connect is, you can fairly argue that there's not really a need to link to anything else.

We'd love it if the watch was as good as the app, but sadly the Forerunner 235's unreliable accuracy denies it the highest of marks. This may be better than the Fossil Q Control, but the Withings Steel HR Sport, even without built-in GPS, is the fitness smartwatch we'd rather have.
**WEARABLES**

**MOBVOI Ticwatch Pro**

★★★★☆

£220 • From www.amazon.co.uk

**VERDICT**

It improves on its predecessors in nearly every way, but the Ticwatch Pro falls down in one crucial area: performance

**THE TICWATCH PRO** is the latest creation of Chinese company Mobvoi, a relative newcomer to the UK smartwatch market whose previous wearables were launched via a Kickstarter campaign just last year. The Ticwatch E (for ‘Express’) and S (for ‘Sport’) stood out among their premium rivals for one simple reason: they offered much the same features but at a fraction of the price.

Both models run Wear OS, have a built-in optical heart-rate monitor and GPS, and let you store music offline, allowing you to enjoy a few tunes when you go for a run or bike ride without having to take your phone with you.

**EXTREME MAKEOVER**

However, the Ticwatch E and S both lack the kind of high-end build quality you’d expect from bigger names such as Apple and Fitbit, and neither model supports contactless payments via NFC. Mobvoi has managed to right both these wrongs with the Ticwatch Pro, which is an altogether more robustly designed smartwatch, swapping plastic for stainless steel and introducing a ‘hybrid’ strap that’s silicone on the underside but covered with strips of leather.

There’s still no altimeter, but the watch has built-in Wi-Fi, GPS and an optical heart-rate sensor, and while the Ticwatch Pro runs the same Wear OS 1.3 operating system as its siblings, it’s built around the better-known Qualcomm Snapdragon Wear 2100 chip.

Waterproofing, meanwhile, has improved to meet the IP68 standard, meaning you can submerge it in 1.5m of fresh water for up to half an hour. That said, Mobvoi itself doesn’t recommend that you swim with it, and there are no dedicated swimming tracking features to speak of, so the waterproofing is mainly to cover showers and accidental drops.

Broadly speaking, the styling of the Ticwatch Pro mimics that of the Ticwatch S, with second numbers marked on the bezel around the edge of the watch face. However, unlike the cheaper model, the Ticwatch Pro has two buttons on its right side as opposed to one button on the left. One of these opens the app list and doubles as a back button, while the other is a dedicated shortcut to Mobvoi’s Fitness app.

The biggest change is the layered display, which comprises a basic FSTN LCD display stacked on top of an OLED panel. This innovation lets you check the time and date, along with your step count at a glance, without needing to wake the power-hungry OLED screen underneath. When the battery is really low, you can also activate Essential Mode and squeeze out a few extra days’ use.

There is one downside to cramming in all these new materials and features: the Ticwatch Pro weighs a mighty 78g with the strap attached, which is far off double the 42g weight of the Ticwatch E. Even so, the Ticwatch Pro is surprisingly comfortable thanks to its silicone strap and smooth stainless steel casing. There’s a slight protrusion where the optical heart-rate sensor is positioned, but this didn’t create any discomfort in our experience.

**TWO FACED**

It’s also not as stylish as the Apple Watch Series 4 or even cheaper watches like the Fitbit Versa, but where the Ticwatch Pro has its flashier rivals beaten is the dual-screen display.

It’s a clever concept, not least because it lets you check the time without having to set the power-sucking OLED display to always-on. As well as being more energy-efficient, the FSTN LCD is also more easily visible in bright light. One downside is that the OLED times out after a few seconds if you don’t touch it, which can often feel too soon, and we couldn’t find an option to change this.

However, a definite perk is that when the Ticwatch Pro is running low on battery, it enables Essential Mode, where only the low-energy screen is used. You can’t check your notifications or use apps in this mode, although it still measures your heart rate and at least you can tell the time until you get the chance to charge the watch again. We found that Essential Mode adds three extra days of battery life to around a day and a half of normal use.

Wear OS takes full advantage of this tiered display by integrating it into Mobvoi’s own fitness apps. Whereas there was no reason to use these instead of the Google-developed equivalents on the Ticwatch E and S, here the details of your workout can be kept on the low-energy LCD, giving you the essential data without putting unnecessary strain on the battery. The Ticwatch Pro is an accurate fitness tracker, too, with generally spot-on GPS and a heart-rate sensor that consistently provided readings in line with what we expected.

Google Assistant is also supported, for convenient voice controls, and NFC finally enables the use of Google Pay. This remains a much better payments app, in terms of how many banks support it, than Garmin Pay and Fitbit Pay.

**INACTIVE LIFESTYLE**

Sadly, one area in which we found the Ticwatch Pro distinctly underwhelming was performance. The Snapdragon Wear 2100 doesn’t turn out to be much of an upgrade at all; to give just one example, opening Google Play Music took several seconds longer on the Ticwatch Pro than it did on the Ticwatch S, and even in more general use, the newer model just feels sluggish.

This is, unfortunately, a crucial point to stumble over. Unless performance is significantly improved by software updates, you’re better off sticking with the cheaper Ticwatch E or S – a shame, as the Pro is packed with improvements otherwise.
MOOV Now

★★★★☆
£45 • From www.amazon.co.uk

VERDICT
It’s only a simple tracker, but the Now’s unique technology and coaching set it apart.

FOR MORE CASUAL exercise regimes, you don’t need an expensive smartwatch to monitor activities and improve your fitness – and the Moov Now proves it.

It’s an incredibly simple device, to the point of looking slightly peculiar: there’s no screen, just a rounded pod cradled inside a stretchy strap. It’s not ugly, just different – like some kind of extra-terrestrial bracelet – and it’s very comfy as well. That’s down to the strap and tracker having a combined weight of just 15g, making it something we could easily forget we were wearing. It’s also dirt-proof, sweat-proof and waterproof up to 3m, so can handle anything short of scuba diving.

Another reason not to remove the Moov Now is how fiddly it is to secure the strap in the first place. Two metal pegs must be slotted through perforations on the strap to suit your wrist width, but it’s so tricky to fit securely you have to invert the strap and push through from the other side. Once it’s on properly, it does at least stay put.

TRAIN CHECK
The Moov Now works in conjunction with the Moov Coach app, available for free on iOS and Android. Once you’ve paired the device with your phone, you use Moov Coach to select workouts, view progress and ‘achievements’, and compete with friends who also use the Moov Coach app. The app has several types of ready-to-go workouts, which are broken down into two categories, Motion or Heart Rate; however, you’re stuck with just the former, as the Moov Now is one of the few fitness trackers to lack heart-rate monitoring. Moov would clearly prefer you bought one of its dedicated heart-rate tracking straps as well.

The best part of the Moov Coach software is the audio encouragement it provides during each workout, telling you how you’re doing and pushing you to work just that little bit harder to meet your targets. If you’re out on the streets or in the gym this audio coaching is best listened to via headphones, to avoid disturbing those around you.

With Moov’s coaching tips, even a simple stroll can turn into a hardcore power walk workout. This makes the Moov accessible to people who aren’t looking to train at an enthusiast level, but want to build up a base level of everyday fitness.

Walking, running and cycling are most accurately recorded with the Moov Now attached to your ankle. Another neat feature of the accelerometer inside the Moov Now pod is its ability to record stride length and the force of impact when you’re running; if you’ve never had a professional consultation about your running gait, this feedback can be revelatory.

DO IT YOURSELF
There is one drawback to all this activity: syncing your workout data is a slow process. The Moov Now is a low-power device, so it doesn’t send data to your phone continuously like other rechargeable fitness trackers. The benefit of this is that the battery lasts a long time, while the downside is that you have to press down on the tracker manually so it transfers activity and sleep-tracking data from the pod to the app.

It’s especially slow when you’ve finished a swim, because during swim workouts the tracker doesn’t communicate continuously with the app – it uploads at the end, and that process can take minutes to complete. The data bank is undeniably impressive, however: when you return to your locker after the swim, the Moov app provides a detailed breakdown of the number of laps swum, the types of strokes performed, the rate of your strokes and your lat times too. Not bad for a £45 device that only uses accelerometers.

Still, you do have to be mindful to always end your workout in the Moov Coach app when you’ve finished, otherwise it won’t save the information properly. This is easy to forget, especially when you’re wearing it on your ankle following a bike ride and your phone is in a bag or back pocket.

We felt afoul of this ourselves, having failed to end a workout immediately after a bike ride. Upon inspection, the Now had recorded the travel distance correctly, but all other data was skewed beyond usefulness.

It can therefore be pretty frustrating that workouts don’t end when the exercise clearly does. The fact that it’s necessary to dig a phone out so often when using the Moov Now can also be slightly off-putting to the notion of tracking every walk and cycle trip.

Another problem, which pertains mostly to outdoor cycling, is the need for headphones to receive Moov Coach’s active coaching feedback in your ears. Anything that distracts your senses from the hazards of the road has the potential to be very dangerous. If you choose to play it from your phone instead, you’ll still get the feedback but unless you have it in a breast pocket it will be too muffled to hear anyway.

BASIC INSTINCTS
For such a cheap wearable, the Moov Now has amazing potential to improve your overall fitness and motivate you towards achieving your long-term goals. While its tracking technology may seem rudimentary compared to the advanced smartwatches made by Samsung, Garmin and Fitbit, the data that Moov Now provides can actually be more useful, especially the feedback it gives about stride and landing impact.

Not only that, but its motivational coaching feature is highly sophisticated and, importantly, actually works. You feel encouraged and you benefit as a result.

The Moov Now may not be for everyone, but if you don’t mind working out with your headphones on, then this unconventional fitness tracker could give you the boost you’ve been looking for.

ISSUE 371 | COMPUTER SHOPPER | JANUARY 2019

95
SAMSUNG Galaxy Watch
★★★★½
£299 • From www.amazon.co.uk

VERDICT
Samsung’s most accomplished smartwatch yet, but some of the new features could be better

IT’S BEEN NEARLY two years since Samsung unveiled a new flagship smartwatch, the Gear S3 (Shopper 350), but even with all this time (plus a name change) the Galaxy Watch is clearly descended from the old Gear series.

The 46mm Galaxy Watch is about the same size as the Gear S3, and combines design elements from both the Frontier and Classic versions of the latter. Mostly, it has a slick, polished look, but the two flat, grippy buttons – used instead of a traditional crown – are straight out of the rugged Gear S3 Frontier.

ON THE TURN
The Gear series’ rotating bezel is here as well, and still works brilliantly at scrolling through menus and apps without your finger getting in the way. The screen, too, is a familiarly superb 360x360, 1.3in AMOLED effort.

There’s also a smaller 42mm Galaxy Watch model, which might appeal to those with small wrists, but it’s still chunkier than the Gear Sport (Shopper 361), so you’ll be disappointed if you specifically wanted an Android-compatible smartwatch that competes with the Apple Watch Series 4 on sheer slimness.

Like the Gear Sport, the Galaxy Watch features swim tracking and waterproofing to 50m – both big improvements on the Gear S3. However, Samsung only recommends pool swimming rather than more extreme pursuits such as scuba diving or waterskiing.

Elsewhere, not a huge amount is new about the Galaxy Watch in terms of what you can do with it. Automatic activity detection, stress tracking and sleep tracking are all features we’ve seen in Samsung wearables before, and they’ve been included again here.

Sleep tracking is limited to summarising the time you spend motionless, restless and sleeping lightly, as well as giving you an efficiency score. We found it often failed to measure different sleep stages, saying it ‘couldn’t get a consistent heart-rate reading’.

The stress tracking feature is more at the forefront than before. It now automatically detects when you’re too stressed and invites you to carry out breathing exercises to combat this. Unfortunately, this too needs work: we never received a notification even at times of moderately high stress.

Thanks to its new dual-core 1.15GHz Exynos 9110 processor, the Galaxy Watch is more than sufficiently zippy, especially next to Snapdragon Wear 2100-powered watches such as the Mobvoi Ticwatch Pro. It seems to be a very efficient chip, as we comfortably got a full working week’s use between charges.

That’s well ahead of the Apple Watch, and on a par with Samsung’s own estimate of seven days. Notably, that’s just for the 46mm model; the 44mm model is only rated at four days, although that would still be very good.

HITS THE SPOT
The Galaxy Watch runs Samsung’s own Tizen operating system, and interfaces with the Samsung Galaxy Wearable and Health phone apps. All three work well enough, and the Tizen platform is clearly very power efficient.

However, the downside of Tizen is that it doesn’t offer a huge selection of third-party apps. Spotify is the one major exception to this rule; unlike Wear OS and Apple’s WatchOS, which only let you store music offline in Google Play Music and Apple Music respectively, the Spotify app for Tizen is the perfect companion for runners who want to leave the house without their phone but still accompanied by their favourite soundtrack.

The only significant limitation is that the Galaxy Watch still has a mere 4GB of storage, which means there’s enough space to save your favourite playlists, but you’ll need to perform more regular housekeeping of what’s stored offline than you might on the Apple Watch, which has 16GB of storage on the Series 4 models.

