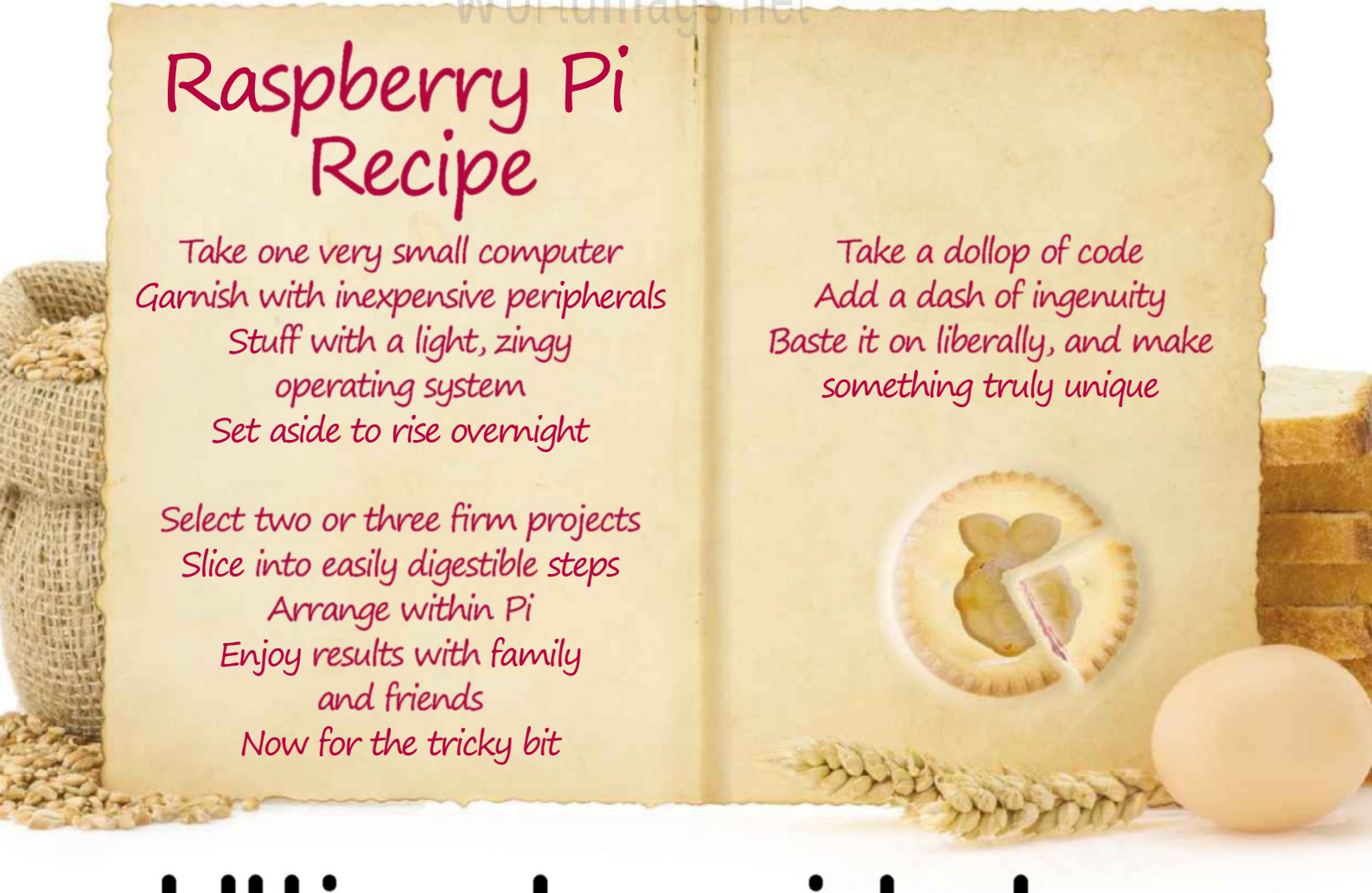


Ultimate guide to Raspberry Pi

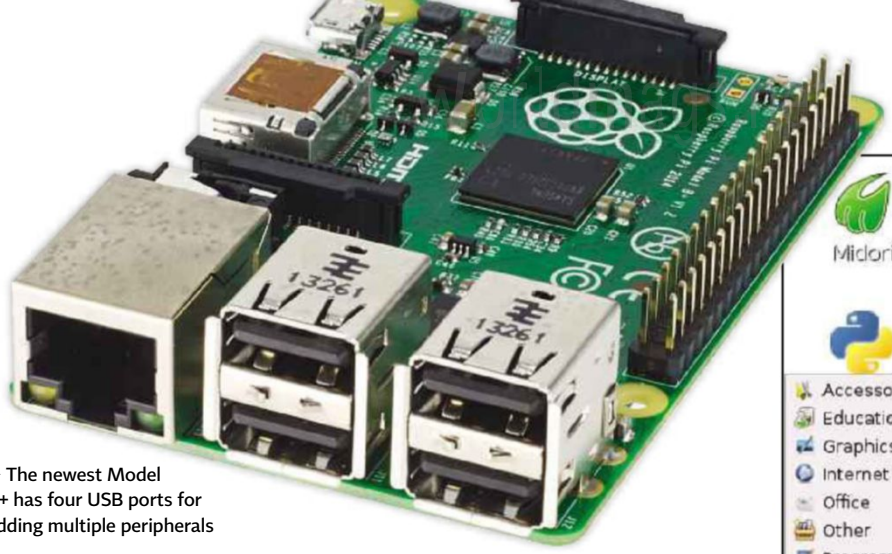
It can be used as a media centre, a NAS device and even for playing games – yet costs less than £30. ***Shopper*** presents its complete guide to a life of Pi

Raspberry Pi computers were originally conceived to inspire young programmers to hone their coding talents and earn themselves a place on the computing degree course at Cambridge University. But when word got out about a tiny sub-£30 computer anyone could buy and write programs for, suddenly everyone wanted to get their hands on a slice of Pi.

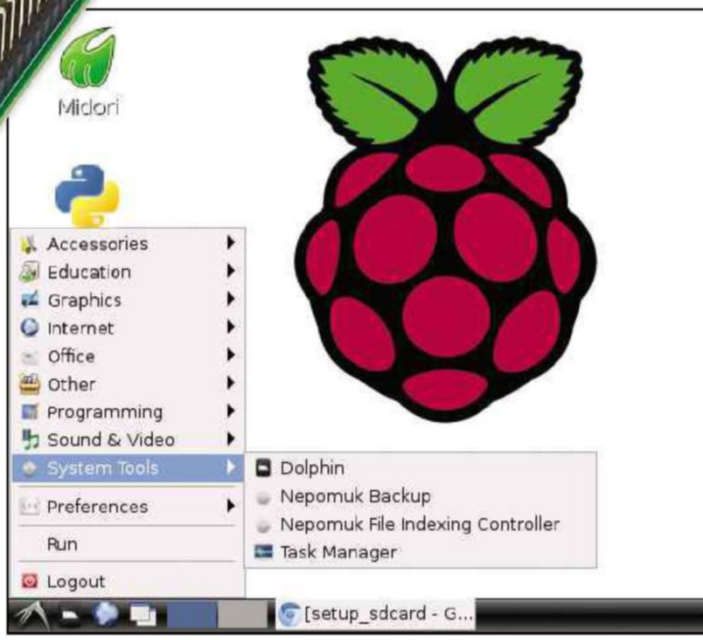
When your Raspberry Pi arrives, the first thing you'll notice is that it's very different to the type of computer you might be used to. For starters, it's tiny – the size of a pack of cards. It also has no case; it's simply a printed circuit board. Despite its diminutive size, low price and unglamorous appearance, however, the Pi is a fully functional computer. Let's take a closer look at the Pi's component parts and find out what kinds of task it's capable of.

The brains

A single chip contains the Pi's memory, central processing unit and graphics chip. The Raspberry Pi uses a chip designed by ARM, the same Cambridge-based company that designs processors used in many smartphones and tablets. The version used in the Pi is slower than you'll find in devices such as the iPad, but it's fast enough to do the job.



➡ The newest Model B+ has four USB ports for adding multiple peripherals



⬆ Just like a PC, the Pi's OS has a user-friendly, graphical interface

Unlike the relatively pedestrian CPU, the Graphics Processing Unit on the Pi is equivalent to that in a high-specification mobile device. It can run 3D games and play high-definition video (indeed, one of the most common uses for the Pi is as a very cheap media centre). With the right software, a TV and a broadband link you can have iPlayer, YouTube and other internet video services at your fingertips.

The Pi comes with 512MB of RAM, which is plenty for the projects in this guide. It also comes with an SD or microSD card slot – the same as that used by many digital cameras – which takes the place of the hard disk found in most laptops. Programs are stored on the SD card and, once the Pi is powered on, these are copied into the much faster RAM until the computer is turned off, at which point the RAM is cleared. One of the most convenient aspects of the Pi is that you can transform it from a media player to a desktop computer simply by swapping out the SD card, which is easier than removing a laptop's hard disk!

Sound and vision

One of the design requirements for the Raspberry Pi was that it should be easy to hook up to existing equipment, so the latest model includes an HDMI port for connecting to a TV or computer monitor. HDMI carries both pictures and sound, so if you use a monitor without built-in speakers, you may need to plug a set of speakers into the stereo audio jack. If your monitor doesn't have an HDMI socket, you can buy a cheap adaptor to convert HDMI to DVI. It's even possible to connect a VGA-only monitor with an adaptor and a bit of wrangling.

On the older Model B, you can use an RCA video jack to connect to the composite video input on an old-fashioned CRT TV. However, this was added mainly to allow the Pi to be used in the developing world, where TVs are more common than monitors, and the picture quality over composite is poor.

You can transform the Pi from a media player to a desktop computer simply by swapping out the SD card

Connections

The current Raspberry Pi Model B+ has four USB ports that you can use to connect a keyboard, mouse, Wi-Fi dongle or any compatible peripheral. The slightly older but still very common Model B has only two USB ports, so you may want to use a powered USB hub to attach more devices.

You can connect either the B or B+ directly to your router or a wired network via the standard Ethernet port – this gives the fastest and most reliable connection to the internet. Note that

Where can I get a Pi?

If you haven't yet got a Raspberry Pi computer, head to CPC (*http://cpc.farnell.com*) or RS (*http://uk.rs-online.com*) to buy one. You can also buy a Pi through Amazon. Prices fluctuate, but you should be able to pick up the latest Raspberry Pi Model B+ for around £25 including delivery.

