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FREE EBOOK

HARDWARE, NETWORKING AND REPAIR

Computer Hardware and Maintenance Study Book

The complete study notes, practice questions and glossary for
Computer Hardware and Maintenance

INSIDE THIS BOOK

- Inside the PC: Motherboard and CPU
- Memory: RAM Types
- Storage: HDD, SSD and NVMe
- The SMPS and Computer Ports
- ...and 3 more chapters, practice questions and a glossary

Beginner

Students learning to assemble, maintain and repair computers

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Computer Hardware and Maintenance Study Book

Know every part inside a PC, assemble one safely, set up BIOS/UEFI, install Windows and drivers, and diagnose and prevent common hardware faults.

WHO IT IS FOR	Students learning to assemble, maintain and repair computers
LEVEL	Beginner
SUBJECT AREA	Hardware, networking and repair
WHAT IS INSIDE	7 chapters, practice questions with answers, and a glossary

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Inside the PC: Motherboard and CPU

Looking inside a desktop computer

Open the side panel of a desktop cabinet and you will see a large printed circuit board fixed to one side. This is the **motherboard**, and every other part connects to it. The main parts covered in this subject are the motherboard, the CPU (processor) with its cooler, RAM, storage drives, the SMPS (power supply) and expansion cards such as a graphics card.

The motherboard

The motherboard carries power and data between all the components. Important parts on it include:

Part	Purpose
CPU socket	Holds the processor; each socket fits only certain CPUs
RAM slots	Hold the memory modules
Chipset	Manages communication between the CPU and devices such as USB and SATA
PCIe slots	For graphics cards and other expansion cards
M.2 slots	For small SSDs (some boards also have one for a Wi-Fi card)
SATA ports	Connect hard disks, SATA SSDs and optical drives
24-pin power connector	Main power input from the SMPS
CMOS battery	A coin cell (commonly CR2032) that keeps the clock and settings when the PC is unplugged
Front-panel header	Small pins for the power button, reset button and case LEDs

Form factors

Motherboards come in standard sizes called **form factors**. The common ones are **ATX** (full size, more slots), **Micro-ATX** (smaller, fewer slots) and **Mini-ITX** (very small, for compact PCs). The cabinet must support the motherboard's form factor.

The CPU

The **Central Processing Unit** (CPU or processor) carries out the instructions of programs. The two main makers of PC processors are **Intel** (for example the Core series) and **AMD** (for example the Ryzen series). Key specifications:

- **Cores:** independent processing units inside one chip. More cores help when many tasks run at once.
- **Threads:** many CPUs can run two threads on each core, which helps multitasking.
- **Clock speed:** measured in gigahertz (GHz), the number of cycles each core performs per second.
- **Cache:** very fast memory inside the CPU that keeps frequently used data close at hand.

Sockets and compatibility

A CPU fits only a motherboard with the matching socket, and the board's chipset and BIOS version must also support it. Always check the motherboard maker's **CPU support list** before buying. On Intel's current desktop sockets and AMD's AM5 socket, the pins are in the socket on the motherboard (**LGA**, land grid array). On AMD's older AM4 socket, the pins are on the processor itself (**PGA**, pin grid array). Bent pins on either side can stop a PC from working, so handle a CPU only by its edges.

Cooling

A CPU produces a lot of heat. It needs a **heatsink and fan** (or a liquid cooler) on top, with a thin layer of **thermal paste** between the CPU and the cooler. The paste fills tiny air gaps so heat flows into the heatsink. Without proper cooling, the CPU slows itself down (throttles) or the PC shuts down to protect itself.

Many CPUs have built-in (integrated) graphics. If a CPU has none, the PC needs a separate graphics card to show any picture at all.

KEY POINTS

- The motherboard connects every component and carries power and data.
- Form factors such as ATX, Micro-ATX and Mini-ITX must suit the cabinet.
- CPU specifications include cores, threads, clock speed (GHz) and cache.
- A CPU must match the socket and appear on the motherboard support list.
- Thermal paste and a cooler stop the CPU from overheating.

TRY THESE EXERCISES

1. With your instructor's permission, open the side panel of a switched-off and unplugged desktop and draw a labelled sketch showing the CPU socket and cooler, RAM slots, PCIe slots, M.2 slot (older boards may have none), SATA ports, 24-pin power connector, CMOS battery and front-panel header.
2. Open the Performance tab of Task Manager on a Windows computer, select CPU, and note the processor's name, base speed, number of cores, logical processors and cache sizes; repeat on a second computer and compare the two.
3. Choose two motherboards from a shop brochure or a manufacturer's specification sheet and make a comparison table of their form factor, CPU socket, chipset, number of RAM slots, M.2 slots and SATA ports.

CHAPTER 2

Memory: RAM Types

RAM and ROM

RAM (Random Access Memory) is the computer's working memory. Programs and files you have open are kept in RAM because it is far faster than any storage drive. RAM is **volatile**: everything in it is lost when the power goes off, which is why you must save your work to a drive.

ROM (Read Only Memory) is non-volatile and holds firmware. On a modern motherboard, the BIOS/UEFI firmware is stored on a flash memory chip that can be updated.

How much RAM?