SPACE AGE
Overall, the Samsung Galaxy Watch improves on the Gear S3 in every conceivable way. Battery life in particular is stellar, and the watch also fills the only significant hole in the Gear S3’s feature set: swim tracking. Bar a few annoying bugs, it’s a brilliant smartwatch, especially if you have an Android phone and thus can’t use the Apple Watch.

At the same time, anyone who can opt for the Apple Watch should get that instead. While the Galaxy Watch makes many steps forward, it’s still behind the best of the best, especially on the software side.
AFTER BEING BOUGHT by Nokia in 2016 and sold back to a co-founder in 2018, you might have thought Withings would step back and consolidate before launching itself back into the harum-scarum of the wearables market. Yet it’s wasted no time at all, recently launching the fitness-focused Withings Steel HR Sport.

Based strongly on the Nokia Steel HR, which was also released in 2018, the Steel HR Sport adds much-needed extra features and ramps up the style, but follows a similar template to the firm’s previous wearables.

FORM AND FUNCTION
Just like the regular Steel HR, the Sport model is a watch first and a smartwatch or fitness tracker second. It has a stylish, understated physical watch face with analogue hour and minute hands and an analogue sub-dial to show progress to your daily step count target. It also has a small, circular monochrome OLED screen that shows more detailed info such as notifications.

It’s a classy-looking device, the idea behind which is not only to look like a normal watch but also to offer much better battery life than regular smartwatches. It tracks your steps, your sleep and your heart rate, is waterproof to 50m, but doesn’t include built-in GPS, and its notification-handling isn’t as advanced as on a proper smartwatch.

What, then, makes this Sport version worth splashing out on? Its looks, for a start, which are in a different stratosphere compared with most fitness trackers and smartwatch rivals at this price. It’s available with a white or black face (we prefer the latter, but both look lovely), and comes with a stretchy rubber sports wristband in the box. This pliable design allows you to get the watch comfortably tight without cutting off the blood supply to your fingers.

Whether you like the way it looks or not, there’s no denying that the Steel HR Sport is a superior smartwatch to the Steel HR, as there have been a number of major improvements. The first of these is improved handling of notifications. The tiny OLED screen is still too small to show the full text of messages – you only see a snippet, but it’s enough to tell if you should get your phone out and read more – plus there’s now support for apps, which wasn’t available with the Steel HR for nearly a year after launch.

Paired to a smartphone, the Steel HR Sport was able to notify us of new email, Slack messages and Twitter notifications, where the original Steel HR was limited to texts, calendar and calls. You can pick and choose which apps to block and which to allow, in case you get tired of your watch buzzing every five minutes.

The Steel HR Sport is better at tracking your exercise than the original Steel HR, too. First on the list is tethered GPS. Where the original Steel HR was limited to distance estimates based on your stride length, the Sport allows you to track your runs more accurately by piggybacking off your smartphone’s GPS. You’ll need to have the app open on your phone to do this, however, which is a bit of a pain and easy to forget in the rush to start a run or a ride.

KEEPING DISCIPLINES
And that’s not all. There’s also multisport tracking, which includes swimming, cycling, running and even activities such as volleyball, Zumba, skiing and ice hockey. You can cycle through these on the watch’s tiny screen, although because there are so many (30 in total), the number shown on the watch is mercifully restricted to six. You can select which are displayed through the Withings Health Mate app.

The last big new feature is that the Steel HR Sport will now give you a ‘fitness level assessment’ via VO2 max estimation – a measurement you only usually get on more serious fitness tracking wearables. Slightly annoyingly, this assessment is only delivered after you go for a 10-minute (or longer) run, but it’s nice to have nonetheless.

Plus, of course, there’s all the stuff that made the Nokia Steel HR so good in the first place. You get continuous heart-rate monitoring that updates every 10 minutes when you’re not exercising for a view of your resting heart rate, (it updates every second during workouts). It also has sleep tracking, which keeps tabs on your heart rate and how much deep and light sleep you get in a night, awarding you a ‘sleep quality score’ afterwards. This appears to be mostly accurate, although it thought we’d gone back to sleep one morning when in fact we were simply sitting in bed. Still, if you notice this happening it’s pretty easy to edit sleep events, and alter start and finish times.

Despite all the new features, the Steel HR Sport still lasts for ‘up to 25 days’ per charge according to the specifications. The more you use it for exercise tracking, the less time the battery will last, but after three-and-a-half days (including around two-and-a-half hours of activity tracked), the watch still had 68% remaining on the gauge. That’s a brilliant display of endurance.

The big weakness is the small number of third-party fitness tracking apps the accompanying Health Mate app connects to. Only Google Fit (Android), Apple Health (iOS), MyFitnessPal and Runkeeper were available to us, although it is possible that more will be added in the future.

WELL FIT
Not everyone wants to wear a watch that looks like a bulky lump of assorted tech, and this delivers a spectacularly good compromise between traditional timepiece design and fitness functionality. It looks great, tracks more than just steps and lasts ages on a single charge. It might not deliver full-text notifications, and it might be limited compared with fully fledged smartwatches, but it offers a compelling alternative for those who prefer a more classic look.
It’s almost a shame that the most finely crafted, fully featured wearable here is the Apple Watch Series 4 – anyone with an Android smartphone will be missing out. In itself, however, this latest Apple Watch is a masterful mix of slick design, versatile app compatibility and a surprisingly complete suite of fitness tools. We’d have liked it to have been cheaper, but this is Apple after all.

For Android-owning smartwatch fans, the Samsung Galaxy Watch and Withings Steel HR Sport both make great alternatives. The latter in particular benefits from excellent battery life and a very stylish look. The Galaxy Watch has better third-party app support; it’s much more of a typical smartwatch in this regard, while the Steel HR Sport is more of a fitness tracker with some smart functionality added in.

Speaking of which, the Fitbit Versa is another strong example of the smartwatch/fitness tracker hybrid approach. Fitbit’s activity-tracking expertise is in full view, naturally, but the onboard FitbitOS software is remarkably accomplished, too.

VERDICT

It’s almost a shame that the most finely crafted, fully featured wearable here is the Apple Watch Series 4 – anyone with an Android smartphone will be missing out. In itself, however, this latest Apple Watch is a masterful mix of slick design, versatile app compatibility and a surprisingly complete suite of fitness tools. We’d have liked it to have been cheaper, but this is Apple after all.

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Choose from a fantastic selection of magazines to suit all interests

The perfect gift this Christmas
Security threats aren't going away and, if anything, the breaches are getting worse. David Ludlow shows you 30 foolproof ways to stay safe and protect yourself against some of the biggest threats today.

Life used to be relatively simple, with only the odd virus to combat, which any half-decent security software could do. Today, installing quality security software is only the start of your protection journey. While leading software, such as our recommended package Kaspersky Security Cloud Personal, can prevent most direct attacks on your computer, they're all useless when it comes to a greater threat: your online accounts.

As we've seen from the recent Facebook attack, which has seen up to 90 million accounts hacked, security software on your home computer can't do anything when the hackers are focusing on attacking central services that most of us use. You can see why this route has been used: by exploiting a big service like Facebook, the hackers have stolen millions of bits of data, which will be valuable to them; writing a virus and trying to attack individual computers just doesn't yield the same results (although there are still other reasons to go for specific computers).

What this means is that a different tack is required to deal with modern threats. Thinking outside of your PC and carefully planning your approach to security everywhere is key to protecting your personal information. In this guide, we'll show you what to do.

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Don’t enter real information for security questions

Don’t enter the first car you bought or the name of your first pet for security recovery questions. Instead, create secure passwords (manually or with LastPass or another password tool) and enter these instead. This increases security and is information that a hacker can’t find out or guess. Note these answers down somewhere securely, so you can reference them if needed.

Lock down Facebook

The Facebook hack showed that nobody is safe. We show you how to boost protection and limit the damage that this kind of attack can cause.

When Facebook revealed that up to 50 million accounts had been hacked, there was collective shock. Yet so bad was the flaw that Facebook took the step of logging out an additional 40 million users in order to safeguard information – that’s a staggering 90 million people affected.

The attack was caused by a flaw in the View As feature, which lets you see how other people can view your profile. The idea was that this feature would let you check if your privacy and sharing settings were working the way that you wanted them. It’s a little ironic that a security check-up setting should be the cause of a huge breach.

The attack itself managed to retrieve access tokens, which are used to provide quick logins to other sites using your Facebook details via the single sign-in service. This is a feature of convenience, as it means that you can register to use a new service without having to go through the rigmarole of having to enter your private details (username, password, etc) into a new site. Instead, you just link the site to your Facebook account and you can then log into and use loads of services using just your social network.

Yet, as the hack demonstrates, this feature causes two problems. First, it gives hackers a way of accessing Facebook accounts without having to break the password first. Second, it gives hackers the ability to access third-party sites linked to your Facebook account and you can then log into and use loads of services using just your social network.

The Facebook hack showed that there’s a matter of when, not if, one of your internet accounts gets hacked. The goal, then, is to make it as hard as possible for hackers to gain access and, in the event of a hack, to prevent further damage. Specifically, we’ll start with Facebook.

Unlink other accounts

Your first job is to remove access to third-party apps and websites. Log into your Facebook account and go to Settings, then select Apps and websites. Here, you’ll see a list of Active apps and websites: these are the ones that you’ve granted access to. You can revoke access given to third-party apps and services to your Facebook account easily.

Google has a similar system in place, letting you log into other services with your Google account. While Google hasn’t been hacked, if it were (or if your account is hacked), hackers could then access all the sites linked to your account. For this reason, we recommend never using the option to log in with Facebook or Google, and instead creating a separate account protected by a fresh password.

Ultimately, what the Facebook attack showed was that it’s a matter of when, not if, one of your internet accounts gets hacked. The goal, then, is to make it as hard as possible for hackers to gain access and, in the event of a hack, to prevent further damage. Specifically, we’ll start with Facebook.

Unlink other accounts

Your first job is to remove access to third-party apps and websites. Log into your Facebook account and go to Settings, then select Apps and websites. Here, you’ll see a list of Active apps and websites: these are the ones that you’ve granted access to.

Select them all and click Remove. You’ll see a dialog box asking if you also want to delete the posts these services may have created; it’s up to you whether you want to do this.

The downside of this step is that you’ll now need to create a new account on any of the services that you’ve used, but that’s a price worth paying.

Turn off single sign-in

The next thing to do is turn off the single sign-in option, which will prevent other sites ever being able to access your information.
Key lessons from the Facebook hack

With so many accounts breached in the Facebook attack, it’s opened a lot of people’s eyes to the security risk posed by online accounts getting hacked. With that in mind, here’s our security checklist that should be applied to all accounts.

1. **Set a different password for each account**
   - Don’t let one account getting hacked affect all your other accounts. Instead, make sure you use a separate and strong password for each account.

2. **Don’t use single sign-in**
   - Using Facebook or Google to create accounts on other services quickly may seem a time-saver, but it’s fraught with danger: if your main account is hacked, the hackers will have access to every other service, too. Instead, always create a separate account for each service.

3. **Use two-factor authentication**
   - Where possible, turn on two-factor authentication. This adds an extra level of security to your accounts so that you have to enter an additional one-time code that’s generated by an app or sent via SMS. If your password is compromised, two-factor authentication can save the day.

4. **Don’t share private information**
   - Make sure that your social media accounts aren’t giving away your birthdate or other sensitive information. This kind of data is often used to verify accounts, so you don’t want to let hackers have easy access to it.

5. **React quickly**
   - Think that there’s something going on, or worried that an account might have been hacked? React quickly and change your password as soon as you can. That way, you can either avoid or reduce the damage caused by a hack.

6. **Assume you will be hacked at some point**
   - The Facebook hack shows that we’re all in danger of being hacked, and that strong passwords may not prevent this. Watching out for signs of illegal access to your accounts can really help.

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- Turn off the option to log into other services using Facebook to boost your protection.
- Log out of all Facebook sessions to remove access to anyone that has already accessed your account.
- Change your password and security settings:
  - It’s worth updating your Facebook password, replacing it with something strong and long (see page 104 for more information on generating and storing strong passwords).
  - You should also turn on two-factor authentication, which requires you to enter an additional one-time code when you log into your Facebook account (see page 106 for more information on how to do this).
- Remove trusted computers:
  - When you log into Facebook, there’s an option to trust a computer to keep you logged in. This is handy if you don’t want to have to re-log in every time you use Facebook, but it can leave you exposed. The best thing to do, in the wake of the recent attack, is to regularly log out of all Facebook sessions everywhere.
  - This will force you to log back in from your devices, but ensures that nobody else has access to your account.
- To do this, go to Settings, Security and login. You’ll see a list of devices under Where you’re logged in. Next to any device, you can click the three vertical dots icon and choose the Log Out option to remove that session’s access. However, it’s easier to scroll to the bottom of the page and select Log out of all sessions. The next time you use Facebook on any device, you’ll need to log back in.