You'll also notice that's there's a £17 Raspberry Pi Model A+ available. This cheaper model has just 256MB RAM, compared to 512MB on the Model B+. Both use the same 700MHz Broadcom SoC (system on a chip). However, the Model A+ has a single USB port and doesn't have an Ethernet port, so you'll need to plug in a USB Wi-Fi dongle to get online. If at all possible we highly recommend finding the extra cash to buy the Model B+ or shop around to pick up a second-hand Model B, which only has two USB ports but still has the network port.

In addition to the Pi itself, you'll need a few other accessories before you can get started. Head to page 107 to find out what you'll need, together with some important tips.

⬆ CPC is one of the official suppliers of the Raspberry Pi in the UK

the cheaper Model A and A+ variants lack the all-important network port. They're great for educational purposes, but we'd avoid these models for home projects.

Pins and needles

So far, everything we've described (apart from the SD card slot) is pretty standard to all computers. However, the Pi has some extra capabilities not found on your common or garden laptop. The most important of these are the General Purpose Input Output (GPIO) pins, which offer various ways to control devices and receive input from sensors and suchlike. However, misusing these pins can bake your Pi, so it's best to use one of the many add-on boards that allow you to experiment safely. We cover some of these options later on.

The Pi also includes a connector for a camera module and a DSI connector for connecting the Pi to certain specialist displays such as mobile phone screens.

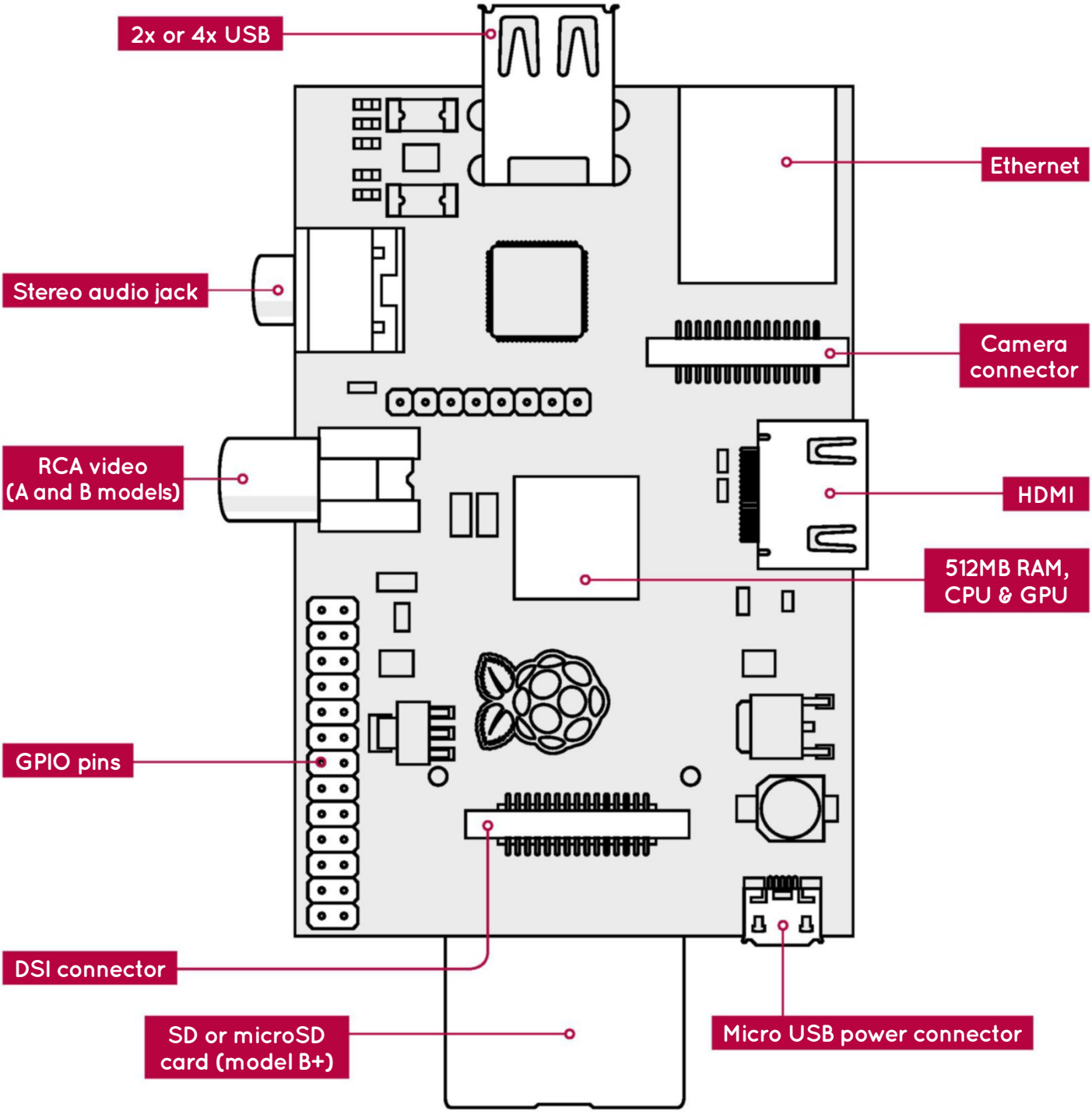
The software

There wouldn't be much point in a cheap computer if you had to install an expensive OS on it (such as Windows or Mac OS X) to get it to work. This, and the fact that no version of Windows or OS X will work on the ARM chip in the Pi, means that the various OSes created for it are all based on the free and open-source Linux OS.

The Raspberry Pi Foundation recommends Raspbian, a version of the popular Debian Linux distribution. If this sounds like gobbledygook, don't worry – if you've used Windows, you'll find Raspbian pretty familiar.

You can even install Linux versions of many of the programs you're familiar with, including LibreOffice for Microsoft-compatible word processing and spreadsheet work, and even the Chrome browser. We'll explain how to add software of all kinds from page 111. But before you do that you'll need to install Raspbian on your Pi first. Head to page 108 to find out how.

Pi ingredients



What do I need?

Although the Raspberry Pi is cheap, the barebones circuit board comes without many of the basic bits and pieces needed to turn it into a usable computer. While adding these can cost money, in many cases you can use spare kit that you have lying around, or pick things up second-hand.

Here we'll explain the must-have items, and some optional accessories that can make the Raspberry Pi experience even more fun. Most accessories mentioned here are widely available and *http://cpc.farnell.com*, one the official UK sellers, even sells kits with bundled peripherals under the U:Create brand.

Storage

As the Raspberry Pi has no built-in storage, the most important extra you will need is an SD card or, if you have a model B+, a microSD card. This stores the operating system along with your own files and projects. It must be at least 4GB in size and preferably a Class 4 speed grade or higher. The bigger the capacity, the more room you'll have for your own stuff. Cards up to 32GB are supported; anything larger than that needs some advanced tinkering to make it work. Cards are often bundled with the Pi itself for a couple of pounds extra, but a new 4GB SD or microSD card normally costs under £7. Always buy branded cards from a reputable store to avoid fakes.

As the operating system is entirely contained on the SD card, there's nothing to stop you putting it on several cards and swapping them as needed; for example, you could have one card for programming projects and another configured to use your Raspberry Pi as a media player (see page 114).

Experienced users can connect USB hard disks or USB flash drives to add more storage later if needed, but these storage devices can't easily be used for the OS, as the Pi can only start from an SD card. We'll be considering USB storage on page 113.

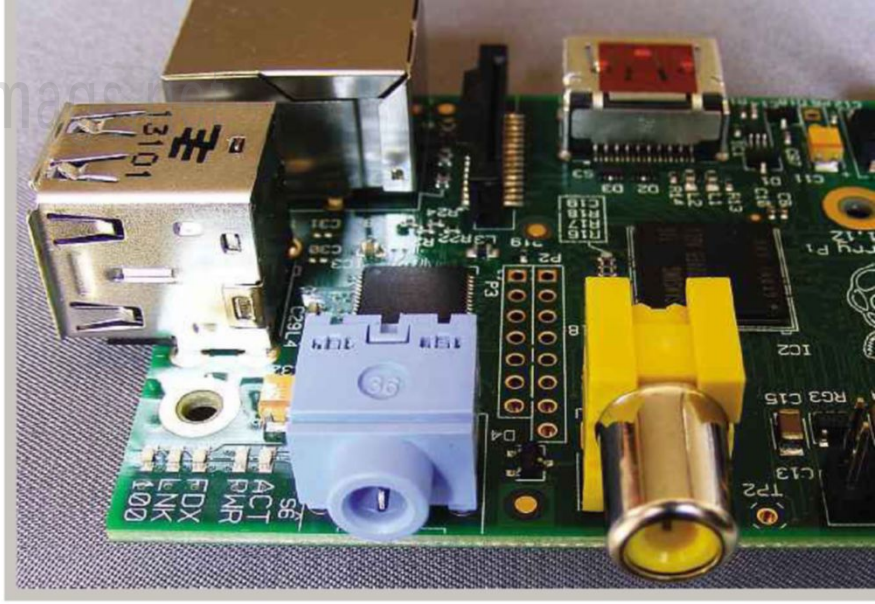
Power supply

The Pi gets its power from a separate Micro USB power adaptor, which can be bought very cheaply (CPC sells one for £3.54). However, if you have a mobile phone charger with a Micro USB connector you might be able to use that instead.

The only requirement is that the power supply can supply five volts and least 700 milliamps (mA) of current. Check the label on the power supply and look for the Output figures. It should say '5V' and the milliamp rating; it doesn't matter how large the milliamp number is, as long as it's over 700mA. The more power your supply has, the less likely you are to have problems with USB devices.

Keyboard and mouse

To get up and running, a USB keyboard and mouse are essential. Any model is suitable, and no software or drivers are needed. Wireless sets are a good choice, as they use only one USB port. However, if the wireless adaptor takes too much power, it can prevent the Pi from starting up. If this happens, it can be solved by using a powered USB hub instead (see below). CPC sells a basic wireless desktop set for £18 including VAT.



⬆ The older A and B models have composite video outputs for connecting to old CRT TVs

Display

The Pi has two display connectors: HDMI and, on the old Model A and B, composite video. For best results, use an HDMI cable (just over £1 on Amazon). Most HD TVs and some newer PC monitors have HDMI, but some older monitors have only DVI or VGA connectors. An HDMI-to-DVI cable costs around £5. If you already have an HDMI cable, a DVI adaptor is a little cheaper. HDMI-to-VGA converters are more expensive at around £18, but still cheaper than a new monitor. Composite video cables costing less than £1 can be used with older CRT TVs.

> You can put the operating system on several SD cards and swap them as needed

Audio

The stereo minijack audio output on the Pi can be connected to headphones, powered speakers or a standard hi-fi system. A 3.5mm minijack to dual-phono cable costing about £1 might be needed if the hi-fi has phono (also called RCA) connectors. If you use HDMI to connect to a TV (or a monitor with built-in speakers), a separate audio cable isn't needed.