More RAM lets you keep more programs and browser tabs open without slowing down. When RAM is full, Windows moves data out to the drive (the page file), which is much slower. Windows 11 needs at least 4 GB, but 8 GB or more gives a much smoother experience for office work and browsing, and heavier work such as video editing benefits from more.

DDR generations

Desktop and laptop RAM today is **DDR SDRAM** (Double Data Rate). Each newer generation is faster and runs at a lower standard voltage:

Generation	Standard voltage	Where you meet it
DDR3	1.5 V (low-voltage DDR3L: 1.35 V)	Older PCs and laptops
DDR4	1.2 V	Very common in PCs of recent years

Generation	Standard voltage	Where you meet it
DDR5	1.1 V	Current generation on new platforms

Generations are not interchangeable. The notch in each module sits in a different position, so a DDR4 module will not fit a DDR5 slot. A motherboard normally supports only one generation, so check its manual before buying RAM, and never force a module into a slot.

Desktop and laptop modules

- **DIMM:** the long module used in desktops.
- **SO-DIMM:** the shorter module used in most upgradeable laptops and mini PCs.

Many thin laptops have their RAM **soldered** to the motherboard, so it cannot be upgraded. Check the laptop's specification before promising a customer an upgrade.

Speed and channels

RAM speed is given in MT/s, although shop listings often write MHz, for example DDR4-3200. If you mix modules of different speeds, they normally all run at the speed of the slowest one.

Most desktop boards support **dual-channel** memory, where two matching modules work together for more bandwidth. Two 8 GB modules in the correct slots usually perform better than a single 16 GB module. The motherboard manual shows which slots to use; on four-slot boards it is often the second and fourth slots (labelled A2 and B2).

Installing RAM

1. Switch off and unplug the PC, and wear an antistatic wrist strap.
2. Open the clips at the end of the slot.
3. Line up the notch on the module with the key in the slot.
4. Press down firmly and evenly on both ends until the clips click into place.
5. Check in the BIOS/UEFI, or in Windows under Settings > System > About, that the full amount is detected.

A PC that powers on but shows no picture, and beeps or lights a memory warning LED, often has a loosely seated RAM module. Reseating the RAM is one of the first things a technician tries.

KEY POINTS

- RAM is fast, volatile working memory; its contents vanish without power.
- DDR3, DDR4 and DDR5 are not interchangeable because the notch position differs.
- Desktops use DIMMs, laptops use SO-DIMMs, and some laptops have soldered RAM.
- Matching modules in the correct slots run in faster dual-channel mode.
- A loose RAM module is a common cause of no display.

TRY THESE EXERCISES

1. Check how much RAM a Windows computer has under Settings > System > About, then open Task Manager > Performance > Memory and note the speed, the number of slots used and the form factor shown there.
2. With the PC unplugged and an antistatic wrist strap on, remove one RAM module, look at the position of its notch and read its label for the generation, capacity and speed, then reinstall it and confirm the full amount of RAM is detected.
3. Make a chart comparing DDR3, DDR4 and DDR5 with their standard voltages, and draw a desktop DIMM beside a laptop SO-DIMM showing the difference in length and notch position.

CHAPTER 3

Storage: HDD, SSD and NVMe

Storage and memory are different

Storage keeps your data permanently, even with the power off: Windows itself, your programs, photos and documents. People often say "memory" when they mean storage, but a technician should keep the two apart. RAM is temporary working memory; storage is permanent.

Hard disk drive (HDD)

An HDD stores data magnetically on spinning platters. A read/write head on a moving arm floats just above the surface.

- Common speeds are 5,400 and 7,200 RPM (revolutions per minute).
- Desktop drives are usually 3.5-inch; laptop drives are 2.5-inch.
- **Advantages:** low cost per gigabyte and large capacities.
- **Disadvantages:** slower, noisier, and sensitive to drops and knocks because of the moving parts.

A clicking or grinding noise from an HDD is a warning sign of mechanical failure. Back up the data immediately.

Solid state drive (SSD)

An SSD stores data in **NAND flash memory** chips and has no moving parts. It starts Windows and opens programs much faster than an HDD, uses less power and survives knocks better. Replacing an old HDD with an SSD is one of the most effective upgrades for a slow computer.

SATA SSD and NVMe SSD

The interface decides how fast an SSD can go.

Type	Connection	Common shapes	Speed
SATA SSD	SATA data and power cables, or an M.2 slot working in SATA mode	2.5-inch or M.2	Limited by SATA III (6 Gb/s), a little over 500 MB/s in practice
NVMe SSD	PCI Express (PCIe) lanes	Usually M.2	Several times faster than SATA, depending on the PCIe generation

M.2 is a shape, not a speed

M.2 describes the small card shape and its slot. An M.2 SSD can be either SATA or NVMe, and some M.2 slots support only one of the two. Always check the motherboard or laptop manual before buying. The most common M.2 size is 2280, which means 22 mm wide and 80 mm long.

Capacity units

Drive makers count in decimal units (1 GB = 1,000,000,000 bytes), while Windows calculates in binary units. That is why a "1 TB" drive shows about 931 GB in File Explorer. Nothing is missing.