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- Restrict what information people can see about you to prevent data leaks.
- Don’t save credit card details online:
  - Websites will often offer to save your credit card details to speed up payment. We recommend not using this option, particularly on sites that you don’t use regularly. It can be a security threat, as the recent BA hack showed.
  - You can save credit card details in your browser or, even better, in LastPass.

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- Restrict what information people can see about you to prevent data leaks.
Create and manage secure passwords

A secure password that's hard to break isn't a guarantee of protection, but it's a good start and certainly makes life harder for hackers.

Passwords remain the most popular way to protect account security, so choosing the right ones is critical to success. The most basic form of hacker attack involves brute-force guessing of passwords. This is typically done in two ways. First, hackers will try a list of the most common passwords, with a few common alterations (password1 or password!, for example). Second, hackers will run a dictionary attack against your passwords, hoping to gain access to an account because you've chosen a common word. Avoiding these two traps is the key to success.

How to create secure passwords
Generating a password that's secure enough for it not to be broken easily but easy enough to remember is quite a challenge. Traditionally the advice has been to use a random mix of upper- and lower-case characters, plus symbols and numbers. In fact, many websites will enforce such rules. That doesn't make passwords easy to remember.

The easy way is to use a password made up of common words joined together that aren't a common phrase, which hackers will often try. So 'TheQuickBrownFox' isn't very secure. However, 'FoxWoodRunChicken' is far more secure, as it's made up of random words. And with capital letters for each word, we've already hit one requirement for secure passwords.

Next, as many websites require a number or symbol to make a password secure, you can try splitting up a memorable year around your password, plus tacking on a symbol at the end. So, 19FoxWoodRunChicken88# hits our goal (1988 for the launch of Computer Shopper, of course).

Checking for secure passwords
When you come up with a new phrase, it's worth checking how secure the final password is before you start using it. The website www.passwordmeter.com is a great resource. Visit the site and enter your chosen password to get a breakdown of how secure it really is.

How to manage secure passwords
Our advice on creating secure passwords is a good starting point for creating easy-to-

Keep a record of your passwords
Whether it's in LastPass or written on a bit of paper that you keep somewhere secure, such as a safe, having a record of all of your passwords is a great idea. That way, you've got somewhere to refer to if you should forget your details.

.Password Meter is a great resource for checking how strong your passwords really are.
Account (you have to be signed into your account in Chrome for this to work). This feature lets Chrome create random combinations of characters and digits, autofilling the information when you need it. It’s a good start, and for people that only use Chrome or Android could be everything you need. However, Chrome passwords don’t synchronise with iOS or macOS.

The alternative is to switch to a password manager such as LastPass. Available for Chrome, Edge, Internet Explorer, Firefox, Safari, Android and iOS, LastPass can generate secure passwords and autofill them in websites and apps. Cleverly, LastPass securely synchronises passwords between all of your devices, too.

When you first create a LastPass account, you initially need to create a master password. Use the advice above to do this. For safety, write this password down on a piece of paper and store it somewhere secure, such as a drawer. That way, if you get stuck, you know where to look.

LastPass is free for basic use, but if you want to synchronise between different device types, it’s worth paying the $2 a month fee for a premium account.

Once you’ve finished creating your account, you’ll be prompted to download the appropriate extension for your browser. We’ll show you how to configure this with Chrome.

Manage LastPass in Chrome

Once LastPass has been installed, you’ll see an icon next to the address bar in Chrome. Click this and you can log into your account. You can choose to remember your username and password, but only do this if your computer is securely locked with a password. For maximum security, you should just log in when you start a new browsing session.

Next, you can import your usernames and passwords. To do this, you first need to export your Chrome details. For security reasons, this option is disabled by default. To turn on the option, type Chrome://flags into the address bar. Find the Password export option and change it to Enabled, then click Relaunch.

In Chrome, click the three vertical buttons and choose Settings from the menu. Click on

LastPass now has all your saved passwords. To clean up Chrome and stop it from remembering future passwords, you need to go to Chrome’s settings again. Go to Clear browsing data and click the Advanced tab. Select All time from the drop-down menu and then tick the Passwords box. Click Clear Data. Next, go to the Passwords section of Chrome’s Settings menu and turn off the Offer to save passwords option.

You may want to copy your exported Chrome passwords to a USB drive and store this somewhere safe, just in case you ever have to manually enter a password. Click the fill button when done.

Password generation works when creating a new account or when changing your password on another site. For the latter, LastPass will update the secure password it has stored.

Entering passwords with LastPass

Next time you go to a website and have to log in, you’ll see a LastPass icon in both the username and password fields. Click this to show a list of usernames for that site (LastPass can remember multiple usernames for each site). Select the one you want and LastPass will enter your information automatically. If the

LastPass icon turns orange, click the icon and you’ll see a warning about it, such as that you’ve used a duplicate password for another website. This should be a good wake-up call to change your password for that site.

Adding secure passwords with LastPass

If you want to create a new account on a website, or want to change an insecure password for a secure one, LastPass can help. When you click a password box, LastPass will show you a padlock icon with an arrow around it. Click this for the Generate Password box. Click more options to choose more about the password, including length; 12 digits should do it, just in case you ever have to manually enter a password. Click the fill button when done.

Password generation works when creating a new account or when changing your password on another site. For the latter, LastPass will update the secure password it has stored.

Viewing your passwords

There may be times when you have to enter a password manually. To view the password that LastPass stored for a site, click on the icon and select Open my vault. You can use the Search bar to find the site you want a password for. Don’t click the main icon for a website, as this will open the site, but click the spanner icon to open the edit form. Then click the eye icon next to the password to reveal it.

Using LastPass on mobile

The LastPass mobile app can be downloaded from Google Play or the Apple App Store. Once signed in, your app pulls down any passwords shared in your LastPass account. You can then autofill usernames and passwords using apps or your phone’s browser (paid-for version only).

LastPass doesn’t give quite the same options for generating secure passwords directly into mobile browsers, although you can do this from the app and manually save a site (see www.lastpass.com for detailed mobile browser information). For this reason, we find it easier to create accounts using a desktop computer, relying on the mobile version for form filling.

You can enable an option to export your Chrome passwords
How to use two-factor authentication

Adding an extra layer of protection with two-factor authentication can prevent your account from getting hacked, even if your password is stolen.

Secure passwords are one thing, but what if yours gets stolen through a website hack? Unfortunately, as we’ve learnt over the years, it’s more a matter of when your details will be stolen rather than if. Two-factor authentication (sometimes called multi-factor or two-step) adds an additional layer of security to protect you.

As well as entering your password, two-factor authentication also requires you to enter a one-time code. This code typically refreshes every minute, and without this information your account can’t be accessed.

There are three main ways of generating a code: being sent an SMS, using an app on your phone; or using a dedicated USB key, such as the excellent YubiKey 4 (Shopper 354). The latter is the easiest way, but it only works with the Chrome browser. And having an app as a backup is essential.

Using the LastPass Authenticator

Codes can only be generated by a single app on a single device. So, if you change your phone, you have to remember to transfer your authentication to a new device, which is time-consuming. If that doesn’t bother you, the Google Authenticator app (Android and iOS) is a great choice. If you want an easier way to transfer to a new phone (or restore your information should you lose your handset), then the LastPass Authenticator (Android and iOS) is a great choice. With a LastPass premium account, you can back up your code generators to your account, letting you transfer phones more easily.

Google has a dedicated two-factor authentication page

Once you’ve installed the app, tap the button to add a new account. Choose the option to scan a barcode. We’ll show you how to get started with your Google account. Log into Google as usual, then visit the 2-Step Verification sign-up page (www.google.com/landing/2step) – 2-Step Verification is Google’s own name for two factor.

You can read more on this page about the benefits and features of 2-Step Verification, or just click Get Started to begin.

On the next page, click Start Setup, enter a phone number to use for codes (if you entered one at sign-up, Google will autofill the information), and choose between voice calls and SMS. In most cases, it’s best to use a mobile so you can log in on computers when away from home; a regular non-smartphone will work fine. When you’ve provided a number, click Send code. On the next screen, you’ll need to verify your phone by entering the code you received and clicking Verify. If nothing’s happened after a few minutes, click Didn’t get the code? to go back a step and resend it or change your setup.

Once your phone has been verified, 2-Step Verification has been enabled for your account.
Cover your webcam

If you’ve got a webcam, you don’t want someone to hack it to spy on you. A small bit of tape over a laptop’s webcam will do the trick, and unplug webcams that you’re not using. Even Facebook’s Mark Zuckerberg covers his webcam, so it’s not crazy to think that this type of hack happens.

account. When you next log in, you’ll be sent a code to your phone, although you can choose to trust a device for 30 days; this means you’ll only be prompted for a code once a month.

If you want to use the Authenticator app (available in the Apple App Store or Google Play store) to generate codes, click Setup underneath the Authenticator option. Open the Authenticator app on your phone and click the ‘+’ icon, then point the camera at the QR code on your computer’s screen. Click Next, enter the code your Authenticator app has generated and click Next. Now, when you need to enter a code to access your Google account, you just open up the app and enter the code it displays.

Add a security key

If you want to add a security key, such as the YubiKey 4, make sure that your key is not connected to your computer. Then select Add Security Key underneath the Security Key option. Click Next on the dialog box that appears, plug in your security key and tap its button. When prompted, enter a name for the security key. Security keys become the default login option, and you just tap the button to generate a code. If you don’t have a key with you, Google lets you choose an alternative two-factor option.

Generate back-up codes

If you lose your phone, you’ll need to have a way to log back into your account. Google provides backup codes for this. Click Setup underneath Backup codes and you’ll see 10 codes. Print these out and keep them somewhere safe: if you ever lose your phone, you can use one of these codes to log into your account.

When you get a new phone, you’ll need to transfer the Authenticator app to it. Click Sign-in & security, and click 2-Step Verification. Enter your account password, then click the Pencil icon next to Authenticator app and click Change. On your new phone, scan the QR code with the Authenticator app and follow the onscreen instructions. Your new phone can now generate your codes.

Use your Authenticator app for other services

Google Authenticator and security keys are also supported by a lot of other services, as we mentioned in the introduction. Each service has to be configured individually, so check its website for full instructions. However, the rough steps are the same for all.

For example, with Facebook, go to Security settings and click Login approvals. Click the Require a security code to access my account from an unknown computer. Click Get Started to follow the wizard through, entering your phone number to get an authentication code.

To use Google Authenticator, click Code Generator. There’s an option to use Facebook’s app for this, but it’s not very good and it’s easier to have everything in one place. Instead, click Set up another way to use codes, and Facebook will bring up a QR code. In Google Authenticator, tap the ‘+’ icon. Tap Scan Barcode and point your phone’s camera at the QR code on the screen.

When prompted, enter the code that your app generates into Facebook. Similarly, select the Add key button to add a security key, following the wizard through. Finally, if you change your phone, you’ll need to go through these steps again to configure Authenticator on your new handset.

For LastPass, go to your desktop computer and open your browser. Select the LastPass extension and choose Open My Vault. Click your user account (top right) and choose Account Settings, then click the Multifactor Options tab. Choose the LastPass Authenticator option, then follow the wizard through, scanning the QR code on your phone when prompted, and entering your phone number as a backup. When done, next time you want to sign into your LastPass account, you’ll also need to authenticate using the app (a push notification lets you allow access without having to type in the code, although typing remains a backup option).

Back up your codes

To back up your LastPass Authenticator codes, go to your app. You’ll need to have enabled multifactor protection on your account (see above) first. Tap the Settings icon and slide on the Backup to LastPass option. Confirm your email address when prompted and you’re good to go. Authentication accounts will now be saved online, and you can restore these when you get a new handset.

You need backup codes just in case you lose your phone. Each code can be used only once.

You can turn on multi-factor authentication to protect your LastPass account.

You can back up your accounts to LastPass.
Stay safe on Wi-Fi

While free wireless hotspots can be convenient, they can be fraught with danger and could lead to your details being stolen. Here’s how to stay safe when using them.

Don’t connect devices you don’t need
More and more devices are becoming smart, connecting to your home network. However, with this connection comes the added risk of security breaches. Our advice is that if you’re not using a device’s smart functions, don’t connect it to your home network.

Be careful using Wi-Fi
Hackers have been known to set up free hotspots with the sole intention of stealing information, and in some cases you may not even know what’s going on. The problem with Wi-Fi is that public networks tend to open without security, potentially asking you to sign up for access once you’ve joined. Once you’ve joined a network, computers will remember it, and will try to reconnect. So if you joined the ‘free_hotel_wifi’ network when you were on holiday, the next time your computer sees that network it will join it automatically, regardless of whether it’s the real thing or a copy.

Taking action to prevent this from happening is key to staying safe. First, only join a public Wi-Fi network if you really have to, and definitely verify the name that you should be connecting to. For example, airports, cafes and hotels will usually have information signs that show you the name of the network that you should be connecting to.

When you’ve finished using the network, forget the name and details so that your device won’t connect automatically in the future. For Windows 10 devices go to Settings, Network & Internet, WiFi. Click Show available networks, select a network and click Forget. With Android, go to Settings, Wi-Fi, select a network from the list and then click Forget.