Networking

To connect the Pi to the internet, a wired or Wi-Fi network connection to your home router is needed. The Model B/B+ Pi has a wired network port that takes a standard Ethernet network cable costing a couple of pounds. A USB Wi-Fi dongle can also be used, and CPC sells a compatible Dynamode 11n model for £7. If you already have a spare dongle it's worth trying, but not all work. No software is needed as the drivers are included in the operating system. For the Model A/A+, you'll need a USB hub to connect dongle, keyboard and mouse at the same time. Head to page 112 to read more about using Wi-Fi.

⬇ The Pi can be powered by Micro USB phone chargers

Optional extras

One of the most useful accessories for your Pi is a powered USB hub. This connects to one of the Pi's USB ports and allows several devices to be connected at once without draining power from the Pi. Hubs typically have four or seven ports, and a seven-port model from CPC costs just £10. Don't use unpowered hubs, as they could overload the Pi's power supply.

A great addition to any Pi is a case to protect the components. A basic plastic case costs £5.39 from CPC and is available in several colours. There are loads of other exciting new accessories appearing all the time, including a very cool Raspberry Pi camera board.

Install an operating system on your Pi

Once your tiny new computer arrives, you have a little work to do before you can connect it to a display and boot it up, including installing an operating system – the software that provides an interface for the Pi and allows you to run other programs.

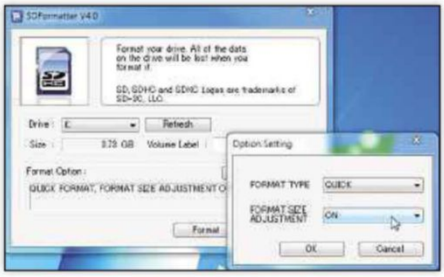
The Raspberry Pi uses a standard SD card instead of the hard disk you'll find in most laptops, and your first job is to prepare the SD card and transfer a suitable operating system to it. Until recently, you had to use a special Windows program to 'burn' an OS image to your SD card; that option is still available should you wish to use it (see Steps 5 and 6). However, the process of installing an operating system has been now been made a whole lot simpler thanks to something called NOOBS. It stands for New Out Of Box Software and makes setting up your Pi much simpler than before. Follow these steps to install the recommended operating system – Raspbian – on your Pi.

01 The Pi's Raspbian OS runs from an SD card. Programs you install will also be stored and run from this card. You can use SD cards of up to 32GB, but 4GB or 8GB is plenty.

You can buy an SD card with the Raspbian operating system installed on it, such as the one at *www.snipca.com/9314*. However, this Kingston-branded card is only a Class 4 SD card and won't work with a Pi B+, which needs microSD. We recommend buying a faster SD card (one with a higher class number), such as a Class 10 model, and installing the free Raspbian OS yourself. You'll need a Windows or Mac computer for this. If your computer doesn't have a built-in SD card slot, you may need to attach a USB SD card reader. Many photo printers have built-in SD card readers.

02 You'll need to format the SD card first. This will wipe the card's contents, so make sure nothing you need is stored on it. Windows has a built-in formatting tool, but the Raspberry Pi Foundation recommends using the official SD Card Association Formatting Tool, as this is capable of formatting the entire card. PC users can download this tool free of charge from *www.snipca.com/9721*. If you're on a Mac, an OS X version (also free) is at *www.snipca.com/9722*. We'll assume you're using Windows. Download the SDFormatter4 Zip file to your desktop, right-click it and select Extract All, then Extract. Double-click the Setup.exe file in the extracted folder and follow the onscreen instructions to install the SD Formatter tool.

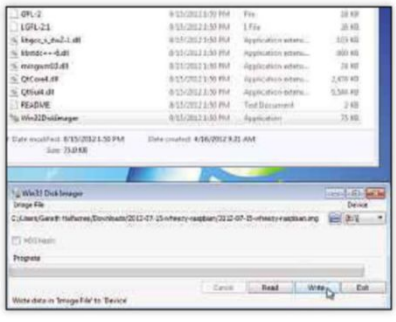
03 Insert your SD card into your PC, printer or card reader and launch SD Formatter. Under Drive, make sure the drive letter selected is the one for your SD card; pick the wrong one and you could end up wiping another drive. Unplug any other external drives to be safe and double-check you have the correct drive selected by clicking Start, Computer. In SD Formatter, click Option and set Format Size Adjustment to On. Click OK then click Format and OK again twice. A summary will be displayed. Click OK and close the formatting tool. Now go to *www.snipca.com/9319* and download the NOOBS Zip file, using the Direct Download option. It's quite big (about 1GB) so it might take a while to transfer to your PC.



04 Right-click the Zip file and select Extract All. In the dialog box, click Browse, navigate to the SD card and click OK, Extract. Use the Safely Remove Hardware tool (in the Windows Notification Area) to eject the SD card and insert it into the Raspberry Pi. Set up the Pi (see opposite) and switch it on. Your Pi will now boot into NOOBS and should automatically display a list of operating systems you can install. If your screen is blank, you can try manually selecting the correct display mode using the number keys on your keyboard. Tap 1 for HDMI mode, 2 for HDMI safe mode, 3 for Composite PAL (UK) mode and 4 for Composite NTSC (US) mode. Once you see the NOOBS dialog box, select Raspbian and click Install OS.

05 We recommend that new users employ the NOOBS method, as described above, but there is an alternative way of writing the Raspbian OS image to an SD card using a utility called Win32 Disk Imager. Format the SD card as described in steps 1 to 3. Then, on a Windows PC, go to *www.snipca.com/9723* and download the most recent version of Win32 Disk Imager. Make sure you get the Binary (win32diskimager-binary.zip), not the source version. Go to your Downloads folder, right-click on the Zip file and select Extract All. You'll then be asked to pick a folder into which to copy the files the Zip contains; do so, then click Extract.

06 Go to *www.raspberrypi.org/downloads* and, under Operating System Images, you'll see a link for Raspian (the Debian Wheezy version is recommended for newcomers). Click the Download Zip link. Go to your Downloads folder, right-click and extract the Zip. There will be one file, with the extension IMG. Double-click the Win32DiskImage.exe file you extracted in Step 5. Click the blue folder icon and use 'File open' to find the IMG file you extracted. Under Device, select your SD card from the list, being careful to choose the correct drive letter for the SD card. Once you've checked this, click Write to transfer the image to the card.



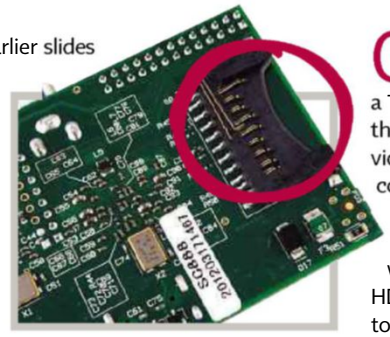
Set up your Raspberry Pi and switch it on

If you followed the workshop opposite, you should have an SD card ready with your Raspberry Pi's operating system installed. Now it's time to look at the hardware side. Thankfully, this is straightforward. In most cases, there is only a single place for each cable to go and little chance of confusion with regards to what goes where.

As the Pi is supplied as a bare circuit board, you should discharge static electricity before handling it, by touching an earthed metal object (such as a radiator) or wearing an anti-static wrist-strap.

We're using a Model B, but we'll explain any differences for Model A. For more information on the cables required, refer back to page 107.

01 The SD card you prepared earlier slides into a wide, black slot that lies flush with the underside of the Raspberry Pi. The card should be inserted with the label facing away from the circuit board. The easiest way to insert the SD card is to flip the Pi on to its front, revealing the SD card slot. Push the SD card into the Pi with firm finger pressure. When fully inserted, the top of the card will be flush with the back of the slot, and the card itself will protrude from the edge of the Pi – it may look a little odd but this is how it should be. On the Pi B+, the microSD card will spring into place against a spring.



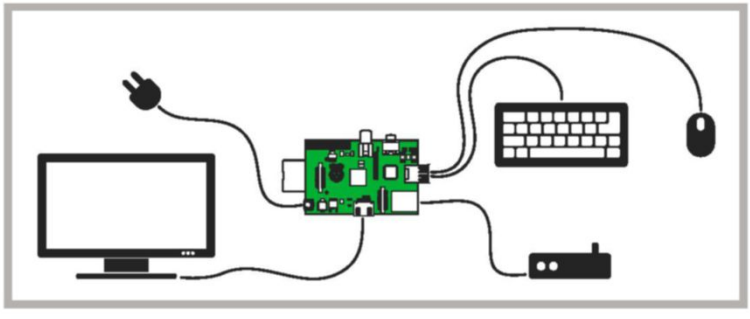
02 The Raspberry Pi is designed to be connected to a television or a computer monitor. There are two ways of connecting a Pi to a TV: a digital connection via an HDMI cable (the same type of cable that the latest games consoles use) or analogue through a composite video cable (see Step 3). For the best image quality, use the HDMI connection by connecting an HDMI lead from the port on the bottom of the Pi to your TV. You can connect to computer monitors that support HDMI in this way, too. In both cases, HDMI will also carry sound to the TV or monitor's built-in speakers. If your monitor has a DVI input, you'll need an HDMI-to-DVI cable. Plug the DVI end into the monitor, and the HDMI end into the port on the bottom of the Pi.

03 If you're using an older TV that lacks HDMI, connect a composite video cable from the yellow port on the top of the Pi to the TV's yellow composite socket. If the TV lacks a composite input but does have a Scart socket – the wide, flat connector type used by older video recorders – then composite-to-Scart adaptors can be purchased at most electrical shops. If you're not connecting from HDMI to HDMI directly and you want to hear sound through your TV speakers, you will also need an audio cable with a 3.5mm jack and a pair of phono plugs. This should be connected to the black or light blue audio port on the top of the Pi, with the two plugs on the other end going into the TV's audio inputs or the Scart adaptor.

04 The Pi requires a keyboard and mouse that use USB connections; most modern devices do. The Model B Pi has two USB ports on its right-hand side, and the B+ has four. Attach the keyboard and mouse, checking that the USB connectors are the right way up before pushing them in. Both the Pi's full-size USB ports will now be occupied. This doesn't matter in the short term, but connecting additional USB devices later will require the purchase of a powered USB hub. Owners of Model A Raspberry Pi units will definitely need a hub, as this edition of the device only has a single USB port. See page 107 for more advice on USB hubs.

05 The PC will need a network connection in order to provide access to the internet. The Pi doesn't have built-in Wi-Fi connectivity, so this needs to be done using a traditional Ethernet network cable strung between the Pi and a router or modem. Push one end of the cable into the network port on the right-hand side of the Pi, making sure the small plastic lug is facing downwards. Once inserted far enough, the plug should make an audible click and resist being pulled out again. The other end of the cable should be connected to a router, ADSL modem or cable modem. It's also possible to add wireless network facilities; this is particularly useful for owners of the Model A/A+ Raspberry Pi, which doesn't have an Ethernet socket. See page 112 for detailed instructions.