Looking after drives

- **HDD:** defragmenting rearranges files into continuous blocks, which helps a mechanical drive.
- **SSD:** do **not** defragment it. The Windows Optimize Drives tool recognises SSDs and sends them a TRIM command instead, which helps the SSD manage its free space.
- **Health checks:** tools that read a drive's **S.M.A.R.T.** data report warning signs, such as reallocated sectors on an HDD or the wear level of an SSD.
- **Free space:** an almost full system drive makes Windows slow and can stop updates installing.

Data recovery from a failed drive is expensive and not always possible. The cheapest data recovery is a backup made yesterday.

Example

Meena's office PC took several minutes to start. The technician cloned her HDD to a new SATA SSD, and the same PC now starts in well under a minute.

KEY POINTS

- HDDs use spinning platters; SSDs use flash memory with no moving parts.
- SATA SSDs are limited by the SATA interface; NVMe SSDs use faster PCIe lanes.
- M.2 is a form factor, and an M.2 drive can be SATA or NVMe.
- Defragment HDDs but never SSDs; Windows uses TRIM for SSDs.
- A clicking hard disk means back up the data immediately.

TRY THESE EXERCISES

1. Open the Defragment and Optimize Drives tool on a Windows computer and note the media type of each drive, then write down whether Windows will defragment it (hard disk drive) or send it TRIM (solid state drive).
2. Work out how many GB Windows will show for drives sold as 256 GB, 512 GB, 1 TB and 2 TB by dividing the decimal number of bytes by 1,073,741,824 (Windows shows the 2 TB result, about 1,863 GB, as 1.81 TB after dividing by 1,024 once more), then compare one answer with a real drive in File Explorer, where the C: drive may be a little smaller because Windows keeps small hidden system partitions.
3. Compare a 3.5-inch HDD, a 2.5-inch SATA SSD and an M.2 SSD at the centre, or pictures of them, writing for each its connection, typical use and one advantage and one disadvantage; measure the M.2 SSD with a ruler, if you have the real drive, to work out its size code, such as 2280 for 22 mm wide and 80 mm long.

CHAPTER 4

The SMPS and Computer Ports

What the SMPS does

The **SMPS** (Switched-Mode Power Supply), also called the PSU, converts the AC mains supply (230 V, 50 Hz in India) into the low DC voltages that computer parts use. In the standard ATX colour code:

Wire colour	Meaning
Yellow	+12 V
Red	+5 V

Wire colour	Meaning
Orange	+3.3 V
Black	Ground (0 V)
Purple	+5 V standby, present whenever the SMPS is plugged in and switched on at the back
Green	Power-on signal from the motherboard
Grey	Power-good signal to the motherboard

In a modern PC, the +12 V supply delivers most of the power, feeding the CPU and the graphics card.

SMPS connectors

- **24-pin ATX:** the main connector to the motherboard.
- **4+4 pin (8-pin) EPS:** CPU power, plugged in near the CPU socket.
- **6+2 pin PCIe:** power for graphics cards; some newer high-end cards use a single 16-pin connector instead.
- **SATA power:** for SATA hard disks and SSDs.
- **Molex** (4-pin peripheral): for older devices and some fans.

Choosing and protecting an SMPS

- The **wattage** must cover all the components with some headroom; a PC with a powerful graphics card needs far more than an office PC.
- An **80 PLUS** rating (Bronze, Gold and so on) shows efficiency: a more efficient unit wastes less power as heat.
- Very cheap unbranded units may not deliver their label wattage and can damage other parts when they fail.
- A **UPS**, or at least a surge protector, protects against power cuts and voltage fluctuations.

Never open an SMPS. Its capacitors can hold a dangerous charge even after it is unplugged. A faulty SMPS is replaced as a complete unit.

Computer ports

Port	Purpose
USB Type-A	Rectangular port for keyboards, mice and pen drives
USB Type-C	Small, reversible oval port; may carry data, charging and video, depending on the device

Port	Purpose
HDMI	Digital video and audio to monitors, TVs and projectors
DisplayPort	Digital video and audio, common on monitors and graphics cards
VGA	Older 15-pin analogue video port, usually blue
RJ-45 (Ethernet)	Wired network cable
3.5 mm audio	Green for speakers or headphones, pink for a microphone, blue for line in

USB versions

USB 2.0 runs at up to 480 Mb/s, while **USB 3.x** ports start at 5 Gb/s and are often blue inside on desktop PCs. **USB-C** describes only the shape of the connector; it does not tell you the speed or features on its own.

If a monitor shows "No signal" on a PC with a separate graphics card, check that the cable goes into the graphics card's port, not the motherboard's video port.

KEY POINTS

- The SMPS converts 230 V AC mains into low DC voltages: +12 V, +5 V and +3.3 V.
- Main connectors are the 24-pin ATX, 8-pin CPU, PCIe and SATA power.
- Choose adequate wattage from a reliable brand and protect it with a UPS.
- Never open an SMPS: its capacitors can stay charged.
- USB-C is a connector shape; speed depends on the USB version.