Use a VPN
A virtual private network (VPN) encrypts your data and transmits it across the internet to a secure endpoint. This prevents anyone from being able to spy on what you’re looking at, including Wi-Fi hotspot owners.

There’s a secondary element: a VPN can also make it look as though you’re located in a different country, which means that you can do things such as watch BBC iPlayer when you’re on holiday. We recommend ExpressVPN (Shopper 347) as it’s fast and great value, and you can choose to appear as though you’re in any one of a wide range of countries.

Don’t use shared computers
Public computers can be exceptionally dangerous, and you can’t guarantee that the computer in a library or hotel lobby is free of malware. Using that computer can make it easier for hackers to steal your data, aided by hidden keyloggers and the like. For that reason, we don’t recommend using shared computers anywhere.

If you really have to use another computer, such as a friend’s computer, make sure you use a private browsing session so your login details aren’t saved. Protect your accounts with two-factor authentication (see page 106) and log out at the end of your session.

Protect your home network
Your home wireless network isn’t the best target for hackers, as they have to be in range of it, but that isn’t a guarantee of safety. To protect your network, make sure that you’re using a secure password to prevent unauthorised connections. Most new routers come configured with a secure, unique password; older routers used default passwords across the whole range. In the case of the latter, avoid using the default.
Avoid scams

Criminals will often try to trick you into releasing your personal details, rather than hacking you: it's quicker and often easier to do. Here's how to avoid these attacks

Hack a computer requires a fair amount of technical skill. No wonder, then, that criminals often try to skip this step, aiming to trick people into giving away their personal details directly. There are several ways this can happen, so here's what to look out for.

**Telephone scams**

Cold-calling telephone numbers is a prime scam. We’ve probably all had calls purporting to be from Microsoft warning that our computer has been hacked and we need to install some software to fix it. It goes without saying that companies such as Microsoft and BT don’t phone customers with this kind of advice.

More sinister are the tricks that hackers will use to try and extort details out of you, which they can use to get your personal details. For example, you may get a phone call from someone pretending to be from your bank, saying that there has been an unauthorised attempt to transfer money. They may then ask you some security questions to verify your account.

Do not give this information out over the phone to a cold-caller. It’s very likely that the people calling are just after answers to your security questions, which they may use to breach your accounts. In some situations, the hackers may even have a certain level of access to your account, from a password leak or breach, but just need extra details to log in.

A more common issue is that hackers will phone you, saying that they’ll send a one-time code to your phone, which they need you to read out for verification. What they’re doing is getting you to pass on two-factor details sent via SMS.

**Phishing emails**

Phishing emails often contain bad grammar and spelling mistakes

The truth is that, even though some banks and companies may phone you and ask security questions, all activity like this should be counted as suspicious. Really, banks should know better. If you’re cold-called by anyone, refuse to give any information for verification. Instead, ask for a telephone number to call back on, and then verify this number against the publicly listed ones on the company’s website. If the number is legitimate, you can phone back and go through the verification process; if the number isn’t legitimate, you’ve avoided some trouble.

**Phishing scams**

Tricking people into entering details on a fake website is a key tactic. Typically, the hackers will set up a fake web address that looks very much like the original, but when you enter your username and password, nothing happens: all you’ve done is provide your details to the hackers.

This information can then sometimes be used with a cold-call scam to retrieve additional details, such as a two-factor authentication code. Here’s what to look out for in order to verify any email.

1. **Check the email address**

   Email addresses can be spoofed so it looks as though a message is coming from somewhere it’s not. Even so, many fake emails come from strange-looking emails, as faking details can make it easier for anti-spam software to detect the messages. Check the email address and name that the message is sent from: legitimate emails typically come from an email address using the company’s domain name, such as hsbc.co.uk.

2. **Watch out for bad grammar**

   Phishing messages are often sent from abroad, by people whose first language isn’t English. As a result, many messages are poorly written and littered with spelling mistakes. Anything in broken English is likely to be a scam and should set alarm bells ringing.

3. **Check links**

   Links in a phishing email will take you to a different destination that may look like the intended one. For example, you may end up on a website that looks just like the login page for your bank account. Before you click a link, hover your mouse over it in the email and check it carefully. Most scam links are easy to spot, using a strange domain name; some use domains that are minor spelling mistakes of the original (hsbc.co.uk for example), which are harder to spot.

4. **Go direct**

   Even if the message appears to be legitimate, it’s best to visit the site in question manually and log in from there. That way, you’ll avoid any malicious sites and can verify the information that you were sent.

   Likewise, if an email asks you to call a phone number for more help, verify this number against the website and only call it if it is legitimate.
Physical security

Be very careful how you dispose of personal information in order to keep your data out of hackers' hands

Security is more than just about computers; it should cover everything that you deal with, particularly in the real world. Criminals have been known to find information lurking on old computers and even in post that's been thrown out. Here's how to stop your information from being stolen.

Destroy hard disk information
It's possible to overwrite data on a hard disk to securely wipe it. In fact, Windows 10 has such a feature for resetting and wiping computers, so that they can be sold or passed on to someone else. Go to the Start menu and type Reset, and then select Reset this PC. Read the warning carefully, as this explains that what you're about to do will completely reset Windows and remove most applications that came with your computer.

If you're happy to continue, click Get Started and follow the wizard through. You'll get a list of applications that will be removed, so check this carefully before proceeding. In total, the reset procedure should take around 20 minutes, after which you'll have a PC that looks and feels like new. You'll need to install your applications fresh after this.

Using Fresh start is an absolute must if you're going to pass on your computer.

Simply creating another username and deleting your user account doesn't cut it, as the next user can undelete your information and use it against you.

If your computer is damaged beyond worthwhile repair, a hard disk has failed (internal or external) or you're disposing of the equipment, the process is all a little different. In these cases, physically remove the hard disk and smash it with a hammer. This will destroy a mechanical disk's platters or smash an SSD's chips, making recovery practically impossible (bar in some very expensive data recovery labs, which may be able to get back a small amount of data).

Wipe smartphones
Likewise, if you're getting rid of a mobile phone, you need to get rid of all your data. If you're selling a phone or passing it on to someone else, you should wipe the information.

To reset your Android phone go to Settings, System, Reset option. The first option you might want to try is Reset app preferences. This puts all apps back into their default position, which can alleviate issues by disabling apps that you previously allowed.

Shred everything
Don't throw away any bits of paper with personal information on them, such as bank statements. These pieces of paper can carry crucial bits of financial information, and so need to be disposed of properly. Use a shredder to completely destroy these bits of information. A cross-cut shredder is best, slicing documents up diagonally into tiny bits. Strip-cut shredders just cut your paper into thin strips. Depending on which way data was written and which way you put the paper in, some personal information can remain. However, a strip shredder is better than nothing and increases the complexity of recovering personal data. A basic shredder should cost around £30, but is money well spent.

Remote track and wipe
Make sure you have remote tracking and wiping on your mobile devices so you can clear a lost or stolen computer or phone. Find My Device for Android and Find My iPhone both allow remote tracking and wiping on smartphones. For Windows 10 devices, you'll need Prey (preyproject.com), which costs $5 a month for remote wiping services.

Smashing a hard disk with a hammer will prevent anyone but the most skilled experts recovering data from it to run in the background. If this doesn't work, the more nuclear option is to select Erase all data (factory reset). This clears your phone and puts it back to its original state.

Make regular backups
Regular file backups can protect against ransomware infections, letting you recover files for free without having to pay a fee. Make sure you use security software to clean the infection first.

Fresh start lets you wipe your computer prior to selling it or passing it on to someone else

Smashing a hard disk with a hammer will prevent anyone but the most skilled experts recovering data from it
Although you can take reasonable steps to protect your data, a company that you’ve signed up with may still get hacked, with your personal details leaking as a result. Unfortunately, there’s little you can do to prevent this from happening. Instead, it’s important that you react quickly to any breach to prevent the problem from escalating.

**Reclaim any hacked accounts**

If you’re locked out of any account, your first priority is to reclaim ownership of your account. In most cases, you’ll need to contact the company directly to find out how to recover information, as the process differs from service to service.

Most companies have an online recovery system. For example, Google’s is available at [www.google.com/accounts/recovery](http://www.google.com/accounts/recovery) and Facebook’s is at [www.facebook.com/hacked](http://www.facebook.com/hacked).

**Change all your passwords**

Do you use the same password for any other site? If you do, you need to change your passwords immediately, following our advice (see page 104). Update your password for the service that has been hacked, too, and enable two-factor authentication (see page 106) if you can.

**Tell your friends about the problem**

Often, the first time someone finds out they have been hacked is when they are told by a friend or family member that they have received a suspicious email, message or social media posting purportedly from you. Indeed, hackers will sometimes intentionally hack your account either to target your contacts or to steal as many of your contacts’ details as possible before they are found out. It’s important to let people know you have been hacked and that they may also be caught up in the cyber criminal’s schemes.

**Recover from a hack attack**

Even with all of the precautions we’ve shown you, an internet account may still get breached. If the worst should happen, here’s what to do:

1. **If you’ve been hacked, you’ll need to reclaim ownership of your internet accounts**
2. **Don’t pay ransomware fees**
   - If you don’t have backups, Kaspersky runs a website dedicated to providing free ransomware decryptors ([ noransom.kaspersky.com](http://noransom.kaspersky.com)). Using this site, you may be able to find a tool that will help get your data back, for free.
3. **Remember to use a Kensington lock**
   - A Kensington lock on your laptop can be used to secure your computer to a bench or your person when you’re out and about, making it much harder for your computer to be snatched and stolen.
4. **Have you been hacked?**
   - Visit [havebeenpwned.com](http://havebeenpwned.com) and enter your email address to find out if any of your online accounts have been hacked and leaked online. You should change the password for any accounts that have been hacked, as well as any other accounts that used the same password.
Mike Bedford investigates how research into weird and wonderful new materials may eventually affect our everyday lives by replacing silicon at the heart of computers and other electronic kit.
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<th>Element</th>
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<td>29</td>
<td>63.546(3)</td>
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It seems reasonable to assume that advances in computer technology come about by the dedicated effort of electronics engineers and computer architects. While not wanting to detract from the contributions of these professions, we have to acknowledge that the continual quest to bring us ever faster processors requires a much more varied skill set. In particular, process engineers, manufacturing experts, quality assurance professionals and even physicists and chemists play essential roles in bringing us the advances in technology that we’ve grown to expect.

What’s more, if those experts who claim that silicon technology has almost come to the end of the line are correct in their gloomy prediction, we are surely going to need some major contributions from these other disciplines.

According to the University of Oxford, materials science is an interdisciplinary subject, spanning the physics and chemistry of matter, engineering applications and industrial manufacturing processes. Here we’re going to investigate how research into new and exciting materials is aiming to give our computers a new lease of life.

Primarily this is by developing new semiconductor materials to replace silicon if and when it can go no further, although the potential of new materials doesn’t end there. So, if your image of a chemist or a physicist is of a bearded Victorian scientist in a dingy laboratory filled with glass tubes, Bunsen burners and strange contraptions, prepare to bring your perceptions into the 21st century.

SILICON CHIPS
The phrase ‘silicon chip’ trips off the tongue with barely a thought to what it actually means, so it would be helpful, right at the start, to explain why silicon has been the driver of the electronics revolution for so long.

Silicon is the element with atomic number 14. It sits in group 14 of the periodic table (also known as group-IV, especially among semiconductor researchers), between the metals to its lower left and non-metals to its upper right, and is classified as a metalloid. Metalloids have properties intermediate between those of metals and non-metals, most notably their electrical conductivity.

However, although silicon is a mediocre conductor of electricity, its conductivity can be improved significantly by adding small amounts of impurities, a process called doping. Doping with an element from the group to silicon’s right – usually phosphorous or arsenic – provides additional electrons that are free to...
Plastics might not be the most obvious material for making electronic circuits because they are mostly used as insulators, utilising their ability to impede the flow of an electric current rather than conduct it. Yet for several years, scientists have been researching special conducting plastics, or polymers as they are known to chemists, and are producing plastic semiconductors.

The advantages are flexibility, perhaps for wearable electronics, and low cost. Indeed, a commonly cited method of manufacturing polymer circuits uses a technique similar to inkjet printing, a far cry from the hugely expensive methods of silicon chip fabrication. There’s a snag, however, which is that polymer semiconductors have a much lower mobility than silicon, let alone some of its high-mobility potential successors. So while Belgian R&D company Imec produced a plastic microprocessor back in 2011 – and, yes, it’s bendy – it has a clock frequency of just 6Hz.

Despite this lacklustre performance (less than a hundredth of the speed of the Intel 4004, the first ever microprocessor, released in 1971), don’t be too quick to dismiss the technology. Plastic microprocessors would be suitable for ultra-low-cost applications where speed isn’t important, such as animated greeting cards or even in smart product packaging for foods. To date, however, the main application of polymer electronics is in displays, and you might even have an example in your pocket or your TV. You’ve probably heard of OLED displays but might not be aware that it stands for Organic Light Emitting Diode, or, in other words, plastic LEDs.