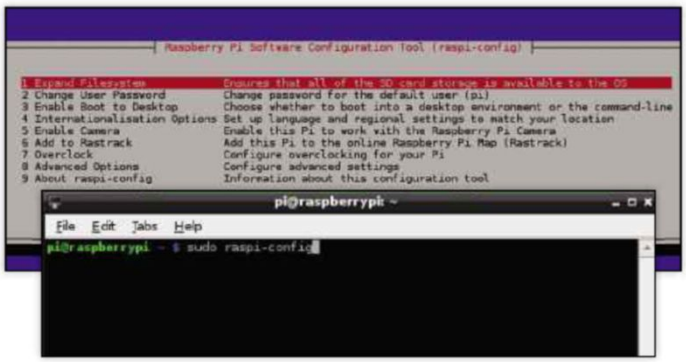
06 Finally, the Pi needs power from a mains adaptor using a Micro USB cable. With all the cables connected, your Pi should look as shown below. As soon as the Pi is connected to the power, it will switch on. Lots of text will scroll up the screen. The Raspi-config menu will appear; for now, these settings can be safely ignored, so just press the Tab key on the keyboard until the Finish option is selected, then press Enter to leave the menu. A text screen will appear asking for a username. For the Raspbian operating system we installed opposite, this is simply 'pi' – so type in pi, press the Enter key, then type raspberry as the password and press Enter again.



Configuring your Raspberry Pi

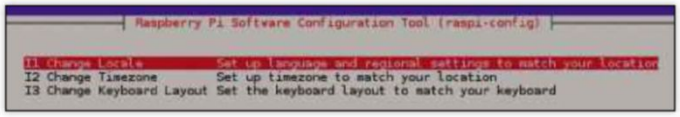
Once the Raspbian operating system is installed on the Pi (see page 108) and it boots up for the first time, the first thing it does is run a special program called raspi-config. This lets you configure many aspects of the Raspberry Pi's software and hardware. You can set the time zone, choose the correct keyboard and even make the Pi run faster. It's a very easy program to use, and is essential for getting the best out of the Pi. Raspi-config can also be run at any time from the desktop or the command line. In this workshop we'll not only explain how to do this, but we'll also walk you through each of the main settings, explaining what they do and how to make the right choices.

01 After installing the Raspbian operating system, the Pi will restart and after a few moments of text scrolling down the screen, the raspi-config program screen will appear. It only does this automatically the first time Raspbian starts, but raspi-config can be started at any time: from the command line, just type sudo raspi-config; from the desktop, open the LXTerminal program and type the same command. Raspi-config is a simple text menu with nine options. Use the up and down arrow keys and the Tab key to navigate around the screen (the mouse doesn't work in this program). The first option on the screen, Expand Filesystem, isn't needed if you used the official NOOBS package to install Raspbian.

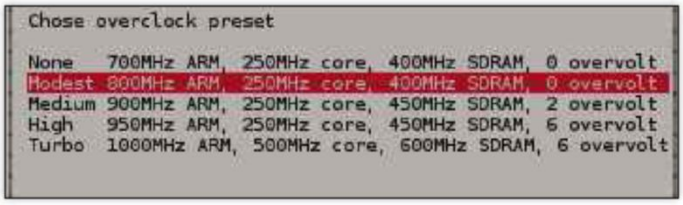


02 The second option allows you to change the default password ('raspberry'), which is a good idea to help keep the Pi secure. Select this option, press Enter, then press Enter again. A command line appears asking for the new password. Type it, press Enter, type it again and press Enter again. When successful you will be returned to the main menu. The third option down is Enable Boot to Desktop, which saves you having to start the graphical desktop manually every time. Select this, press Enter, then choose Yes to go straight to the Desktop, or No if you prefer to start from the command line. Starting the Desktop from the command line is simply a matter of typing startx and pressing Enter.

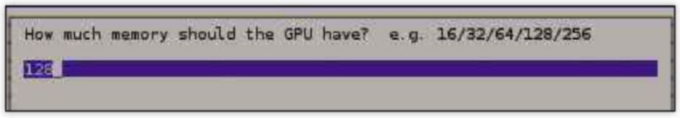
03 If a key on your keyboard produces the wrong letter, fix it with Internationalisation Options. Select the option, press Enter, select Change Locale and press Enter. Choose 'All locales' from the list, press OK, then Enter. Select OK on the next screen, press Enter and wait until the main menu returns, and choose Time Zone. Select Europe from the list, press Enter, select your nearest city and press Enter again. Finally, to set the keyboard layout, open Internationalisation Options again, choose Change Keyboard Layout then press Enter. Choose 'Generic 105-key (Intl) PC', press Enter, then 'English (UK)' and press Enter again. On the next three screens, we recommend keeping the default settings; press Enter until you return to the main menu.



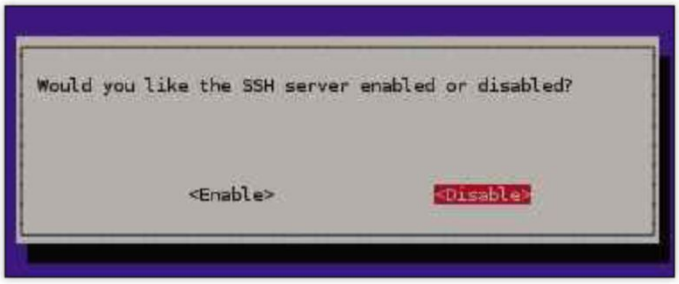
04 Option 5 on the main menu, Enable Camera, is only needed if you have the Raspberry Pi camera module. We don't recommend using Option 6, Add to Rastrack, as it just adds the Pi's location to an online database. The Overclock option is of interest to those wanting to improve the Pi's performance. Open this, press Enter then choose an overclocking option. We recommend trying 'Modest' first to see if it causes any problems. Trying the faster options will make the Pi become hotter and may reduce its lifespan and cause crashes, so don't use them if you leave the Pi turned on all the time. The fastest options will give you a noticeable boost in the Pi's speed, though. The Pi needs to be restarted before the changes take effect.



05 Advanced Options has several useful settings. Overscan is needed only if you are connecting to a TV via the composite video connector; it removes the black bars at the edges of the screen. Hostname lets you change the Pi's network name from the default of 'raspberrypi'. Open this, press Enter, then type the new name in the box. Only standard letters and numbers can be used. Memory Split lets you change the amount of memory used for graphics. In most cases you won't need to change this, but if you're using the Pi as a media player or for games you can boost performance by increasing this to 256MB. If you're using your Pi without a display, you could reduce the figure to 16MB.



06 The next option in the Advanced Options menu is SSH. This stands for 'secure shell' and is a way of accessing the Pi's command line remotely from another computer. It's enabled by default, but can be disabled if you don't want to use it. The final option is Update, which updates the raspi-config tool to the latest version. If your version is out of date, simply select Update and press Enter. The tool will automatically update itself and restart. An internet connection is needed for this. When you're happy with all the changes you've made, from the main raspi-config menu select Finish then press Enter. The Pi will reboot if any of the changes you've made require it.



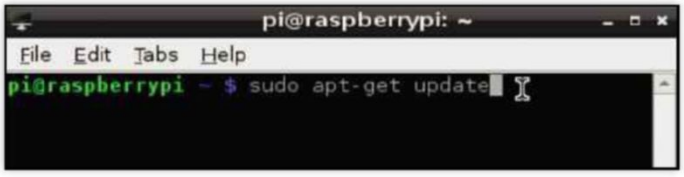
Find and install software

One of the benefits of any Linux-based system is the huge library of free programs that are available. The process for finding and installing software for the Raspberry Pi is different to its Windows equivalent, though. While the Raspberry Pi desktop looks superficially similar to Windows, underneath are many differences.

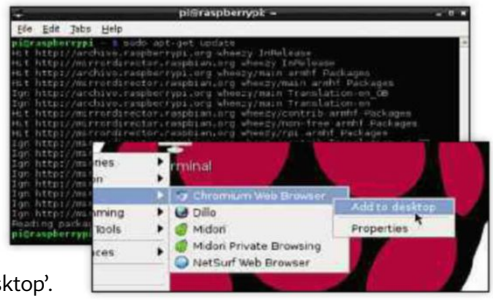
Rather than running a setup program, with Linux you use a 'package manager', and in many cases this is done by typing in commands. Don't panic, though – it's easier than it sounds. Here we'll show you how to use a package manager as well as how to install programs via the terminal, because most online examples use this approach.

01 The Raspberry Pi comes with a basic range of software built in. Similarly to Windows, there's a button in the bottom left-hand corner of the screen that you can click in order to see a launch menu of programs and tools that are installed. In addition, each distribution of Linux comes with a library of optional software, called Package Repositories. You can think of the initial setup as a starting point, to which you can then add software from the repositories to suit your purpose. For a general-purpose computer, you'd probably want to install an office suite such as LibreOffice (a version of OpenOffice), and the Chromium browser (the open-source version of Google Chrome). In this case, we're going to install Chromium and then focus mainly on installing a programming editor.

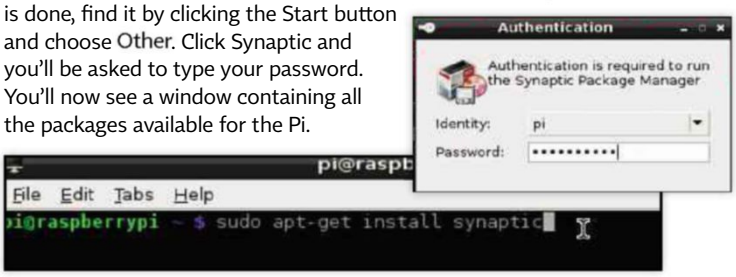
02 Let's begin by installing Chromium. Double-click LXTerminal and type 'sudo apt-get update' followed by the Enter key. This probably looks incomprehensible, so let's take it step by step. The first command, 'sudo', tells Linux you want to run the rest of the command as a super-user. This is similar to the Administrator user in Windows; it gives permission to change the system, which can be dangerous if not used properly. Next, 'apt' is short for 'Advanced Packaging Tool' and this is the program that installs our software. 'Get' is the utility within apt that does this – it gets packages. Finally, 'update' tells apt-get to download the latest list of packages: you should always update apt-get before trying to install software.