TRY THESE EXERCISES

1. On an unplugged SMPS that is kept for practice, identify the 24-pin ATX, 8-pin CPU, PCIe, SATA power and Molex connectors without opening the unit (a basic office SMPS may have no PCIe connector), and make a chart of the ATX wire colours with the voltage or signal each one carries.
2. Read the label on an SMPS and write down its wattage, its 80 PLUS rating if it has one, and the maximum current of its +12 V output.
3. Go round the front and back of a desktop PC and the sides of a laptop and list every port you find, writing its name, what it is used for and, for USB ports, whether it is Type-A or Type-C and whether it looks like USB 2.0 or USB 3.x.

Assembling a PC Safely

Electrical safety first

Before touching anything inside a computer:

- Switch off and **unplug** the power cable from the wall socket.
- Press and hold the power button for a few seconds to drain leftover charge from the motherboard.
- Remove watches and rings, and keep drinks away from the workbench.

What is ESD?

Electrostatic discharge (ESD) is a sudden flow of static electricity, like the small shock you sometimes feel when touching a door handle. Your body can carry a static charge that is too small to feel yet large enough to damage chips. The damage may not show at once; a part can fail weeks later.

To prevent ESD:

1. Wear an **antistatic wrist strap** clipped to unpainted metal on the case.
2. Work on an antistatic mat or a hard table, not on carpet or a bed.
3. Keep new parts in their **antistatic bags** until you need them.
4. Hold cards and memory modules by their edges; do not touch gold contacts or chips.
5. Without a strap, touch bare metal on the case often to equalise your charge with it.

Tools you need

- Phillips screwdriver (a magnetic tip helps; most case screws take a #2)
- Cable ties or Velcro straps
- Thermal paste, if the cooler does not have it pre-applied
- Torch, a small tray for screws, and the motherboard manual

Step-by-step assembly

1. **Prepare the case:** make sure the motherboard **standoffs** (metal spacers) match the holes in the board, and fit the I/O shield if the board has a separate one. An extra standoff in the wrong place can short-circuit the board.
2. **Fit the CPU** while the motherboard sits on its box: lift the socket lever, line up the triangle mark on the CPU with the mark on the socket, lower it in gently without pressing, and close the lever.

3. **Apply thermal paste and fit the cooler:** a pea-sized dot in the centre is enough. Tighten cooler screws a little at a time in a cross pattern, then connect the fan to the CPU_FAN header.
4. **Install RAM** in the slots recommended by the manual.
5. **Install the M.2 SSD**, if used, and secure it with its small screw or latch.
6. **Mount the motherboard** in the case on the standoffs and screw it down.
7. **Install the SMPS**, with its fan facing a ventilated opening.
8. **Install drives** (2.5-inch SSD or 3.5-inch HDD) in their bays.
9. **Install the graphics card**, if used, in the top PCIe x16 slot.
10. **Connect cables:** 24-pin ATX, 8-pin CPU power, PCIe power, SATA data and power, case fans, front USB and audio, and the front-panel header (power switch, reset and LEDs) using the manual's diagram.
11. **Tidy cables** so they do not block airflow or touch fans.

Do the first power-on with the side panel off. If nothing happens, check the front-panel connector and the CPU power cable first; these are the two most often forgotten.

First boot checklist

- The fans spin and the system reaches the BIOS/UEFI screen.
- The CPU, the full amount of RAM and all drives are detected.
- The CPU temperature at idle is steady rather than climbing quickly.

KEY POINTS

- Unplug the PC and drain leftover charge before working inside.
- ESD can damage parts invisibly: use a wrist strap, an antistatic mat and antistatic bags.
- Handle components by their edges and never force a CPU or RAM module.
- A pea-sized dot of thermal paste is enough; connect the fan to CPU_FAN.
- If a new build will not start, check the front-panel and CPU power cables first.

TRY THESE EXERCISES

1. Practise the full safety routine under supervision: shut down and unplug the PC, hold the power button for a few seconds, take off your watch and rings, clip on an antistatic wrist strap to bare metal on the case, and pick up a RAM module and an expansion card correctly by their edges.
2. Under supervision and after the full safety routine (unplugged, power button held, wrist strap on), take apart a training PC step by step, putting the screws for each part into a labelled tray and photographing every stage, then reassemble it in reverse order, cleaning off the old thermal paste and applying a fresh pea-sized dot if you removed the CPU cooler, and confirm it reaches the BIOS/UEFI screen.
3. Using the motherboard manual, copy the front-panel header diagram into your notebook, then, with the PC unplugged, connect the power switch, reset switch and LED wires to the correct pins on a training board, plug it back in and check that the power button works.

CHAPTER 6

BIOS/UEFI, Boot Order, Windows and Drivers

BIOS and UEFI

When you press the power button, the motherboard's firmware runs first. It performs **POST** (Power-On Self-Test), checking that the CPU, RAM and graphics are working, and then starts an operating system from a drive.

- **BIOS** (Basic Input/Output System) is the older type of firmware.
- **UEFI** (Unified Extensible Firmware Interface) is its modern replacement on current PCs. It supports large drives using the **GPT** partition style, mouse-driven setup screens and **Secure Boot**, which blocks boot software that is not signed with a trusted key.

Many people still call the UEFI setup screen "the BIOS".