Advantages in phones are thinner screens with an improved contrast ration and reduced power. They might even lead to the much-vaunted rollable screen.

Silicon isn’t the only metalloid, nor is it the only one that can be doped to produce n-type and p-type semiconductor material, which can then be combined to make transistors. Indeed, the very first transistors were created using germanium, and germanium devices are still available for some specialist electronic applications. So although we’re going to be looking at potential successors to silicon, it would be informative to delve into why it overtook germanium back in the 1960s. There are several reasons, but let’s take a look at a few of the most significant.

First, silicon accounts for 27.7% of the Earth’s crust by weight, second only to oxygen. You can find it in common minerals such as silica, a key ingredient of sand. Germanium, on the other hand, is only the 53rd most abundant element, accounting for less than two parts per billion of the Earth’s crust. It’s produced mostly from the mineral sphalerite, which is a common tin ore, but germanium only occurs in sphalerite as an impurity, so it’s a by-product of tin production.

Needless to say, silicon is much less expensive, costing $16 per kg, compared to $2,300 per kg for germanium. Second, silicon readily forms an non-water-soluble oxide layer which, as an insulator, is essential to the fabrication of integrated circuits. The process is not nearly as straightforward with germanium. And finally, while generalising from a comparison...
with germanium to any possible alternatives, the semiconductor industry now has over half a century of experience in using silicon, but would be starting from scratch with many of the potential alternatives.

THE ALTERNATIVES

With silicon apparently holding all the aces, it’s worth considering why there might be a need for an alternative. Professor Thomas Vandervelde is the director of the Renewable Energy and Applied Photonics Laboratories and the Tufts Interdisciplinary Advanced Materials (TIAMAT) Center in Medford, Massachusetts. His primary area of research is in developing new materials and devices for energy conversion or optical components. His research directly involves several semiconductor materials systems, including those that are most commonly used in products today.

Vandervelde cites the low mobility in silicon compared to other materials as a key problem for its future development (see the box on page 118 for an explanation of mobility and band gap), adding that measures are already being taken to overcome this drawback by adding other elements.

“Some silicon devices presently use germanium channels to improve their switching speed by using germanium’s higher mobility. Some even use silicon–germanium–tin,” he says.

However, there are other problems ahead for silicon.

“Over the decades, the primary mechanism by which computer chips have been made faster is by shrinking the size of the transistors and the spacing between them,” Vandervelde adds.

“The problem is that we have got to the point where we can no longer continue this because of a number of factors, including thermal management, and the insulator...”

SILICON SUBSTITUTE: PROTECTIVE MATERIALS

Semiconductors is the area of materials science that looks most likely to affect the world of computers and electronic devices, but there’s more. Some of these new materials have electronic applications, even though they’re not semiconductors – and here we could mention advances in battery technology – but others have an entirely different use.

Portable and handheld devices such as smartphones and tablets allow us to lead an ever more mobile lifestyle while remaining in touch, but this level of convenience isn’t without its cost. Whenever you take a piece of electronic gear out of your home or office it becomes much more likely to suffer damage. Drenched tablets and cracked or scratched phone screens are testimony to this fact.

Yet it doesn’t have to be that way. Increasing use of advanced materials – some of them with a long heritage in specialised fields and others at the leading edge – offer the possibility of unprecedented levels of protection. Here we could mention composites containing aramid. Already you can buy protective phone cases made from this material. Manufactured by Hong Kong firm Pitaka, they are only 0.7mm thick yet, according to some reviewers, they can stop a bullet, quite literally.

And then there’s water. Sure, you can buy phones that are advertised as waterproof or water-resistant, but they don’t come cheap and not all manufacturers will honour the guarantee if there’s evidence of water damage. In the main, waterproofing is a result of the clever mechanical design of the case and its various joints and openings, but adding all those gaskets and seals is the main reason for the high prices.

An alternative and potentially less expensive solution is to make the circuit board waterproof, so any water entering the case doesn’t trash the electronics, and it’s here that materials science makes its appearance again.

Researchers at the National University of Australia in Canberra, for example, have developed a coating comprising a layer of nanoparticles, which water just slides off. But the necessary nanomaterials are very fragile, so the university’s coating is made of two materials, the other of which is able to provide protection to the nanoparticles.
thicknesses approaching one atomic layer thick. So if we can’t make the transistors smaller, we need to make them out of materials with higher mobilities.”

So if high mobility is the way to go, what are the contenders? Vandervelde told us of several possible new semiconductor materials, after dismissing other group-IV elements because of the difficulties of using germanium – the only viable alternative – despite its higher mobility.

Alloys are of considerable interest, and here Vandervelde started by describing III-V semiconductors; that is, mixtures of elements from group-III and group-V.

“These are referenced by their group-V element, N, P, As, Sb or Bi, listed in order of decreasing band gap and generally increasing mobility. P and As are well studied and are used for speciality high-speed transistors and many photonic applications such as telecommunications, lasers, LEDs and high efficiency solar panels,” he explains.

Despite these benefits, however, it’s not all plain sailing.

“It is hard to create extensive transistor devices with these, because they don’t tend to have a useful native oxide, which complicates device architectures,” Vandervelde adds.

All isn’t good with III-V materials, either, despite them, again, being used for niche applications.

ABOVE: Two-dimensional materials offer huge promise for the semiconductor industry as silicon starts to run out of steam.

“These materials – Mercury Cadmium Telluride (MCTs) – are very fragile, but have a huge possible band gap range with the same basic lattice constant. There are a number of other problems that limit the yield of any devices made from them, too. You mostly see these used for boutique photo-detectors such as astronomical detectors in telescopes,” he says.

2D materials, which have huge two-dimensional molecules but are just one atom thick, could also play a part in the future of electronics. Graphene, one of the newer allotropes of carbon is undoubtedly the best known, but there are lots of others.

Alternative single element 2D materials include silicene, garmanene, stanene (tin), phosphorene and borophene, and research is also being conducted into several 2D compounds that are promising as semiconductors, including zirconium selenide and hafnium disulphide.

“The big promise of the 2D materials is that for some of them you can have extremely high mobility,” Vandervelde says.

However, these aren’t without their problems either.
Talk about semiconductor materials invariably leads to mention of mobility and band gap. An explanation is appropriate.

Mobility – by which we are referring either to electron or hole mobility – is a measure of how quickly the charge carriers move through the material when subjected to an electric field. The higher the mobility, the faster the transistors are able to switch for a given voltage. Using a higher mobility material than silicon would, therefore, provide a means of increasing clock frequencies without the dire consequences for power consumption that cause the clock frequencies of silicon-based processors to stall at about 4GHz.

The band gap is the difference in energy between a material’s valance band and its conduction band. You can think of this as the energy required to free the bonding electrons (those in the valance band) from their atomic confines and allow them to wander around the material as required for electrical conductivity. Insulators have a large band gap that electrons can’t cross, while in metals the two bands overlap. Semiconductors have a small band gap, which can be bridged by applying a sufficiently high voltage.

This is what happens when a transistor is turned on. If the band gap is too small, however, electrons will migrate between the bands naturally, via a process called tunnelling, which means that a transistor can’t be turned fully on or fully off, resulting in electrical inefficiency. On the other hand, if it’s very high, the voltage required to switch a transistor is large. We want a band gap that is small enough to not consume too much power, but big enough to not have too much tunnelling current.

The semiconductors with the highest mobility tend to have the lowest band gap. If we forget about some of the recent initiatives in graphene transistors, for example, ordinary graphene has a mobility around 100 times that of silicon but, unusually for a semiconductor, it has a zero band gap. The upshot of this is that graphene transistors can switch at 1 terahertz (THz) but, while they could be used for analogue applications, they’re useless in digital circuits where transistors need to turn on and off completely. Finding materials with a high mobility and suitable band gap is one of the great challenges in developing new semiconductor materials.
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I regularly have to edit Word documents that have entries scattered through them that are all in capitals, and our company policy is that these documents should be formatted as small caps.

At the moment I just scroll endlessly through, making the change by the somewhat tortuous process of selecting the text in upper case, then selecting ‘capitalize each word’ from the options on the Change Case icon in the Font area of the Office Ribbon.

Once the text has been changed to lower case with leading capitals, I can then select Small Caps from the Effects option that is displayed when I click the arrow to display the Font Dialog Box.

This process takes up far too much time; is there a more automatic way to do it without using a macro, as our company doesn’t allow us to use macros?

Joe Cook

The answer is that it depends, and what it depends on is how the words were capitalised in the first place. Microsoft Word has two ways to enter and set the case of text: as upper case or using the Capitalized setting.

If the person who originally typed the document pressed the Shift button or the Caps Lock button and typed the words in upper-case letters, the text is stored in one way. If they entered the text without using the Shift key or the Caps Lock key but used Word’s Change Case tool (in the Font area of the Home tab of the Office Ribbon) and chose the Upper Case option, then that’s a different thing. We’ll describe the solution for that first.

For this, you can use a Find and Replace operation that uses wildcards. So your Find clause is:

\[{A-Z}\{3,\}\]

This tells Word to look for sets of upper-case letters where there are at least three upper-case letters in a row. The [A-Z] says look for any letter between A and Z, and the \{3\} tells Word to look for at least three of them in a row.

The Replace entry is:

\&

This tells Word to use what was found for the replace operation. You also need to make sure that you’ve ticked the option to Use Wildcards, and that the Replace font format has the Small Caps option checked. To find this, click on More, Format, Font.

Unfortunately, if the text was entered using the Shift key so is really in upper case rather than formatted as upper case, you can’t change it because Word doesn’t support the use of wildcards in the Replace portion of the find and replace. So if that’s the problem, you need another way of working.

In general, most Excel experts say the only way to do a replace operation where the text has been entered as hard upper case is to use a macro, but there is a workaround. It has some drawbacks, but you could try it on a copy of your original document and see if it achieves the results you want.

The process relies on carrying out a multiple stage replace operation. First, you do a find and replace looking for:

\[{A-Z}\{3,\}\]

and replace it with:

\$\$\$\$\$\$\$

This puts a marker round all the text that shows as upper case, because it was either entered or formatted as upper case.

Next, you use Word’s Change Case tool (in the Font section of the Home tab of the Office Ribbon). Select the entire document and set it to Sentence Case. This sets all the text to be formatted with a leading capital letter for each sentence. Then do a Find and Replace where the Find option is:

\$\$\$\$\$\$\$

and the Replace option is:

\&

Set the Font to be Small Caps. Finally, do two find and replace operations where the Find looks for:

\$\$\$\$\$

and replaces it with nothing (leave the Replace box empty). Do the same thing for $$\$$, and you should have all your upper-case letters appearing as small caps.

This has some drawbacks, mainly that you may change formatting that you shouldn’t have changed when you set the entire document to have its case changed to Sentence Case. However, without using a macro, it’s the best you can manage.
Aaxes to grind

I have an Excel chart where the automatic scaling on the axes doesn’t always work for my data. At the moment I set the axis scales manually, but this is a bit of a pain when the data changes, as I have to go into the chart setup to re-enter the manual scales if the values have changed too radically for my manual settings to work.

What I’d ideally like would be to have a way to enter the manual scales into some cells on the worksheet then have those values used for the manual scaling, and either have a way to press a button and have the chart updated, or to have the chart axes automatically change when the values in the ‘scaling’ cells are changed.

Mandy Edge

You can certainly achieve this, but it will need a macro. The macro on the right assumes that the chart is called Chart 1 (the default name for the first chart that is created in a worksheet), and that the cells K2:L4 are used to hold the parameters for the primary X and Y axis scales. If you want to store the parameters somewhere else, change the references to those cells in the macro.

The macro will work whether the cells hold static values that the user can change manually or, if they hold formulas, an axis-scaling algorithm.

It works by setting the .MinimumScale, .MaximumScale, and .MajorUnit properties of the Axis object, and it won’t work if you use a category-type X axis, if that’s the case, you’ll need to rework the macro to alter the TickLabelSpacing and TickMarkSpacing.

The macro is set up to be entered as the Worksheet_Change event, and to alter the axes when one of the values in K2:L4 is changed. Worksheet_Change is triggered whenever a value is changed on a worksheet.

The macro is fairly simple. Worksheet_Change has a parameter called Target that returns which cell was changed to trigger the macro being activated – the target cell.

The address of the target cell is used as the basis of a Case statement that checks whether the cell was any of K2, K3, L2 or L3.

If any of those cells was changed, the appropriate minimum or maximum value for the X or Y axis is set to the new value entered into the cell on the worksheet.

Unread alert

I’ve been trying to use the Filter option in Outlook 2010 to specify what emails I see. In particular, I’ve been using the Unread email filter so I see any emails that I’ve not answered rather than having to hunt through the hundreds that appear every day.

It works well, but when I mark an email as being read, it stays in the list rather than disappearing. How can I make emails disappear rather than hanging around when I’ve marked them as read?