03 Wait for the update to complete; the 'pi@raspberrypi' prompt will appear once it's done. To install Chromium, type 'sudo apt-get install chromium' and press Enter. This time we've told apt-get to install a named package. Your terminal window will fill with lines of text explaining what's happening. You may be told how much disk space the program will use up and be asked to confirm the installation. Type Y and Enter to do so. When it's done, close the LXTerminal window. Chromium will be available in the Internet submenu of the Start button. To place an icon on the desktop, right-click on it in the submenu and select 'Add to desktop'.



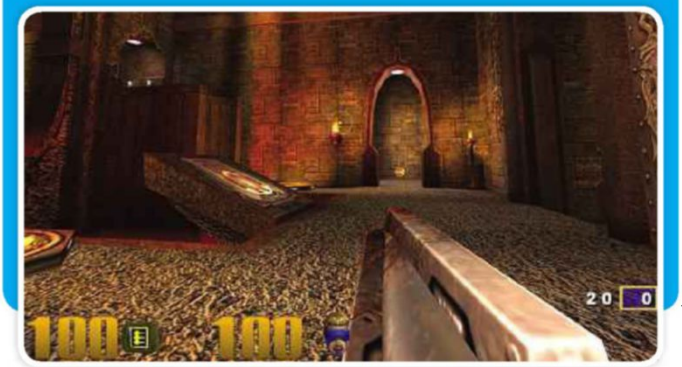
04 This is all very well, but how do you know what to install and what the package name is? One way is to Google 'office software for Raspberry Pi', but another is to install a graphical package manager. In an LXTerminal window, type 'sudo apt-get install synaptic'. This will download and install the Synaptic Package Manager. Once this is done, find it by clicking the Start button and choose Other. Click Synaptic and you'll be asked to type your password. You'll now see a window containing all the packages available for the Pi.



05 We're going to use Synaptic to install a code editor called Geany. On the left side of the Synaptic window, scroll down to the Development category. Now scroll through the right-hand window until you find Geany. In fact, you need to click the package geany-common first, then select Mark for Installation, before doing the same with the geany package. Once you've done this, click the Apply button to install it. This is straightforward, but remember the equivalent command in the terminal would be sudo apt-get install geany, which is clearly much quicker. So, if you know the package name, you should use the command line approach; if you want to browse, choose Synaptic. Why not give it a go and install LibreOffice?

The flip side

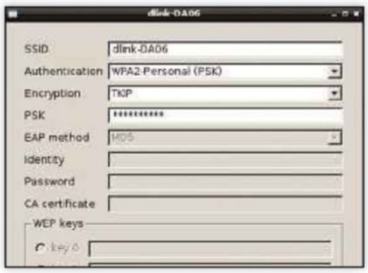
If you're used to a snappy modern computer, using software such as LibreOffice on your Pi will feel like wading through treacle. You'll notice a delay of a couple of seconds after you double-click an icon before the program launches, for example. This is partly because an SD card isn't as fast as a modern hard disk at reading files, and also reflects the speed of the processor. Once your word processor has fully loaded, you should find performance acceptable. Some games will work well on the Pi, too: 3D shoot-'em-up Quake 3 (below) was famously ported across very early on. But the Pi is not designed for playing the latest high-end games, so it won't replace your Xbox.



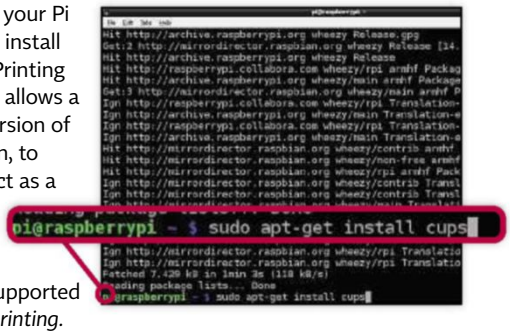
Set up Wi-Fi and print from your Pi

Although the Model B Pi can connect to a network using a standard Ethernet cable, upgrading to Wi-Fi makes it easier to position your Pi wherever you like. And if you own a Model A, Wi-Fi is your only choice, as there's no network socket. Fortunately, the Pi supports a good selection of USB Wi-Fi adaptors out of the box (the Edimax EW-7811UN is a good choice), and you can find a complete list at *www.snipca.com/9740*. In this guide we'll be explaining not only how to set up Wi-Fi, but also how to connect your Pi to a printer. We're connecting our printer via USB (you may need a USB hub for this) but these instructions will also work for printers on a home network.

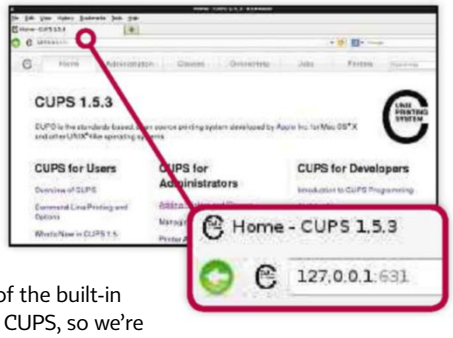
01 To get started, turn off your Raspberry Pi and plug your Wi-Fi dongle into a spare USB socket – for the Model B this can be either one of the two built-in ports. The Model A has only one USB socket, so you'll need to connect the dongle to a hub. Connect your HDMI cable, keyboard and mouse, insert your Raspbian SD card and boot up. Once the desktop has loaded, double-click the Wi-Fi Config icon and choose Manage Networks. Click Scan to see a list of wireless networks. Double-click your network name to select it, then add your Wi-Fi password in the field called PSK and click Add to complete the setup. Your Raspberry Pi will now automatically use that network each time you boot up.



02 To print from your Pi you'll need to install CUPS (Common Unix Printing System). This software allows a computer running a version of Linux, such as Raspbian, to support printers and act as a print server for other computers. Before you install CUPS, check your printer is supported by going to *www.openprinting.org/printers* and selecting your printer's make and model, then clicking the 'show this printer' button. If your model is on the list, this page will provide some information that might be useful later, so bookmark it. Connect your printer to your Pi and switch them both on. Double-click LXTerminal on the desktop; LXTerminal is similar to the command prompt in Windows. Type sudo apt-get update, press Enter, then type 'sudo apt-get install cups'. The installation may take up to 30 minutes.



03 Once CUPS is installed, add the user pi (that's you) to the group allowed to access the printer. To do this, type 'sudo usermod -a -G lpadmin pi' and press Enter. With CUPS all printer management is done via web pages, but none of the built-in browsers works well with CUPS, so we're going to install Iceweasel, the Raspbian version of Firefox. Do this by typing 'sudo apt-get install iceweasel' into LXTerminal and pressing Enter. After installation, start Iceweasel by clicking the start button at the bottom left and selecting Internet. Bring up the CUPS pages by typing 127.0.0.1:631 into the address bar – that address is pointing at your Raspberry Pi. Now, click the 'Adding Printers and Classes' link, type the username 'pi' and password 'raspberry' into the pop-up box and click the Login button. On the next screen, click Add Printer.



04 Assuming your printer is connected via USB, you should see your printer listed on the Add Printer page; you should also see any other printers CUPS has discovered on your home network. You might find that the name CUPS suggests for your printer isn't exactly the same as its model name; just check that it matches with the model name you came up with in step 2. Click the Continue button and, on the next page, you can add a location (for example 'spare bedroom'). If you want other people on your home network to be able to access the printer, click the Share This Printer tick box and click Continue.

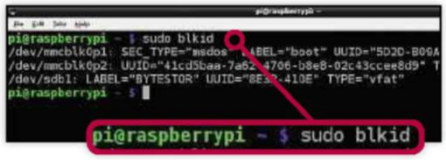
05 The correct model name should now show next to 'model' on the Add Printer page. If it doesn't, as in our case, then you may have to do a little searching on Google to find the nearest equivalent; the older your printer, the more likely it is to be on this list already. Click Add Printer and, on the next page, click Set Default Options and Continue. After a brief message confirming that the default options have been set, the printer summary screen will appear, confirming that the printer is ready.

06 To check your printer is fully working, select the Maintenance dropdown on the left and choose Print Test Page. A message will appear to confirm the page has been sent to the printer, and you'll then see the list of print jobs with the current status. All being well, you'll also hear your printer fire up – be patient, however, as it can take 30 seconds for the test page to start printing. Don't despair if you get an error message: sometimes this is an issue with the browser rather than the printer itself. Check this by selecting File/Print from another application such as LeafPad. If this doesn't work, your best bet is to try another printer driver. To do this, select the Administration menu and choose Modify Printer. You can then walk through the steps you took to set the printer up, looking for an alternative driver. If in doubt, pick one that mentions CUPS in its driver name.

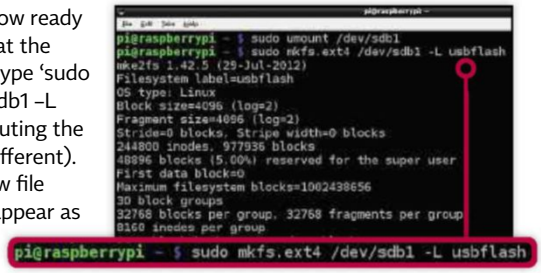
Add USB storage to your Pi

Although the Raspberry Pi boots from an SD memory card, it's not a good idea to store documents, photos, videos and music on such a card, as it's relatively slow and has only limited space. Fortunately, it's easy to add USB storage, whether by using a flash drive or an external USB hard disk. Either way, the process is exactly the same. However, although you can power flash drives from the Raspberry Pi, if you want to add an external hard disk, you'll need to use a powered hub, or a hard disk with a separate power supply. You can also attach USB DVD drives to your Pi, although this is a slightly different process.

01 We're using a USB flash drive like the one shown, but the principles are the same for adding an external USB hard disk too. Most USB flash drives come preformatted with the Windows FAT32 file system. This will work with the Raspberry Pi but it's inefficient and easily corrupted, so the first step is to reformat the drive using the Pi's native EXT4 system. Begin by turning on your Raspberry Pi, then wait for the Raspbian desktop to load and plug in the USB drive. On a PC, Windows assigns the drive a letter such as E: or F: but a Linux system, such as the Raspberry Pi, uses 'mount points'. These are full paths such as '/dev/sda1' rather than letters to indicate where a file is stored.

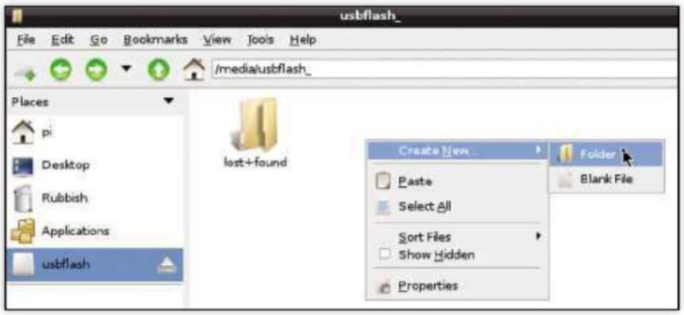


02 Double-click LXTerminal, type 'sudo blkid' and press Enter. You should now see a list of all attached drives. The path name for your drive will start with /dev/sd so look for a line that begins with those letters. You'll also get a clue from the label and the type; usually this will be 'vfat'. Note the path name for your drive – in the screenshot above, the path is /dev/sdb1. Before you can format the USB drive you need to unmount it so that the system can't access it during formatting. Type 'sudo umount' followed by the path you noted earlier. In our case, we'll use sudo umount /dev/sdb1.