Entering setup

Press a key straight after power-on. **Delete** or **F2** is common for setup, and a one-time boot menu often uses **F12**, **F11** or **Esc**. The keys differ between manufacturers, so check the start-up screen or the manual.

In setup you can check the detected CPU, RAM and drives, change the **boot order**, turn Secure Boot and the TPM on or off (the TPM may be listed as Intel PTT or AMD fTPM), and load optimised defaults if settings have been changed badly.

Boot order

The boot order is the sequence of devices the firmware tries when looking for an operating system. To install Windows from a USB drive, put the USB drive first or pick it from the one-time boot menu. After installation, the internal drive that holds Windows should come first.

Installing Windows 11

Key requirements published by Microsoft

- A compatible 64-bit processor (1 GHz or faster with 2 or more cores)
- 4 GB RAM and 64 GB of storage
- UEFI firmware capable of Secure Boot
- TPM version 2.0
- DirectX 12 compatible graphics with a WDDM 2.0 driver

Steps

1. On a working PC, use Microsoft's **Media Creation Tool** to make a bootable USB drive of at least 8 GB. Everything already on that USB drive is erased.
2. Back up all data on the target PC, because a clean installation erases the drive you install to.
3. Boot the target PC from the USB drive using the boot menu.
4. Follow the setup screens: choose language and keyboard, enter a product key or skip it if the PC already has a digital licence, select the drive to install on, and let setup copy files and restart.
5. Finish the out-of-box setup: region, network and user account.

Drivers

A **driver** is software that lets Windows communicate with a piece of hardware. Windows Update installs many drivers automatically, but some, such as chipset, graphics, Wi-Fi or printer drivers, may need to be downloaded.

- Open **Device Manager** by right-clicking Start. A yellow warning icon marks a device with a driver problem.
- Download drivers only from the hardware maker's official website or the PC brand's support page, using the exact model number.
- If a new driver causes trouble, use **Roll Back Driver** on the Driver tab of that device's Properties.

Avoid "driver updater" tools from unknown websites. Many bundle adware and some install the wrong driver.

KEY POINTS

- Firmware runs POST, then starts the OS from the first bootable device.
- UEFI replaces legacy BIOS and supports GPT drives and Secure Boot.
- Setup and boot-menu keys vary by maker; Delete, F2, F12 and Esc are common.
- Windows 11 requires Secure Boot capable UEFI firmware and TPM 2.0.
- Get drivers from official sites; Device Manager shows problems and can roll back a driver.

TRY THESE EXERCISES

1. Restart a PC, find the setup key and the one-time boot menu key from the start-up screen or the manual, enter setup and note the detected CPU, RAM and drives, the boot order and whether Secure Boot and the TPM are enabled, then exit without saving any changes.
2. After copying any files off a USB drive of at least 8 GB, use the Media Creation Tool on a working PC to make a Windows 11 bootable USB drive, then check that a test PC lists it in its one-time boot menu without starting an installation.
3. Open Device Manager, expand each category and note any device with a yellow warning icon; for one device, open Properties > Driver and write down the driver provider, date and version, and whether Roll Back Driver is available.

CHAPTER 7

Troubleshooting and Preventive Maintenance

A method for troubleshooting

Good technicians follow a method instead of guessing:

1. **Ask questions:** What exactly happens? When did it start? Was anything changed, installed or dropped?
2. **Reproduce the problem** and note any error messages or beeps.
3. **Check simple things first:** power cable, wall socket, the switch on the SMPS, the monitor's input setting and loose cables.
4. **Change one thing at a time**, then test again, so you know which change made the difference.
5. **Swap in known-good parts** (RAM, cable, SMPS) to confirm which part is faulty.
6. **Record** what you found and fixed on the job card.

Common faults

Symptom	Likely causes	What to try
Completely dead, no fans	No mains power, SMPS switched off, faulty SMPS, loose front-panel cable	Check socket, cable and SMPS switch; test with a known-good SMPS
Fans spin but no display	RAM not seated, monitor cable in the wrong port, loose graphics card	Reseat RAM, connect the monitor to the graphics card, check cables
Beeps at start-up	POST found a hardware error	Look up the beep pattern in the motherboard manual; codes differ by maker
Date and time reset at every start	Weak CMOS battery	Replace the coin cell
Shuts down under heavy load	Overheating or a weak SMPS	Clean dust, check fans and thermal paste, test the SMPS
Very slow	Nearly full drive, too many start-up apps, malware, failing HDD	Free space, disable start-up apps, scan, check drive health, fit an SSD
Stop-error crash screen (the classic "blue screen")	Faulty driver, RAM or drive problem	Note the stop code, update or roll back drivers, test the RAM

Useful Windows tools

- **Task Manager** (Ctrl + Shift + Esc): CPU, memory and disk usage, and start-up apps.
- **Device Manager**: hardware and driver problems.
- **Windows Memory Diagnostic**: tests the RAM after a restart.
- **Event Viewer**: logs of errors and crashes.
- **Safe Mode**: starts Windows with a minimal set of drivers, useful for removing a bad driver or program.

Preventive maintenance

Preventive maintenance stops many faults before they start.