Paul Dickinson

This is a useful option in Outlook that you apply by selecting the Filter Email drop-down in the Find group on the ribbon and selecting Unread. It takes a while to work through if you’ve a lot of emails in your inbox, but once you’ve applied it, it shows only those emails that haven’t been marked as Read.

Unfortunately, this option has the drawback that when you mark an email as Read while the filter is applied, that email stays visible. You can make the email disappear as it ought to do by moving to view another folder or by re-applying the filter, but that’s a rather frustrating workaround.

Fortunately, there is an alternative way to achieve the same thing. What you need to do is to create a new view.

Start by making sure you’re in a mail folder such as the Inbox. Go to the View menu, and choose Change View, Manage Views. In the dialog that appears, choose Copy to get a copy of the current view and give it a better name than ‘Copy of xxx’, where xxx is the name of the current view.

In the next dialog that appears, click on Filter. Click on the SQL tab, and put a tick into the box labelled ‘Edit these criteria directly’. All other tabs will be unavailable.

You now need to enter the following SQL into the text box:

```
(('urn:schemas:htpmail:read' = 0) OR ('http://schemas.microsoft.com/mapi/proptag/0x10900003' > 1))
```

Click OK, OK again and then Close. You should now have a new view that shows only those emails that are marked as unread, and it will work on any mail folder. What’s more, unlike Outlook’s own Filtered view, if you mark an email as read while the view is in use, the email will be removed from the view.
Wallpaper stripped

I’ve had a Chromebook for something like a year now, but after a recent Chrome OS update it replaced my long-term solid-colour background with the default wallpaper. Assuming it was a one-off I reset it, but after every reboot it’s gone again – always replaced with the default image of a feather.

Reading online, the advice seems to be that I need to Powerwash the Chromebook, but I’d rather not. Is there any other way to stop the computer forgetting my wallpaper choice?

Simon Carter

There was an update to the way users select wallpaper around the time that you contacted us, so it’s possible that you fell foul of a bug as this was introduced. If so, there’s a fair chance the issue will resolve itself with the next update, but if you can’t wait you could try forcing an update by switching to a different Chrome OS release channel. Note that if you want to switch to a more stable channel than the one you’re on, you’ll need to Powerwash the computer anyway.

Click the information panel at the right of the shelf, click the gear wheel icon, then in the Settings app click the menu icon at the top left. Click About Chrome OS, expand Detailed build information and check which channel you’re currently on; if you’ve never changed this, you’ll be on the stable channel. You can change from this to Beta, but we wouldn’t recommend Developer, which can be unstable. Once you’ve selected your channel, wait for Chrome to download and prepare the correct OS files, then reboot when it’s ready.

Switching to a more stable Chrome OS channel? You’ll need to Powerwash

If changing the channel doesn’t fix the issue, or if you subsequently want to switch back to a more stable channel, you will need to perform a Powerwash. The nature of a Chromebook means that this is less onerous than it sounds, and it only takes a few additional seconds. Your data and settings are stored in the cloud and will reappear once you’ve logged back in, but you will lose any files in Downloads, and any data downloaded by apps. We’d recommend copying any downloads you want to keep into your Google Drive, or failing that to an memory card.

With that done, return to the About Chrome OS page, click Powerwash for added security then click Restart. Alternatively, if you’re returning to a more stable channel after trying a different one, you’ll be prompted to Change channel and Powerwash; agree, and you’ll need to restart when Chrome has prepared the correct OS version.

Search me

I’ve got an Android phone running the Spotify app. For some reason, almost whenever I go to search for new music it tells me that it’s offline, regardless of whether the phone’s using mobile data or connected to my wireless network. Clearly it’s online: I can stream the tracks from my albums or playlists even if they’re not downloaded on to the device.

I can’t find anything in the settings to force Spotify to recognise it’s online. Its support pages seem to suggest I just reinstall the app, but I’ve downloaded loads of music: will I need to download it again and, if so, is there an alternative?

Malcolm Glover

This seems a reasonably common problem, but you may be able to cure it without having to re-install the app. Open Spotify, go to Your Library, tap the settings gearwheel, and first check that you haven’t inadvertently selected Offline mode; this is unlikely, given that streaming works. Assuming you haven’t, scroll down to Delete cache, tap it and agree to the warning, then try the search again.

If it still doesn’t work, and if you have a second storage location such as a microSD card, you might try resetting things by moving Spotify’s data store. Return to the settings page, scroll to the very bottom, tap Storage and switch to the SD card if available. Note that it will take some time to move all your downloaded songs.

Unfortunately, if the search still doesn’t work, you’ll need to remove and reinstall the app as suggested. Using a file manager such as Solid Explorer, it’s possible to copy Spotify’s downloaded music directory to a separate location and restore it after you’ve re-installed the app, but we found that Spotify ignored these files and that the content needed to be downloaded again. We can only suggest that you start your downloads overnight, or find a friend or a café with an unlimited and fast internet connection.
Unsupported update?

Perhaps you can shed some light on Microsoft’s support for various Windows 10 updates. My tablet is stuck on Windows 10 version 1709. If I don’t upgrade, will version 1709 become unsupported after a time, like Windows XP?  

Dave Sheppard

Unfortunately, the short answer is yes. Using Microsoft’s terminology, its policy is to service feature updates (Windows 10 versions) with monthly quality updates for 18 months after their release date. Windows 10 version 1709 was released on 17 October 2017, so by our reckoning, its update support will end in mid-April 2019. Despite the name, quality updates also include security fixes, so we would strongly recommend upgrading to a newer Windows 10 version before that time.

We remember from an earlier email that Windows 10 version updates have been failing on your Windows tablet. Although the error code was unspecific, we suspected insufficient drive space could be a factor, even though the update didn’t warn of it before starting. It’s counter-intuitive, but you may be able to solve the issue by temporarily filing up more space on the disk, thus forcing the installer to detect low disk space and offer additional options. You’ll need an empty USB drive of at least 16GB, or two drives of 8GB or more.

Use a different PC to visit www.microsoft.com/en-gb/software-download/windows10 and click Download tool now, then when it’s downloaded, run the Media Creation Tool, accept the licence and choose Create installation media. Select the language, edition and PC architecture you want, then choose to create a bootable USB drive.

While this is in progress, create a new folder on your tablet’s desktop called something like Padding, then open File Explorer and establish how much free space there is on your drive. Now right-click various folders on your hard disk, choosing Properties and making a note of their size. Find a combination of folders that, together, add up to all but a gigabyte of the remaining free space on the disk, then copy – don’t move – them to the Padding folder. You should now have only a gigabyte of free space on the drive.

When the USB drive is ready, insert it in one of the tablet’s ports and run setup.exe. Proceed with the install, being sure to select Not at the moment when asked if you want important updates. Windows 10 Setup should complain that there isn’t enough space. At the bottom of this screen, click I want to use external storage instead, then either point the installer to the large drive you’re installing Windows from, or insert and select your second USB disk. If you’re not sure which drive letter it is, check first in File Explorer.

Windows Setup will now need up to 4GB less free space to install Windows; it will tell you how much it still needs in Part A of the insufficient space page. Click the Free up space button, select the system drive if necessary, then click through the options in the Storage usage app to free up as much space as possible (without deleting your Padding folder). Once this is done, click the refresh button in Part A of the Windows Setup screen, view how much extra space is needed, then delete just enough files from the Padding folder for the Continue button to become available; you may need to click the refresh button a few times as you go. Once Continue is available, click it, but before you click Install on the following screen, use File Explorer to delete the Padding folder entirely: select it, hold down Shift and hit Delete, then agree to permanently delete it.

Windows will now begin the upgrade using the USB drive to store some of the necessary files. Unfortunately, we couldn’t replicate your exact issue so we can’t be sure if this will work, but it may do if your upgrade problem really is down to a lack of space.

Do you speak my language?

Ever since a recent Windows 10 update, my keyboard has defaulted to US settings, so every time I boot up I have to reset it manually to a UK layout. Also, all the distance measurements seem to be stuck in Imperial units.

Is there a way to keep UK as my preferred keyboard layout? I have tried looking within the Region & language page in Windows’ settings app, but it shows only English (United States). If I select this, the remove option is greyed out. How do I change my keyboard back to UK, and my measurements to metric? Is there a Registry hack, or will I need to reinstall?  

Michael Hession

We recently experienced something similar after a Windows update to one of our Labs PCs, although the issue resolved itself before we’d had a chance to look into it. If your PC didn’t cure itself, you should be able to fix things by going back to the Region & language page and manually adding English (United Kingdom). To do this, click Add a language, search for English and select it to reveal the options, then choose English (United Kingdom) from the list. Windows will take a moment to add the new language, which will appear beneath English (United States). Click to select UK English, then click Set as default. This should put it above English (United States) in the list, for which the Remove button should now be enabled.

With US English removed you should find that the keyboard issue is resolved, but if not, retrace your steps, select English (United Kingdom) and click Options, then check that the US keyboard doesn’t also appear in the list of associated keyboards. Again, if it does, click to select it and click Remove.

The above steps should also switch the computer to metric measurements, but if not, return to the Region & language page and click Related settings. Then, under Region click Change date, time or number formats, click the Additional settings… button, then for Measurement system select Metric and click OK.

Install the language you want, set it as the default, and then you can remove English (United States).
Advanced Projects

Clive Webster has been tinkering with computers ever since Windows 98 forced him to manually install his drivers

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Make a Wi-Fi detector

Locating the best place for a multiroom speaker or Wi-Fi relay could drive you mad. Luckily, Clive Webster has two solutions, one that’s fun and one that’s quick.

Wi-Fi is an unreliable connection at times, with the internal fabric of walls and floors interfering in unpredictable ways. To map the best location of an Internet device or Wi-Fi relay is therefore not obvious: will a relay in the spare back bedroom broadcast downward on to the patio, or are you better off putting the relay in the kitchen and hoping the broadcast sphere will push through to the upstairs? Is it OK to place that Sonos or Alexa device on the far wall of your study, or does it need to sit further out into the room? There’s a better way than trial and error, as we’ll show you.
YOU CAN’T BEAT Wi-Fi for neatness and convenience: no wires trailing around your house, no HomePlug devices flashing incessantly, you can place fancy network-enabled devices wherever you like, and you can wander around your home or sit in the garden watching YouTube or Skypeing. Wi-Fi is freedom.

Until it goes wrong, and then it’s an absolute nightmare. Why does this device work fine when placed at one end of a shelf, but not at all when nicely centred? Why must you sit at the awkward end of the sofa to get decent download speeds? What you need is a Wi-Fi detector to trace the ethereal blockages and map your coverage.

THE FUN WAY
The fun way to measure Wi-Fi reception in your home is to build some kind of Ghostbusters’ PKE Meter-type gadget to wave about the place (brown jumpsuits and repainted hearses are optional). For that, you need only three things: a microcontroller board with embedded Wi-Fi, a battery and some kind of readout. We’ve used an Adafruit Feather Huzzah ESP8266 as the core of our Wi-Fi gadget, and a 12-LED, RGBW NeoPixel ring; to power this combination we’ve used a 2,000mAh LiPo battery.

You might be able to use a USB battery – the kind that charges phones – but typically these have a shut-off when the current draw drops below a certain level, and the Feather Huzzah is such a low-power device that this is likely to happen after 20 seconds or so. The Feather, NeoPixel ring and LiPo battery cost £39 altogether, but you’ll also need to solder some wire to connect the NeoPixel ring to the Feather.

Feather boards are best thought of as an alternative to small Arduino boards. The processor of a Feather might be less powerful, but the boards themselves incorporate useful additions such as battery input and charging, and on-board Wi-Fi to make them really useful for building small and cheap gadgets.

You might not have come across NeoPixels, however, despite them being pretty ubiquitous in anything that needs something to flash, blink or pulse. In fact, they’re pretty ubiquitous in things that don’t need to flash or blink as well.

The reason for the proliferation of blinky NeoPixel lights on everything from door hangings to hats is how easy they are to use.

If you want to control a load of LEDs independently, you would previously have had to run wires to each LED. With a set of NeoPixels, you just run one wire from your microcontroller to the NeoPixel unit, and you can control which LEDs turn on and off, their brightness, their colour, which order they turn on and off – almost anything. The magic happens in the code, but for neatness of build, single-wire programmable LED units are unbeatable.

To build a Ghostbusters’ PKE Meter-type gadget to wave about, you need only three things: a microcontroller board with embedded Wi-Fi, a battery and some kind of readout
we found that our NeoPixels flickered when we did this, which isn’t an encouraging sign.

Connect GND to the GND pin of the Feather (or CND as it appears on our board) and the Data Input to pin 2 of the Feather (you can use other pins, but some don’t work for this project – pin 16, for example). We’ve soldered the headers to our Feather, but you can solder wires directly into the holes if you’d rather. If you’re not so keen on soldering, we’ve seen projects that use conductive thread to connect electronics: just tie one connector to the other, but beware of threads touching and shorting your device.

CODE TO JOY
Once everything’s attached, you can get coding. We’ve covered how to code a Feather before, but it’s not an obvious process. First, download the Arduino IDE software from www.arduino.cc/en/Main/Software. You might also need a driver so Windows can talk to the Feather properly: head to tinyurl.com/371projects1 to download the latest version for the Silicon Labs Serial chip.