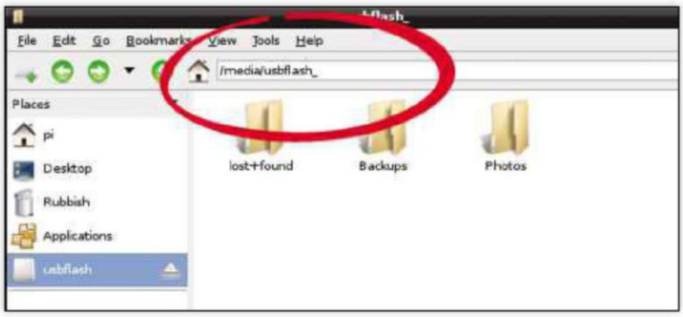


03 We're now ready to format the card. To do this, type 'sudo mkfs.ext4 /dev/sdb1 –L usbflash' (substituting the path if yours is different). This creates a new file system that will appear as 'usbflash' in the file explorer. We now need to create a folder to link with the flash drive; it's a good idea to use the same name as the label you've given the drive. Create a location for it by typing 'sudo mkdir /media/usbflash'. Press Enter and then type 'sudo mount /dev/sdb1 /media/usbflash' to mount the drive, again substituting the path to your flash drive.

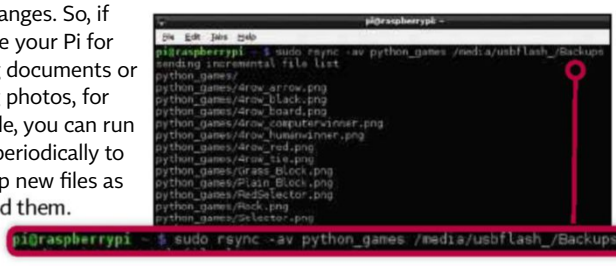
04 To give permission to all users to save to the disk, type sudo chmod 777 /media/usbflash followed by Enter. Open File Manager and select Places from the dropdown box in the left-hand pane of File Manager. You should see your flash drive appear beneath Applications. From now on, it will always be visible whenever it's plugged into your Pi. You can now create new folders on the USB drive, which you do in File Manager by selecting it from the list of places. You'll probably see a 'lost+found' folder there; this is a system folder, so don't interfere with it. Move your mouse over the white area and right-click to launch the contextual menu. Hover over Create New item, select Folder and give it a name before clicking OK.



05 Now we have a working external disk, we can use it to back up files from the Pi's SD card. This may be something you want to do so that you can restore the files on your Pi in case something goes wrong, or you might only back up when you're about to change files or install new software. Either way, we're going to use the simple command-line program called rsync that's built into Raspbian, so you don't need to install any new software. For a simple directory backup, use the form at sudo rsync –av [source folder] [destination folder]. Begin by checking the exact name of the USB disk to which you're backing up by looking again in the file manager under Places. Click your flash drive and you'll see the path appear at the top; this is the path you must use. Note that in the screenshot, the Raspberry Pi has added an underscore to the end of the path, which must be included.



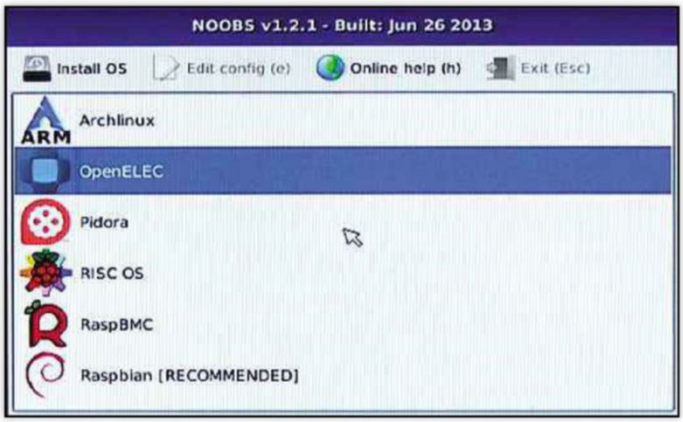
06 In our example, we're copying a folder called 'python_games' to a directory called 'Backups' on the flash drive. To do this, we type 'sudo rsync –av python_games /media/usbflash_/Backups'. The 'a' (archive) parameter tells rsync to preserve all file information (such as which user it belongs to), and the 'v' (verbose) parameter causes rsync to tell us exactly what's going on (you can leave this one out once you've got used to the process). Once you've pressed Enter, rsync will copy over the files. What's really clever is that rsync supports 'differential' copying, so it only copies files that have changed. If you ran the exact same command again, it would check to see if any new files have been added to the source folder and only proceed if it detects any changes. So, if you use your Pi for writing documents or editing photos, for example, you can run rsync periodically to back up new files as you add them.

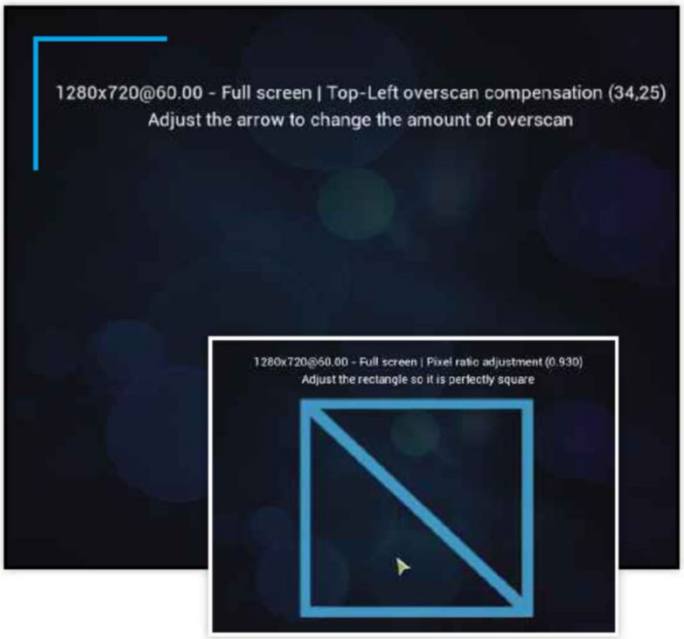


Turn your Pi into a media centre and watch BBC iPlayer

One of the Raspberry Pi's best features is the fact that the hardware is capable of playing high-quality music and videos. However, Raspbian doesn't have all the necessary software, so a media centre application like XBMC is needed. You can install this manually, but NOOBS makes it much easier, as it comes with a great pre-configured version of XBMC called OpenELEC. This lets you play media files in a TV-friendly interface, and you can even add the BBC iPlayer app to stream your favourite shows. Here we explain the basics of getting up and running with XBMC, how to connect to a network, install iPlayer and play files from a USB drive or via a Windows network.

01 To install XBMC, you need an SD card containing the latest NOOBS installation package (see page 108). If Raspbian is already installed on a card, you can either reinstall over the top of this (all your files on the SD card will be deleted), or use a different card with a fresh copy of NOOBS. In the latter case, just insert the card and power on the Pi. To use an existing installation, power on the Pi while pressing the Shift key. This launches the same menu you see when first installing, where you can choose which operating system to install. Select OpenELEC, press Enter and wait for the install to complete. Once it's finished, press Enter to restart the Pi.





02 The OpenELEC interface works well with keyboard and mouse, but sometimes the edges of the screen may be cut off. To fix this, use the right and left arrow keys (or push the mouse pointer to the right or left edge of the screen) until the System category is highlighted, then press Enter. Click System, click Video Output, then click Video Calibration. Move the mouse into the top left corner of the screen, and click and drag the corner inwards until the two blue lines fit perfectly in the corner. Repeat for the bottom right corner. Put the mouse in the centre of the screen, and if the blue square looks rectangular, click and drag it until it is square (use a ruler to check). Press Esc three times to return to the main desktop.

If you have problems when using a Wi-Fi connection, switching to a wired connection should fix them

03 To use the internet, the Pi needs to be connected to a router. If using a wired (Ethernet) connection no configuration is normally needed, and OpenELEC should connect automatically. Wireless dongles need setting up, though. Hover the mouse over the System category on the menu bar (see Step 2), then click OpenElec. Click Network, then in the section 'Network Technology', click the small up or down arrows to choose WLAN. In the Network Interface section, choose wlan0. Next click WLAN SSID, then type in the wireless network name. Click Done. In WLAN Security, choose the correct security type for your router (usually WPA/WPA2), then click WLAN Passphrase to enter the wireless password. Click Done, then click OK. After a few moments the connection should be made and a small Wi-Fi icon will appear at the right end of the taskbar.

04 Now OpenELEC looks good and is connected to a network, it's time to install the BBC's iPlayer. Download the Zip file from *http://tinyurl.com/openeleciplayer* and copy it to a USB flash drive (but don't unzip it). Plug the USB key into the Pi. Click Programs on the OpenELEC menu bar. Click Get More, then click the two dots (..) at the top of the left panel, then click them again when the second list appears on your screen. Click 'Install from zip file', then look for the USB drive in the folder list in the right panel (ours is called USB_KEY). Click this, then navigate to the Zip file and click it to automatically install the plug-in; it should take only a few seconds.

05 To use iPlayer, click Videos on the main desktop menu, then click Video Add-Ons. Click iPlayer then choose the content to watch from the list. Watching live TV is supported, via the Watch Live link, but remember that you need a valid TV licence to do this. A good reliable internet connection is needed for an enjoyable experience, and if you have problems when using a Wi-Fi connection, switching to a wired connection should fix them. Moving the mouse while a video is playing will bring up a menu at the bottom of the screen with programme information and all the standard playback controls. To listen to live or catchup radio programmes, from the desktop click Music, then Music Add-Ons, then iPlayer. Not all radio channels support the live streaming feature.