- **Dust**: clean inside every few months, more often in dusty areas. Use a blower or compressed air, holding fans still so they do not over-spin. Do not use a household vacuum cleaner inside the PC, because it can build up static.
- **Airflow**: keep vents clear, leave space behind the cabinet and never shut the PC inside a closed cupboard.

- **Thermal paste:** renew it if CPU temperatures climb over the years.
- **Power protection:** use a UPS or surge protector and make sure the socket is properly earthed.
- **Software:** keep Windows, drivers and antivirus updated, and uninstall unused programs.
- **Storage:** keep free space on the system drive, check drive health and keep regular backups.
- **Peripherals:** clean keyboards and mice; wipe screens with a soft microfibre cloth and never spray liquid directly onto a screen.

Keep a simple maintenance log for each computer: the date, the work done and parts replaced. It makes the next repair much faster.

KEY POINTS

- Troubleshoot methodically: ask, reproduce, check simple things, change one thing at a time.
- Fans without a display often means RAM seating or the wrong monitor port.
- A clock that resets at every start points to a weak CMOS battery.
- Beep codes differ by manufacturer, so check the motherboard manual.
- Regular cleaning, good airflow, a UPS and backups prevent many faults.

TRY THESE EXERCISES

1. Make a job card with fields for the customer, the symptom, questions asked, tests done, parts swapped, the fix and the date, and fill it in while solving a practice fault set by your instructor, such as a loosened RAM module or an unplugged front-panel cable.
2. Open Task Manager with Ctrl + Shift + Esc, sort the processes by CPU and then by memory, disable one unnecessary program on the Startup apps page (the Startup tab on Windows 10), and schedule Windows Memory Diagnostic to run at the next restart, noting its result.
3. Carry out preventive maintenance on a training PC: with it shut down and unplugged, blow out the dust while holding the fans still, then power it on with the side panel off and check that every fan spins, wipe the keyboard and the screen the correct way, and record the date and the work done in a maintenance log.

Practice questions

Choose the best answer for each question. The answers, with a short explanation, are in the next chapter.

1. Which component connects all the other parts of a computer together?

- a) SMPS
- b) Hard disk
- c) Monitor
- d) Motherboard

2. What is the job of the CMOS battery on a motherboard?

- a) It keeps the CPU running during short power cuts and outages
- b) It stores the Windows files when the PC is off
- c) It keeps the clock and settings when the PC is unplugged
- d) It supplies power to the fans at start-up

3. CPU clock speed is measured in which unit?

- a) Gigahertz (GHz)
- b) Gigabytes (GB)
- c) Watts (W)
- d) Megapixels (MP)

4. Why is thermal paste applied between the CPU and its cooler?

- a) It glues the CPU firmly into the motherboard's CPU socket
- b) It fills tiny air gaps so heat flows into the heatsink
- c) It stops electricity from reaching the CPU's pins
- d) It makes the cooler's fan spin more quietly

5. Before buying a new CPU for an existing motherboard, what should you check?

- a) The colour of the cabinet's front panel
- b) The CPU support list for that motherboard
- c) The size and resolution of the monitor
- d) The layout and language of the keyboard

6. A desktop PC powers on and its fans spin, but the monitor shows nothing. What is a sensible first step?

- a) Replace the CPU with a new one straight away
- b) Reinstall Windows from a bootable USB pen drive at once
- c) Reseat the RAM and check the monitor cable and port
- d) Buy a new monitor and a new graphics card

7. RAM is described as volatile. What does this mean?

- a) It can catch fire easily if it gets too warm
- b) It keeps its data permanently, even without any power
- c) It works only in laptops and not in desktops
- d) Its contents are lost when the power is switched off

8. Can a DDR4 memory module be installed in a DDR5 slot?

- a) Yes, all DDR modules fit all DDR slots
- b) Yes, if you press down a little harder
- c) No, the notch is in a different place
- d) Only if the computer is a laptop

9. What are upgradeable laptop memory modules usually called?

- a) Full-size DIMM
- b) SO-DIMM
- c) SATA
- d) PCIe x16

10. What is the benefit of installing two matching RAM modules in the slots shown in the manual?

- a) They use less electricity than one module
- b) They turn RAM into permanent storage
- c) They remove the need for drivers
- d) They can run in dual-channel mode for more bandwidth

11. A PC beeps in a pattern at start-up and shows nothing on screen. How do you find out what the beeps mean?

- a) Look up the pattern in the motherboard or BIOS maker's manual
- b) Every computer uses the same beep codes, so no lookup is needed
- c) Count the beeps and add that many GB of RAM
- d) Beeps always mean the speaker is broken

12. A hard disk starts making a clicking noise. What does this usually indicate?

- a) Normal operation that needs no attention at all
- b) Possible mechanical failure; back up the data now
- c) That the drive is charging its small internal battery
- d) That Windows is busy installing updates

13. What does M.2 describe?

- a) A type of RAM module used in laptops
- b) A drive that always runs at 2 GB/s
- c) A card shape and slot used by SATA or NVMe drives
- d) A connector for monitors and projectors

14. Why is an NVMe SSD faster than a SATA SSD?

- a) It spins its platters faster than a hard disk
- b) It borrows part of the system RAM as storage
- c) It uses PCIe lanes instead of the slower SATA interface
- d) It is always physically larger than an ordinary SATA SSD