Once the driver and the Arduino IDE are installed, launch the latter and open File, then Preferences. Add http://arduino.esp8266.com/stable/package_esp8266com_index.json to the Additional Boards Manager URLs: box and click OK, then head to Tools, Board: and select Boards Manager. Search for esp8266 and install the result (provided by ESP8266 Community). Finally, you’ll need to add the NeoPixels library. Head to Tool, Manage Libraries… and search for neopixel; install the Adafruit NeoPixel library, by Adafruit.

Once everything’s installed, open the Tools menu again. Hover over the Board: menu and select Adafruit Feather Huzzah ESP8266. Windows should have detected the correct COM port in the Tools menu, but you can check by opening Device Manager (search the Start menu to find it quickly) and expanding the Ports (COM & LPT) entry; the Silicon Labs CP210x USB to UART Bridge should have the same COM number.

LIGHTEN UP
The code to make a Wi-Fi scanner is fairly complex, so we’ve provided it for you in a Google Document, mostly adapted from Adafruit WiFiScan and Neopixel tutorials. To copy and paste the code from the document, visit tinyurl.com/371projects2, but we’ll talk you through the various sections so you know...
what to do if you want to change anything. For now, open a new file in the Arduino IDE (called a Sketch), delete the guide text and copy in the code from our download file.

The first section of the code has a lot of include and define commands, which tells the Arduino IDE to fetch other chunks of code, called libraries, to include in the final ‘compiled’ program that’s sent to the Feather. If your NeoPixel has more or fewer LEDs than ours, change the define NUMPIXELS value to match. The lines that should now be mostly in orange in the Arduino IDE are basic setup code; you’ll need to change the NEO_RGBW bit if you bought an RGB NeoPixel unit (that is, one that can’t turn its LEDs white).

While the WiFi.mode(WIFI_STA); line probably won’t mean much at first, you can probably guess what it does given that the next line asks you for your Wi-Fi SSID and password: this is where you tell the Feather to behave like a Wi-Fi device and how to connect to your network. The other section within the void setup() section sets up the NeoPixels so they’re ready to shine.

The main work of the code happens in the void loop() section. The first test is an ‘if’ command with a load of baffling terms as its logical test. The test is to tell whether the Feather is connected to your network yet or not; if it’s not, it will do a fancy pattern of circling lights until it is. At that point the Feather will move on to the even longer ‘else’ portion of the Sketch.

We’ve been a bit fancy with our coding here, as the first line takes a fair bit of unpacking to understand. The problem we solved with this int meter = map(WiFi.RSSI(), -127, -1, 0, NUMPIXELS); line is that the signal strength of Wi-Fi (the WiFi.RSSI(), or Received Signal Strength Indication) is on a scale of –127 to –1, where –1 is strongest,
but we have only 12 NeoPixels to display that information. We therefore mapped the -127 to -1 scale to the 0 to NUMPIXELS scale, where NUMPIXELS is the variable that sets how many pixels our NeoPixels unit has. So the whole line says to create an integer variable (i.e., a whole number) called meter, which takes the current Wi-Fi signal strength and maps that from its native scale on to the NeoPixel scale; a signal strength of -95 would therefore equate to 3 NeoPixels. Our thanks to Hackster’s Katelyn Rule for sharing those RSSI numbers.

COLOURCODE

That’s only half the battle, as while we might now know how many NeoPixels to light up at any given time to show the strength of the Wi-Fi signal, we’d quite like to colour them in line with signal strength too. So, while NeoPixel One might be dangerously red, NeoPixel Two might be optimistically orangey, and NeoPixel Nine might be encouragingly light blue.

Rather than work out and code each NeoPixel’s colour individually, we’ll make the Feather do the work:

```
for (int i=0; i<NUMPIXELS; i++) {
  float colour = (i*(255/NUMPIXELS));
  if (i <= meter) {
    pixels.setPixelColor(i, Wheel(colour));
  }
}
```

The `for` command is really handy for getting a computer to fill out the properties of a list, in this case a list of all NeoPixels. The weird string maths-like syntax within the `for` command’s brackets just means that for every NeoPixel, now referred to as i, do the following. Specifically, that is to assign each value of i (therefore each NeoPixel) a unique colour value derived from the NeoPixel’s range of possible colours (255, or 256-bit colour) divided by the number of NeoPixels, multiplied by the specific number of each NeoPixel. So, NeoPixel 6 has a colour value of 6 x (255/12) = 127.5, or turquoise.

The `if` statement that comes next says to assign that colour to a NeoPixel only if the NeoPixel’s number is equal to or less than the measured signal strength, and the next chunk of code (not listed above) tells the Feather to turn off a NeoPixel if its number is above the measured Wi-Fi strength.

There are two chunks of code at the end of the Sketch, both lifted directly from the NeoPixel tutorials that are installed as part of the library. They’re both pretty dense, so we won’t go into them much here. The rainbow code provides an easy way to invoke the fancy colour-spin effect, while Wheel makes it easy to use a single number
The quick way

As promised, there is an easier way to do this. Although nowhere near as much fun, you can download apps to measure and analyse your Wi-Fi reception. For example, Webprovider’s Wifi Analyzer (free, Android) will not only give you a live readout of your current connection, but can also map the signal strength on to a plan of your home and garden. We had no joy with this feature, but the app’s free so it’s worth a try. There are many more Wi-Fi analysing apps for Android, including many that could be easily confused with Webprovider’s app.

Things are not so rosy in Apple’s walled garden, however, as iOS locks developers out of the iPhone and iPad Wi-Fi hardware.

This means that only ‘external’ network information can be gleaned, and that means that every iOS Wi-Fi analysis app actually measures download speed from servers scattered around the world, rather than the actual connection between your device and your router.

There are handy apps out there, such as Techet’s Network Analyzer (free, iOS 11 onwards and Android) and Fing Limited’s Fing – Network Scanner (free, iOS and Android), but these only give you device lists, MAC addresses, available networks and so on. That is not nearly as useful as the actual quality of connection between your phone and your router.

or variable to create a colour rather than the standard three-value RGB code. It’s the Wheel code that allowed us to use our ix(255/NUMPIXELS) maths to create our per-NeoPixel colours.

To upload the code – once you’ve input your SSID and password – plug the Feather into your computer by its Micro USB connection and click the Upload button at the top left of the Arduino IDE. It looks like a rightward-facing arrow. If you want a more precise readout, try using large NeoPixel units with more LEDs (though this might push the Feather beyond its power delivery limits) or even use the Serial output and a small TFT screen to get the raw RSSI data.

There are many Android apps available to measure the quality of your Wi-Fi signal in real time. Apple doesn’t allow developers access to the Wi-Fi chip of iPhones and iPads, so Android is best for Wi-Fi detecting.

NEXT MONTH

SORT OUT YOUR BACKUPS

A perennial item on so many people’s technology to-do lists, we’ll show you how to give yourself complete peace of mind quickly and easily.
Photographer, musician, sound engineer, designer and video producer Ben Pitt guides you through a multimedia project.

ben@computershopper.co.uk

Interior photography

If you’re selling a home or advertising a business, high-quality interior photos make a huge difference. We show you how...
MOST PHOTOGRAPHERS HAVE one or two subjects that they prefer to shoot: perhaps portraits, wildlife or something more specialised such as macro or drone photography. We don’t know many people who specialise in interior photography – that is, photographing the insides of buildings. It’s an interesting discipline, though, and one that presents a number of transferable skills.

High-quality interior photography is crucial when it comes to selling a home. The estate agent industry is increasingly moving online, with low-cost agents doing little more than uploading details of homes to Rightmove. With no-one actively promoting sales, it’s down to the photos to grab people’s attention and convince them to arrange a viewing.

If you appoint a high-end estate agent that charges a big commission, they can justify hiring a professional photographer with all the specialist skills and experience. If, however, you’re just paying a low, flat fee, you can expect only some basic snaps.

Estate agents must comply with Consumer Protection from Unfair Trading Regulations, which state that photos can’t be misleading. As a result, most estate agents won’t just take it on trust that any photos you submit are true representations of the property you’re selling. However, they may be happy to use them once a member of staff has inspected the property. It’s worth discussing with the estate agent what their policy is before you appoint them. You should also take it upon yourself not to mislead potential buyers, as it could come back to bite you.

Interior photography also has its uses if you’re promoting a business. It might be something obvious like a hotel or restaurant, where attractive interior shots are essential for your marketing materials, but pretty much any type of business can benefit from attractive photos of the office, shop or factory floor. They can make your Facebook and Google Maps profiles look more inviting, giving existing and potential customers a more personal connection with your company.

If you’re short of reasons to take some interior photographs, why not practise on your own home? If nothing else, your cohabitees will appreciate how tidy everything is.

Maps profiles look more inviting, giving existing and potential customers a more personal connection with your company.

A room that’s completely devoid of household objects can look sterile, so it’s worth adding a few choice items back into the scene. When selling a home you don’t want to impose too much of your own personality and tastes; the objective is to encourage potential buyers to imagine themselves living there. Flowers, books and fruit bowls are common, but be sure to go for an attractive vase, interesting coffee table books and delicious-looking fruit rather than whatever you happen to have to hand.

Depersonalising is generally good, but then again, it may be worth adding a few items that could be described as aspirational. If you have a clear idea of who your potential buyer might be, consider dressing the room so it appeals to

Pretty much any type of business can benefit from attractive photos of the office, shop or factory floor.
that type of person. A city-centre flat for young professionals might be embellished with some Sonos speakers, an Amazon Echo and an orchid. Meanwhile, the kitchen of a large family home may be better off with a herb garden on the windowsill, a KitchenAid food mixer on the worktop and some wine storage. If there’s a spacious landing with a big window, you could draw attention to it with a carefully placed telescope.

Be careful only to include things you’ll be able to keep hold of when people come to view the property to avoid any sense of disappointment. The same goes for all the clutter you removed; try to find somewhere out of sight to keep it for a few months. A few hundred pounds in storage bills will be worth it if it adds a few thousand to your sale price.

BUSINESS HELP
The same principles apply if your photos are for promotional purposes rather than to sell a home. The building may or may not be an architectural masterpiece, but you can enrich or spoil its appearance with your choice of objects to include in the shot. Again, think about the intended audience and try to make the scene look inviting for that person.

That usually means representing what the business does, as well as what the space looks like. A restaurant’s dining area could be set up ready for service, for instance, which tends to look more attractive than a busy restaurant with half-eaten plates of food. You can always show plates of food separately. Food photography is a skill in itself, and something we will return to in a future issue.

The restaurant kitchen will look more engaging with a chef or two at work. Cooking ingredients could be placed carefully in the foreground, with the chef applying his or her trade further back in the frame.

Long exposures of around half to two seconds can work well to anonymise people with some motion blur. It will give a sense of people going about their business without putting too much focus on them. It’s just the thing for a warehouse or factory floor, where you might want to give a sense of industrious activity. One or two people are probably enough; don’t overdo it with dozens of blurry bodies moving around.

COMPOSITION
With the room looking shipshape, it’s time to set up the camera. It’s not easy capturing an entire room from a single vantage point, but estate agents often try with the help of a wide-angle lens. This can work, but it’s easy to overdo it. The stretched perspective can look pretty odd, and the vast stretch of floor in front of the camera is unlikely to fool anyone that the room is bigger than it really is.

The wide end of a typical kit lens will suffice in most instances. An 18-55mm lens on a cropped-sensor SLR gives a 27-83mm equivalent focal length. You may want to go to 24mm if you have a suitable lens, but anything lower than 20mm equivalent tends to look heavily distorted.

Its common for interior shots – and exterior architectural photos, for that matter – to have vertical and horizontal lines that run parallel with the edges of the frame. This squared-off appearance keeps everything neat and adds some impact. However, it’s not always easy to achieve.

The best way to do so is with a tilt-shift lens. These specialist lenses are available for SLRs only. The process involves pointing the camera dead level at the scene so the vertical lines appear straight, and then adjusting the tilt control on the lens so it captures more of

The estate agent didn’t spend much time on the image on the right. The photograph above was taken with a bit more TLC

⬆➡The estate agent didn’t spend much time on the image on the right. The photograph above was taken with a bit more TLC
Maciek Platek is a Cambridgeshire-based photographer who specialises in interior, architectural and food photography. You can see examples of his work in this article, with more at www.maciekplatek.com. We caught up with him to find out how he approaches interior photography.

How did you get into interior photography?
I used to be a chef, so when I got interested in photography I started off with food at first, as it was the closest thing to me at that time. After a while, I noticed great interiors that every restaurant had and because I really enjoyed interior design I wanted to capture that as well.

How long do you typically spend on a single shot?
It all depends who the client is, how well the space is staged (or not!), when I get there, and how many photos/rooms I'm scheduled to take. The photoshoots usually vary between three to eight hours of work and sometimes can take two days. Every session requires some sort of staging, be it adding books or plants to liven up the space or using a model to add a human element to sometimes cold interiors.