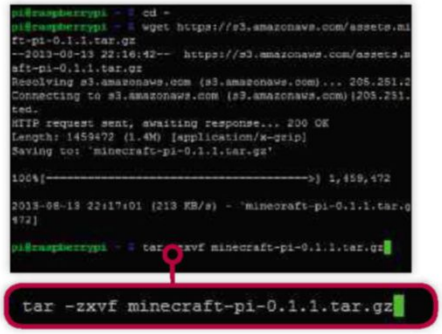
06 Media files can be stored on the Pi's SD card, on a USB drive, or on shared network folders. Head to page 113 for more about adding USB storage to your Raspberry Pi. Most popular audio and video formats are supported, apart from WMV and MPEG2 videos. When playing music, the current track is shown as a thumbnail above the menu bar with play controls at the right of the screen. To play files from a USB drive or network location, click the relevant category and choose Files. USB drives should automatically appear in this list. For networks, click Add Source. Click Browse then choose Windows Network (SMB) to browse PCs on the network. To connect to a PC via UPnP streaming, choose UPnP Devices in the Browse window, select the PC, then click OK.

Play Minecraft on the Raspberry Pi

Minecraft is more than just another game: it has become a worldwide phenomenon, thanks to its winning combination of attractive graphics and open-ended, creative-led gameplay. At the beginning of 2014 the company behind Minecraft, Mojang, announced that it was making Minecraft available for the Raspberry Pi.

The Pi version is free and doesn't include all the gameplay of the online and desktop versions, but it does have something unique: you can control what happens in the game using the Python programming language. If you want a great way to get youngsters interested in programming, Minecraft will be the key.

01 Start LXTerminal by clicking the bottom left button, Accessories, then LXTerminal. Type 'cd ~', press Enter, then type 'wget https://s3.amazonaws.com/assets.minecraft.net/pi/minecraft-pi-0.1.1.tar.gz', press Enter, then type 'tar -zxvf minecraft-pi-0.1.1.tar.gz' and Enter. This creates a folder called mcpi containing Minecraft. To start it, type 'cd mcpi', press Enter, then minecraft-pi and Enter. Now select 'Create new'. You'll find yourself in a new Minecraft world. Press E to see a full list of items in your inventory; click one to select it. Press the right mouse button to place an item and left-click to destroy a block. Press Space once to jump or twice quickly to enter the flying mode.



02 You can do more than simply build structures in Minecraft by interacting with it using the Python programming language and what's called the Minecraft API. An API is a set of programming tools; in this case these tools let you find out what's happening in Minecraft and change it while the game is running. Press Esc in Minecraft so that the normal mouse cursor appears and move the Minecraft window off to the right. Now rearrange the LXTerminal window so that it fills the left-hand space left by Minecraft. It will be a narrow window, but everything we're going to do can either wrap text or scroll backwards and forwards.

03 Create a folder to store your Minecraft programs and copy the special API files from Minecraft. Return to the LXTerminal window, type 'mkdir ~/minecraft-api' and press Enter. Type 'cp –r ~/mcpi/api/python/mcpi ~/minecraft-api/minecraft', press Enter, then 'cd ~/minecraft-api' and press Enter. Type 'nano minecraft-api-demo.py' and press Enter to start the nano text editor and create a new file. The first part of the program is used to import the Minecraft commands and the ones used by Python to understand time, so we can use delays in between commands. Type 'import minecraft.minecraft as minecraft', press Enter, type 'import minecraft.block as block', press Enter, type 'import time' and press Enter twice more.

```
pi@raspberrypi ~ $ mkdir ~/minecraft-api
pi@raspberrypi ~ $ cp -r ~/mcpi/api/python/mcpi ~/minecraft-api/minecraft
pi@raspberrypi ~ $ cd ~/minecraft-api
pi@raspberrypi ~/minecraft-api $ nano minecraft-api-demo.py
```

04 The next section of the program is where it actually starts. Type if __name__ == "__main__": and press Enter twice. Note that there are two underscores in each part of the command. Python uses tabs to understand how a program is divided, so every line following this must be preceded by at least one tab. The next command connects our program to Minecraft. Press Tab once, then type 'mc = minecraft.Minecraft.create()' and Enter. Save your program by pressing Ctrl-O and Enter. Create a message that will appear in Minecraft by typing a tab then 'mc.postToChat("Hello World")'. Press Ctrl-O, Enter, then Ctrl-X to quit the text editor. Type 'python minecraft-api-demo.py' and press Enter. The message will appear in the Minecraft window above the inventory list and then disappear after ten seconds.

05 Return to the LXTerminal window and type 'nano minecraft-api-demo.py' to load the program in nano. Use the cursor keys to move down to the bottom of the file. In order to build a tower of blocks near the player, we need to find out where they are. Enter the command 'playerPos = mc.player.getPos()' below and in line with the messages and press Enter. Press Tab again and then enter 'playerPos = minecraft.Vec3(int(playerPos.x), int(playerPos.y), int(playerPos.z))' and press Enter. The second command converts the player's position into the correct type of data that Python can use.

```
 GNU nano 2.2.6          File: minecraft-api-demo.py          Modified

import minecraft.minecraft as minecraft
import minecraft.block as block
import time


if __name__ == "__main__":


        mc = minecraft.Minecraft.create()
        mc.postToChat("Hello World")

        playerPos = mc.player.getPos()
        playerPos = minecraft.Vec3(int(playerPos.x), int(playerPos.y), int(play$
```

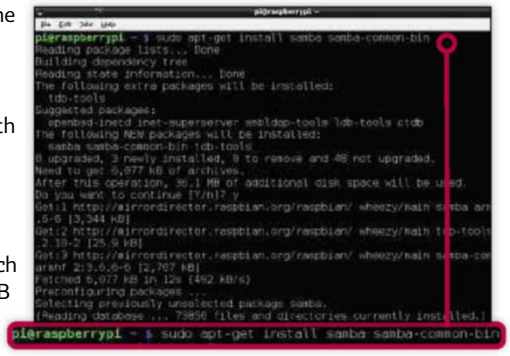
06 To create the tower as simply as possible, create a loop so you will only need to enter the setBlock command once. All the commands inside the loop must be preceded with two tabs for Python to interpret it correctly. Press Tab once, then type 'for towerBlocks in [1, 2, 3, 4, 5]:' and press Enter. Press Tab twice and then type 'mc.setBlock(playerPos.x, playerPos.y + towerBlocks, playerPos.z +5, block.DIAMOND_BLOCK)'. Press Ctrl-O and then Enter to save the program. Press Ctrl-X to quit. Type 'python minecraft-api-demo.py' and press Enter to run the program. It doesn't know which direction you're facing so you might need to turn around to see the tower after the Hello World message appears.

Turn your Pi into a network storage drive

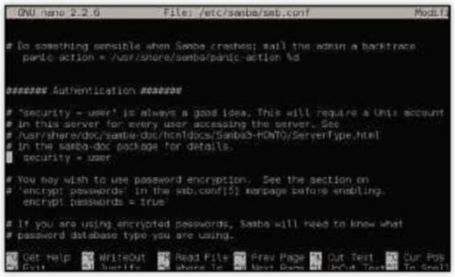
Once you've attached a USB drive or USB hard disk to your Pi (see page 113) you can use it as a network-attached storage (NAS) drive. The Pi can then be used to store digital photo albums, videos and music that everyone on the network can share, whether they're using a Windows computer, Mac, tablet, phone or another Pi. It's a great way to keep important things easily accessible.

If possible, connect your Raspberry Pi and its USB storage to the network using Ethernet rather than Wi-Fi; this makes transferring files faster and more reliable. It's also worth housing the Pi in a case or finding a case for it and its disk: just bear in mind that a hard disk needs good ventilation. Site your new NAS as near to the router as possible and set it up so it won't need to be turned off once it's up and running.

01 Samba is the software used to allow Windows machines to communicate with Linux computers (including the Pi), which use different file formats – including EXT4 which we used for our USB drive on page 113. To install Samba, make sure your Pi is connected to the internet and open LXTerminal. Type 'sudo apt-get update' to make sure your system is up to date followed by 'sudo apt-get install samba samba-common-bin'. This process will take up to 30 minutes, depending on the speed of your broadband connection.



02 We now need to set up Samba by editing its configuration files. In common with many Linux programs, there's no graphical user interface but you only have to set it up once. We're going to use nano, one of the Raspberry Pi's built-in text editors.

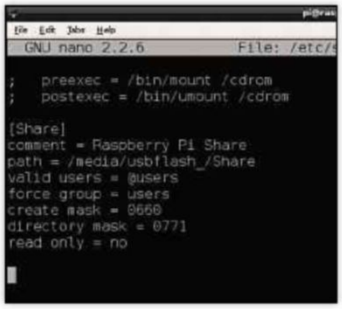


In LXTerminal, open the configuration file in nano by typing 'sudo nano /etc/samba/smb.conf'. You use the keyboard rather than your mouse to edit files in nano, but it's straightforward. Navigate through the file using the arrow keys until you reach a section called Authentication. We want to add some security to our network, so find the line # security = user and remove the hash symbol at the beginning of the line. Hash is often used to tell computers not to pay attention; by removing it we're turning on user-level security and preventing people who connect to your network as guests from having access.

03 Use the arrow keys to move down to the very bottom of smb.conf and press the Enter key at the end to insert a new line. Add these lines to the file, pressing Enter at the end of each:

```
[Share]
comment = Raspberry Pi Share
path = /media/usbflash_/Share
valid users = @users
force group = users
create mask = 0660
directory mask = 0771
read only = no
```

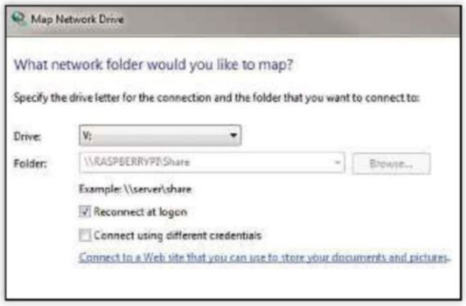
Once you've done this, press Ctrl-O to save the file, then Enter to confirm. Press Ctrl-X to exit nano and you'll return to the command prompt in LXTerminal.



04 We need to restart Samba so that it reads the configuration file back in. To do this, type 'sudo /etc/init.d/samba restart'. We now create a Raspberry Pi user who can access the share; we're choosing the username 'networkuser' and password 'raspberry'. It will be these details that people using other computers to connect to your USB drive will be asked for. To do this, type 'sudo useradd networkuser –m –G users' and Enter followed by 'sudo passwd networkuser'. After pressing Enter, the Pi will ask you to set a password. Make sure you write this down as you and all your NAS drive's other users will need it.

05 We need to add this new user to Samba's list of authorised people. Type 'sudo smbpasswd –a networkuser' and enter the password when prompted. Finally, we're going to set the permissions on the share folder so that anyone on the network can add, edit or delete files. To do this, use the chmod command followed by the permission and the name of the folder. Type 'chmod 777 /media/usbflash_/Share' followed by Enter. Now start Windows Explorer on a PC and you should see 'Raspberry Pi' on the list of devices. Double-click it to see the Share folder. Try to open it and you should be prompted for a username and password. Once you've entered these, you can drag and drop files.