15. A new "1 TB" drive shows about 931 GB in Windows. Why?

- a) The drive is faulty and should be returned
- b) A virus has used up the missing 69 GB of space
- c) Makers count in decimal units; Windows uses binary units
- d) The shop sold a smaller drive with the wrong label

16. Should you defragment an SSD?

- a) No; Windows sends the TRIM command to SSDs instead
- b) Yes, every day, to keep it running fast
- c) Yes, once a week, in exactly the same way as a hard disk
- d) Yes, but only with a third-party tool

17. What does an SMPS do?

- a) Converts AC mains into low DC voltages
- b) Stores data permanently when the PC is off
- c) Cools the processor and the graphics card
- d) Connects the PC to the internet and network

18. In standard ATX wiring, which wire colour carries +12 V?

- a) Red
- b) Yellow
- c) Orange
- d) Black

19. Which SMPS connector supplies dedicated power to the CPU?

- a) The SATA power connector on the drive cable
- b) The Molex 4-pin peripheral connector
- c) The front-panel header for the power button
- d) The 4+4 pin (8-pin) EPS connector near the socket

20. Why should a technician never open an SMPS?

- a) Its capacitors can stay charged and give a shock
- b) Opening it erases all the BIOS/UEFI settings
- c) Its fan stops working permanently once it has been opened
- d) It contains a battery that will start to leak

21. Which port carries digital video and audio to a TV or projector?

- a) VGA
- b) HDMI
- c) RJ-45
- d) PS/2

22. A PC with a separate graphics card shows "No signal" on the monitor. What should you check first?

- a) The keyboard and mouse are connected
- b) The cable is in the graphics card's port
- c) The speaker volume is turned up
- d) The printer driver is installed

23. What does a USB-C port tell you on its own?

- a) That it always runs at the fastest USB speed
- b) The shape of the connector, not its speed
- c) That it can only charge devices
- d) That it is limited to USB 2.0

24. What is ESD?

- a) A type of external solid state drive
- b) A Windows error code shown on a blue screen
- c) An energy-saving display setting
- d) A sudden discharge of static electricity

25. Where should an antistatic wrist strap be clipped?

- a) To the top of the CPU
- b) To a RAM module's gold contacts
- c) To unpainted metal on the computer case
- d) To the plastic front panel of the case

26. How much thermal paste is usually enough on a desktop CPU?

- a) The whole tube
- b) A thick layer over the motherboard
- c) A line around the edges of the CPU
- d) A pea-sized dot in the centre

27. A newly built PC does nothing when the power button is pressed. Which connection is a common cause?

- a) The HDMI cable going to the monitor
- b) The front-panel power switch cable
- c) The USB cable of the mouse
- d) The audio cable for the speakers

28. What does POST do?

- a) Sends error reports to Microsoft
- b) Installs pending Windows updates
- c) Defragments the hard disk at start-up
- d) Checks basic hardware at start-up

29. Which UEFI feature blocks unsigned boot software from loading?

- a) Fast Startup
- b) Dual Channel
- c) TRIM
- d) Secure Boot

30. You want to install Windows from a USB drive. What should you do?

- a) Select the USB drive in the boot menu
- b) Remove all the RAM modules first
- c) Disconnect the keyboard and mouse
- d) Put the empty hard disk first in the boot order

31. Which of these is a Windows 11 requirement published by Microsoft?

- a) 1 GB of RAM
- b) Legacy BIOS only
- c) TPM 2.0
- d) A DVD drive

32. In Device Manager, what does a yellow warning icon on a device mean?

- a) The device has a driver or hardware problem
- b) The device is working normally and is up to date
- c) The monitor cable has been disconnected
- d) The hard disk is almost full of files

33. A new graphics driver starts causing crashes. What is the quickest fix in Device Manager?

- a) Format the drive
- b) Replace the motherboard
- c) Roll Back Driver
- d) Disable Windows Update permanently

34. A PC's date and time reset every time it is switched on. What is the likely cause?

- a) A weak CMOS battery
- b) A faulty keyboard
- c) A full hard disk
- d) A loose monitor cable

35. Why should a household vacuum cleaner not be used inside a computer?

- a) It can build up static that may damage parts
- b) It is not powerful enough to lift dust
- c) It sucks the thermal paste off the CPU
- d) It pulls the labels and stickers off the components