Always use props I can find in the house I'm shooting, unless it's a brand new build where nobody has moved in yet, then I will try to get some props to stage with. Sometimes we had to clean the whole space before the shoot because it was unacceptable.

Your pictures often have squared-off geometry of certain parts of the image. Do you do this in camera or in software?
I always try to shoot as level as possible in camera while on location. To achieve this, I use tilt-shift lenses that help keep everything square by shifting the perspective up and down or sideways without actually moving the camera. When I edit, I then double-check that everything is level and, if there is a slight tilt, I use Lightroom's Transform feature. However, it's best to get it right in camera first so you don't lose pixels or the quality of the photo by digitally stretching the image.

Do you take bracketed shots for HDR?
I bracket to get the range of exposures but never blend them for an HDR image. Instead, I use Photoshop to manually mask the bright and dark portions of the photo for more natural and pleasing compositions. HDRs tend to look muddy and dirty in my opinion, ruining what could have been a clean and crisp image.

Are there any other processes you use regularly when processing Raw files?
I want my images to be as natural as possible, so usually it's only a minor boost of shadows, highlights and sharpening.

What equipment and camera settings do you use?
I would be lost without the tilt-shift lenses, so for me that's a must for architectural and interior photography. My most commonly used focal length is 24mm on a full-frame camera. I think it perfectly portrays the rooms without enlarging the space and stretching objects within the frame. Flashguns/strobes are also important for difficult-to-light areas where ambient light can't reach. It also helps to avoid colour casts on walls and furniture.

What are the common mistakes that you see in other interior shots?
Definitely use of super wide-angle lenses that absolutely destroy the proportions of the space, turning an en-suite bathroom into a master bedroom, for example, with the sink the size of a bath. Also use of overprocessed HDR where there are no shadows or highlights - essentially losing all the depth and flattening the image. The last and probably most common mistake would be the verticals, where the camera is being pointed up or down, creating a feeling of falling.

Get rid of the usual kitchen clutter and drop in a few choice items – in this case, vases of flowers and some chopping boards.

This photo is a composite of multiple exposures to balance the exterior and interior light, combined using layer masks.

You don't always need to capture the whole room. A close-up of a particular detail might be more interesting.

Photos: Maciek Platek
the scene above or below the virtual horizon. The shift control works in the same way for horizontal adjustments. It’s akin to panning around a larger image.

This is the approach used by professional interior photographer Maciek Platek (see page 135). However, the Canon TS-E 24mm f3.5L II he uses costs around £1,800, and not everyone can justify spending that much.

Fortunately, there are cheaper routes to achieve the same effect. One method is simply to keep the camera level to ensure that vertical lines appear parallel in the shot, and then crop the image so you only show the part that you want to keep. You can’t add extra pixels, of course, but it might do the trick if your lens’s focal length is plenty wide enough to take in the whole scene.

If it isn’t, you could cheat with the help of panorama stitching software to combine two or more images. We use Microsoft Image Composite Editor (ICE), which is free and has lots of useful features, including various options for how the geometry is interpreted. For wide panoramas it will use some kind of fisheye geometry in order to flatten a panoramic view on to a flat image. However, for interior photography a rectilinear image – in other words, not fisheye – is the norm, in which case you should choose Perspective as the Projection type. You’ll then be able to adjust the vertical and horizontal axes, and rotate the image by dragging the preview at different points. Use these controls to get the vertical lines straight, and also to find the best horizontal position to avoid excessively stretched geometry in the corners. You can always crop the edges if the resulting image is too wide a view or includes lots of dead space.

A third option for achieving parallel vertical lines on the cheap is to use Lightroom’s Transform controls. Click the Vertical button and it will automatically distort the image to straighten up any near-vertical lines. The Level button does the same for horizontal lines, and Full does both. If Lightroom struggles to interpret the image, you can define which lines you want to align in Guided mode.
Don’t square off the geometry in all your photos, however. Perspective lines can add some interest and impact, drawing your eye into the image. Try to create strong, simple shapes with the contours of furniture in the scene, and place key objects such as books and vases at the intersections of these lines. Implying triangles in a composition is a classic technique for giving a satisfying structure to paintings, and it works equally well for photos. Also bear in mind the rule of thirds, whereby key elements and intersections are placed a third of the way from the corner of the frame rather than dead centre.

The great thing about photography compared to painting is that you can keep experimenting with composition right up until the final shutter release. When you’re shooting in controlled conditions such as this, give yourself time to capture a shot, critically evaluate it, and then move the camera and objects in the room as you edge towards the best version of the image.

LIGHTING AND SHOOTING

Most interior shots will benefit from natural light, unless the room has particularly striking lights of its own. However, it’s not easy getting an even distribution of light throughout the room, and even harder to avoid overexposing the windows.

There are various ways to manage this. One is to take multiple shots at different exposure levels – a process known as bracketing – and use HDR software to merge them into a single frame. This produces dramatic images but, as Macie platek notes, they tend to look pretty unrealistic. We much prefer Platek’s approach of combining the various exposures in Photoshop and using layer masks to reveal the areas you want for each exposure. You’ll need to take your time getting the mask shape just right so the borders look natural, perhaps creating a sharp-edged mask using the Polygon Lasso Tool for the window frame, and a soft-edged brush with the Eraser Tool to blend the layers in other parts of the image. The good thing about masks is that they hide rather than delete pixels in a layer, so it’s easy to restore them again by painting the mask white.

If you’re shooting on an overcast day, you might also use masked layers to replace the grey sky with a more flattering blue one. Use a shot taken with the same camera and don’t resize it; this will ensure colours, details and noise levels are broadly consistent.

It’s always best to get as close as possible to your desired image in camera. That will probably mean using a flashgun or two to illuminate the room. A flash that’s mounted directly above the lens creates a flat appearance and will illuminate nearer objects more than the ones that are further away. It’s a much better idea to use off-camera flash and fire it across the scene so there’s some light and shade on the contours of objects. There’s no need to splash out on expensive flashguns and trigger systems. We use generic flashguns costing around £40 and wireless triggers that cost £20 from Amazon, and they do the job perfectly well.

Harsh shadows can be distracting, but you can avoid this by bouncing the flash off a wall or the ceiling to create a large, diffused light source. Aim the flashgun so it reaches the parts of the room that receive less natural light.

Balancing natural and flash light in a single exposure isn’t easy, but you’ll have the advantage of trial and error on your side. Set up your shot, turn the flashgun up to maximum, adjust the aperture to around f/11, the ISO speed to its lowest setting and the shutter speed to the fastest flash sync speed – usually 1/250s or 1/100s. If the flash isn’t powerful enough you’ll need to select a wider aperture. The natural light should now be underexposed. To increase it, simply reduce the shutter speed. This will capture more natural light without affecting the flash light.

EDITING TIPS

As always, shooting Raw will provide plenty of scope to make further adjustments in editing software. Lightroom and its ilk provide tools to recover highlights, boost shadows and make colours pop without looking overprocessed. Use the Radial Filter to brighten up areas of the frame that are still looking a little gloomy, or a Graduated Filter if one side of the frame is brighter than the other. On the whole, a bright image with rich yet natural colours will show off a room at its best, unless you’re specifically aiming for a dark, moody appearance.

Lightroom’s Spot Removal Tool might be useful to remove the odd blemish, but be careful not to be misleading if you’re creating images to sell a home. It’s fine to remove a smudge on the sofa that you’ll be taking away with you when you move, but not for carpets that will be staying, and certainly not to hide any cracks in the walls.

A successful interior shot can take many hours to produce, but it’s a great exercise that gives you time to work on a variety of skills, such as composition, and balancing natural and flash light. The difference between a quick snap and a carefully crafted interior shot can be astounding.

MULTIPLECAMERAS

Setting up a second camera adds a lot of flexibility to your production. We explore the possibilities.
Zygote

Mobile phone companies are ripping us off to the tune of half a billion pounds a year. It's enough to make you want to turn the air blue, says Zygote

SIM CITY
The Citizens Advice charity is a highly respected organisation, so when it declares that British mobile phone users are being ripped off to the tune of half a billion pounds a year, we need to take the accusation seriously.

After a careful analysis of more than 700 pay-monthly phone tariffs, Citizens Advice concludes that customers are being overcharged an average of £22 a month and not being told they can get a far better deal when their contracts end. Instead, the providers simply let the expired contracts run on in the hope their victims are too lazy or too daft to notice.

When it comes to high-end devices such as the Samsung Galaxy or recent iPhones, the rip-offs are even worse.

One big shock is that in 73% of cases it would be far cheaper to buy the phone outright and take out a SIM-only deal, but this is never properly explained to the customer. And it comes as no surprise that it is the more vulnerable and elderly people who suffer the most. They are twice as likely to be charged for a phone they already own, paying an average of £263 more than necessary before they either wise up or get conned all over again. And the pay-monthly merchants have few scruples about flogging them unnecessary handsets in the first place, stuffed with gimmicks they don’t want and extras they will never use.

KEEP IT CLEAN
Proctor & Gamble is a leading producer of fine products designed to remove the filth from our lives. There is no doubt in Zygote’s mind that the world is a better place thanks to its mighty muscled Mr Clean, frothy liquid Fairy and atmospherically refreshing AirWick.

In which case, it’s a little bit weird that Proctor & Gamble has applied for several obscene trademarks based on extremely filthy text message abbreviations, including FML, GFY and WTF. Perhaps it has taken a lead from the US Department of Commerce, which has just ruled that .us domain names can now contain a whole host of ‘dirty words’, including sh*t, p*s*s, c*cks*cker and m*th*rfl*ck*r – all previously banned for use as internet domains.

Zygote is braced for a deluge of obscenity all brightly packaged for household use.

TRIVIAL PURSUIT
When the likes of Google developers offer to help users for free, there’s usually a hidden catch. This time round, it’s the fact that Google Chrome no longer displays any ‘unnecessary’ or ‘trivial’ characters for website addresses in its URL bar. The reason for this is given as a desire to spare us from silly old confusing character strings such as ‘www’.

But Zygote believes the real reason is not to save us from straining our brains and eyes, but to mask the fact that a specific web page may be under the spell of Google’s AMP system, which optimises addresses for mobile phones.

Contrary to what Google maintains, the www is not unnecessary or trivial at all, and in many domains its inclusion or omission can lead to completely different content being displayed, particularly where one page name does not redirect to the other.

However, a bigger problem lies in the fact that when a website uses Google’s optimised mobile tech, the consumer has no idea if they are looking at the AMP cache or the actual destination. Zygote suspects a Google plot to force-feed AMP domains to the world while hoping nobody will notice.

HP SAUCE
Australian owners of HP printers have been awarded compensation of about £28 each by the Oz national watchdog for unfair competition. This was after HP released a printer software update, which had been deliberately programmed to analyse and disable any print cartridge made by a third-party manufacturer. As soon as the brainwashed printer recognised an unauthorised cheap unit, it displayed a fake message saying that the cartridge was either missing or damaged, and simply refused to print anything.

Zygote has reason to believe that there may be up to three million users of HP printers living outside of Australia who are suffering from the same glitch, and now awaits the outcome of some very juicy class actions with great interest.

STONE ME
The oldest image created by a human being dates back 73,000 years to the Stone Age. This resets the evolutionary clock by 73,000 years to the Stone Age. This resets the evolutionary clock by two million years. The oldest image created by a human being dates back 73,000 years to the Stone Age. This resets the evolutionary clock by two million years. The oldest image created by a human being dates back 73,000 years to the Stone Age. This resets the evolutionary clock by two million years. The oldest image created by a human being dates back 73,000 years to the Stone Age. This resets the evolutionary clock by two million years. The oldest image created by a human being dates back 73,000 years to the Stone Age. This resets the evolutionary clock by two million years. The oldest image created by a human being dates back 73,000 years to the Stone Age. This resets the evolutionary clock by two million years. The oldest image created by a human being dates back 73,000 years to the Stone Age. This resets the evolutionary clock by two million years. The oldest image created by a human being dates back 73,000 years to the Stone Age. This resets the evolutionary clock by two million years. The oldest image created by a human being dates back 73,000 years to the Stone Age. This resets the evolutionary clock by two million years. The oldest image created by a human being dates back 73,000 years to the Stone Age. This resets the evolutionary clock by two million years. The oldest image created by a human being dates back 73,000 years to the Stone Age. This resets the evolutionary clock by two million years.

The image has been discovered in a deep cave on the Southern Cape coastline of South Africa, along with the mixed media kit and graphics tablet used to create it. The tablet is made of a neat slice of silica-rich flattened rock smeared with ochre and clay, and the rest of the kit consists of charcoal, pigmented shells and a heated seal bone scriber.

It’s all very impressive, but the real reason Zygote finds this discovery astounding is the subject matter of the image. It consists of two parallel diagonal lines followed by the letter W, and thus provides clear evidence that ancient humans were familiar with the URL protocol http://www but still had to resort to weighty user manuals to get a decent Wi-Fi signal.
PLAY. WORK. CREATE.

Configure your perfect system, for less:

www.cclcomputers.co.uk