06 To make the shared folder easy to use, we assign it a drive letter in Windows so that it appears like a disk drive. In Windows Explorer, right-click the Raspberry Pi's Share folder and select Map Network Drive from the menu. Choose a drive letter from the dropdown menu; it's probably a good idea to pick a high letter so it's clear which are true disk drives and which are network storage. Leave the 'Reconnect at logon' tick box selected and click Finish. After a few seconds, the NAS will appear in alphabetical position under Computer on your Windows PC.



Use Scratch to program a game

The little Raspberry Pi computer has led to a resurgence of interest in the more technical aspects of computing, including programming. However, the challenge with many programming languages is that they don't always offer the quick gratification needed to keep novices interested.

However, a free tool called Scratch takes a different approach by offering an engaging experience from the start. Programs are created simply by dragging and dropping elements around onscreen. A complete novice can create a working program quickly, and projects can be shared with other users on the Scratch website. So, to learn how to program a game in just 15 minutes, read on.

Understanding the interface

Scratch comes built into the Raspberry Pi's Raspbian operating system. You'll find a shortcut for it on your Pi's desktop. A Windows version is also available to download for free from *http://scratch.mit.edu/scratch_1.4*. We'd also suggest signing up for a Scratch account. This is free, and will allow you to share your work with other people. Visit *http://scratch.mit.edu* and click the Signup link at the top of the web page. Fill in the registration form and the blue 'sign up' button at the bottom. Your Scratch profile page will appear; we'll return here later.

Flip back to the Scratch program window. There are several panes; the window in the top-right corner, with the picture of a cat, is the 'stage', and this is where the results of the program will appear. It also controls the starting and stopping of programs, with the green flag and red dot respectively.

Objects on the stage, such as the cat, are known as sprites and are listed in the pane below the stage; the cat is named 'Sprite1'. Here you add new sprites and change their properties.

The tall pane to the left-hand side of the stage is known as the scripts area; this is where the programming code is developed and shaped. Programming essentially involves creating a series of commands in order to control something: sprites on the stage, in this case. A complete series of commands is known as a script.

Scratch's commands are arranged into eight different categories, which can be selected by clicking one of the eight labelled buttons in the top left-hand corner of the Scratch program window. Scripts are created by dragging items from the commands pane into the scripts area.

Programming primer

First, click the Control button in the top left corner and the commands pane will fill with command icons, coloured orange. To start, drag and drop the 'when [green flag icon] clicked' command into the scripts pane. Place it near the top-left corner but don't worry too much about its precise position.

⬆ Scratch is a great way to start learning about computer programming, on Raspberry Pi or Windows

Now click the Looks category button and find the 'say Hello! For 2 secs' command – drag the first (orange) command into the scripts pane. As you do, notice how a white line appears below the orange command; this indicates that the command being dragged can naturally follow the existing command. Now drop the new command below the existing one and the two will 'snap' together. Indeed, examine the command icons and you'll see they are shaped a bit like puzzle pieces; commands that fit together can work together.

Remarkably, you have already created some working computer code. To try it, click the green flag icon above the stage to start the program. A 'Hello!' speech bubble will appear above the cat for a couple of seconds, and then disappear. Now examine the fledging script to consider what is going on. The two commands read 'when [green flag icon] clicked' and 'say Hello! For 2 secs', and that's precisely what has happened.

Creating a game

Let's make a simple game of chase in Scratch. The player will control the cat sprite in an effort to try to reach a snowman, while avoiding a ball that moves across the stage. We'll create the program so that the two characters appear in opposing corners at the beginning of the game, and apply random movement to the ball.

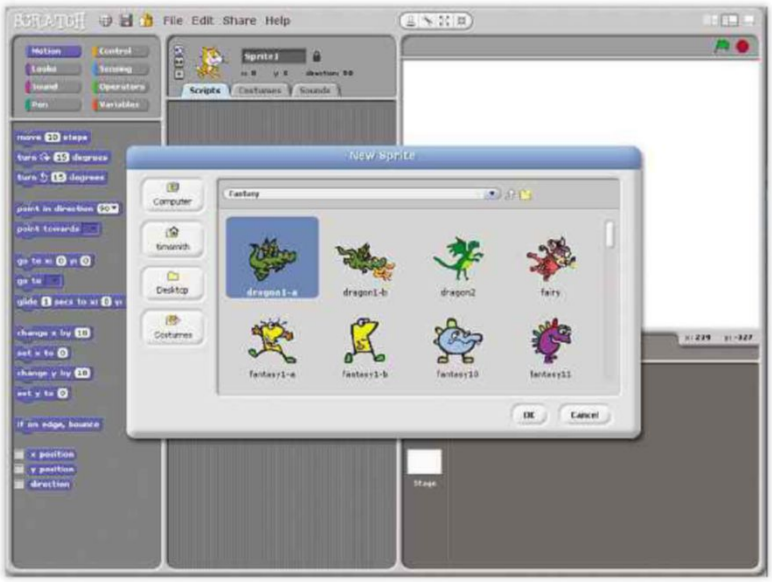
Create a new script by selecting New from the File menu and click No when asked if you want to save your work. Drag and drop the 'when [green flag icon] clicked' command into the scripts pane. Now select the Motion category and drag the 'go to x:[X] y:[X]' and the 'point in direction [X]' icons to join them to the first command. Click in the x: box and type -182 as the new value, and set y: to -112.

To make the cat react to the cursor (arrow) keys, return to the Control category and drag 'when [X] key pressed' to the scripts pane; this won't join up with the previous three commands. Click this command's down-pointing arrow and

Beyond Scratch

Scratch has the potential for creating some fairly sophisticated programs. For example, it makes it easy to perform several tasks simultaneously, which can be quite tricky with traditional coding methods.

However, if you want to develop your skills then at some point it will become necessary to move to a more traditional programming language. Small Basic (*http://smallbasic.com*) is a good one to try. The next step up is Visual Studio. Microsoft produces a free version called Visual Studio Express (*www.snipca.com/9818*). Although some handwritten code is required, it's also possible to design programs by dragging and dropping commands in a similar way to Scratch. Another good choice is Game Maker Studio (*www.yoyogames.com/studio*). The best way, however, would be to try Python (*www.python.org*), which is a simple, free programming language that's ideally suited to your Raspberry Pi.



⬆ In Scratch, you can build up a program just by dragging and dropping

choose 'up arrow' for the [X] value. Return to the Motion category. Drag both the 'point in direction [X]' and the 'move [X] steps' commands to join up with the second orange command. Click the down-pointing arrow to ensure that the 'point in direction' [X] value is set to '0 (up)'. For 'move [X] steps', the [X] value should be 10.

Click Control and drag another 'when [X] key pressed' command to the scripts pane, choosing 'down arrow' for [X]. Add 'point in direction [X]' and the 'move [X] steps' commands as before, changing the first [X] value to 180. Repeat twice more, for the left and right arrows, using -90 for the left arrow [X] value and 90 for the right arrow.

Click the green flag icon to check your work. Tapping the arrow keys should now allow you to control the cat.

Adding the snowman

To add a new sprite, click the middle star-shaped icon under the stage. In the New Sprite dialog box, click the Costumes button on the left and then double-click the Fantasy folder. Scroll down to find and double-click on 'snowman2' and he will appear in the stage. Double-click on the snowman to make him the subject of scripts pane. As before, add a 'when [green flag icon] clicked' command. Then join a 'forever' command beneath it, followed by an 'if' command inside that. The 'forever' command grows to allow 'if' to fit inside.

We have now created a loop. Loops are used to repeat actions either endlessly, or based on a particular condition that will be checked by the 'if' command.

We need the 'if' command to check whether or not the cat has touched the snowman. Click to select the Sensing category and drag the diamond-shaped 'touching [X] ?' command into the diamond-shaped depression inside the 'if' command. Click the down-pointing arrow to change the 'touching [X] ?' command's [X] value to 'Sprite1' – this is the cat's sprite.

Select the Looks category and drag and drop the 'say Hello!' command inside the 'if' loop. Double-click the 'Hello!' text, delete it and replace it by typing 'You Win!'. Return to the Control category and drag and drop a 'stop all [red circle icon]' command (you may need to scroll down the commands list to find it) below the 'say' command. This will end the game when the cat sprite touches the snowman.

Adding the ball

Click the middle star-shaped icon under the stage. Click Costumes then double-click Things followed by 'beachball1'. Double-click the ball in the stage to make it the focus of the script area. Drag a 'when [green flag icon] clicked' Control command into the scripts area, followed by a 'go to x:[X] y:[X]' Motion command. Change x: to 178 and y: to 106.

To make the snowman move, add a 'forever' loop and then a 'repeat' loop within that. From the Operators category, drag a 'pick random [X] to [X]' command into the number field in the 'repeat' command, and change the [X] values to 1 and 5. Below this, attach a 'move [X] steps]' command (from the Motion category) and another 'pick random [X] to [X]' command to the move command, setting the [X] values to 5 and 15.

Drag a 'point towards [X]' Motion command so that it appears underneath the 'repeat' loop but still inside the 'forever' loop. Click on the down-pointing arrow and choose 'Sprite1'. Now insert a 'turn [X] degrees' command underneath this. Drag a 'pick random [X] to [X]' Operator command into the 'turn [X] degree' command's number field and set the values to -90 and 90. This is to make the ball travel in the general direction of the cat but with some randomness, so the game isn't impossible.

Finally, the ball needs to know whether or not it has touched the cat. Insert an 'if' command after the 'turn [X] degrees' command, but still within the forever loop. From the Sensing category, drag a 'touching [X] ?' command into the 'if' command's gap, choosing 'Sprite1' as the [X] value. Add a 'say' command from the Looks category and change the text to read 'Got You!'. Add a 'stop all [red circle icon]' after this 'say' command to end the game.

If you ran the program now (by clicking the green flag icon) you'd discover the ball moves too fast. This can be fixed by adding a 'wait' command (from the Control category) to the very end, but still within the 'forever' loop. Set it to 0.2 seconds.

Scripts are created by dragging items from the commands pane into the scripts area

Now run the program. The ball will move and the cat will respond to direction commands from the cursor (arrow) keys. Try to get to the snowman without being touched by the ball.

If something's wrong, check the code carefully or download the completed program from *www.snipca.com/7950*.

Save and share

Save your work often. Type a name at the bottom of the window. If you're planning to share your creation, add your name in the Project author box and a description in the 'About this project' box, then click OK.

To share the program with other people using your Scratch account, click the orange icon. Enter your Scratch login details and some information about the program, then click OK.

⬇ It won't be long before you've created a simple script using Scratch