Answers

1. **(d) Motherboard.** Every component plugs into the motherboard, which carries power and data between them.
2. **(c) It keeps the clock and settings when the PC is unplugged.** The small coin cell keeps the real-time clock and setup settings alive when there is no mains power.
3. **(a) Gigahertz (GHz).** Clock speed is the number of cycles per second, measured in gigahertz.
4. **(b) It fills tiny air gaps so heat flows into the heatsink.** Air is a poor conductor of heat; the paste fills microscopic gaps between the two metal surfaces.
5. **(b) The CPU support list for that motherboard.** The CPU must match the socket and be supported by the board's chipset and BIOS version.
6. **(c) Reseat the RAM and check the monitor cable and port.** Loose RAM and a monitor cable in the wrong port are common, quick-to-check causes of no display.
7. **(d) Its contents are lost when the power is switched off.** Volatile memory needs power to hold data, which is why work must be saved to a drive.
8. **(c) No, the notch is in a different place.** Each DDR generation is keyed differently to prevent installing it in an incompatible slot.
9. **(b) SO-DIMM.** SO-DIMMs are the shorter modules used in laptops and mini PCs; desktops use full-size DIMMs.
10. **(d) They can run in dual-channel mode for more bandwidth.** Dual-channel mode lets two modules work in parallel, increasing memory bandwidth.
11. **(a) Look up the pattern in the motherboard or BIOS maker's manual.** Beep codes report POST errors, and their meaning differs between firmware makers.
12. **(b) Possible mechanical failure; back up the data now.** Clicking or grinding often means the heads or motor are failing, and the drive may soon stop working.
13. **(c) A card shape and slot used by SATA or NVMe drives.** M.2 is a form factor; the drive inside may use the SATA or the NVMe interface.
14. **(c) It uses PCIe lanes instead of the slower SATA interface.** SATA III limits SATA SSDs to a little over 500 MB/s, while PCIe gives NVMe drives much more bandwidth.
15. **(c) Makers count in decimal units; Windows uses binary units.** 1 TB in decimal is 1,000,000,000,000 bytes, which Windows shows as about 931 GB in binary units.
16. **(a) No; Windows sends the TRIM command to SSDs instead.** Defragmenting gives an SSD no benefit and adds wear; the Optimize Drives tool uses TRIM for SSDs.
17. **(a) Converts AC mains into low DC voltages.** The power supply turns 230 V AC mains into the +12 V, +5 V and +3.3 V DC that parts use.
18. **(b) Yellow.** Yellow is +12 V, red is +5 V, orange is +3.3 V and black is ground.

19. **(d) The 4+4 pin (8-pin) EPS connector near the socket.** The 8-pin EPS connector feeds the CPU's power circuitry; without it, most boards will not start.
20. **(a) Its capacitors can stay charged and give a shock.** High-voltage capacitors inside can still give a serious shock after the unit is disconnected.
21. **(b) HDMI.** HDMI carries digital video and audio; VGA is analogue video only, and RJ-45 is for networking.
22. **(b) The cable is in the graphics card's port.** When a graphics card is fitted, the display output usually comes from the card, not the motherboard's video port.
23. **(b) The shape of the connector, not its speed.** USB-C is a connector type; the speed and features depend on the USB version and the device.
24. **(d) A sudden discharge of static electricity.** Electrostatic discharge from your body can damage chips even when you cannot feel it.
25. **(c) To unpainted metal on the computer case.** Clipping to bare metal on the case keeps you at the same potential as the computer.
26. **(d) A pea-sized dot in the centre.** A small dot spreads under the cooler's pressure; too much paste can spill over and insulate.
27. **(b) The front-panel power switch cable.** The case power button reaches the motherboard through the front-panel header, which is easy to misconnect or forget.
28. **(d) Checks basic hardware at start-up.** The Power-On Self-Test runs before the operating system loads and reports hardware problems.
29. **(d) Secure Boot.** Secure Boot only allows boot software signed by trusted keys, which helps block boot-level malware.
30. **(a) Select the USB drive in the boot menu.** The firmware must start from the USB drive for the Windows installer to run.
31. **(c) TPM 2.0.** Windows 11 requires TPM 2.0, UEFI firmware capable of Secure Boot, 4 GB RAM and 64 GB storage.
32. **(a) The device has a driver or hardware problem.** The yellow warning marks a device Windows cannot use properly, often because the driver is missing or faulty.
33. **(c) Roll Back Driver.** Roll Back Driver restores the previously installed driver version that was working.
34. **(a) A weak CMOS battery.** The CMOS battery keeps the clock running when the PC is unplugged; when it weakens, the time is lost.
35. **(a) It can build up static that may damage parts.** Vacuum nozzles can generate static; a blower or compressed air is the safer choice.

Glossary

BIOS and UEFI

Firmware on a motherboard chip that tests the hardware and starts the operating system; UEFI is the modern replacement for the older BIOS and adds GPT drive support and Secure Boot.

Boot order

The sequence of devices the firmware tries, one after another, when looking for an operating system to start.

Chipset

The chips on the motherboard that manage communication between the CPU and devices such as USB ports and SATA drives.

CMOS battery

A coin cell on the motherboard, commonly a CR2032, that keeps the clock and firmware settings when the PC is unplugged.

CPU

The Central Processing Unit, or processor, the chip that carries out the instructions of programs.

DDR

Double Data Rate SDRAM, the type of RAM in current PCs and laptops, made in generations such as DDR4 and DDR5 that do not fit each other's slots.

DIMM

Dual Inline Memory Module, the long memory module used in desktop computers; most upgradeable laptops and mini PCs use the shorter SO-DIMM instead.

Driver

Software that lets the operating system communicate with a particular piece of hardware, such as a graphics card, Wi-Fi adapter or printer.

ESD

Electrostatic discharge, a sudden flow of static electricity that can damage chips even when it is too small for you to feel.

Form factor

The standard size and layout of a part, such as ATX, Micro-ATX or Mini-ITX for motherboards and M.2 2280 for SSDs.

HDD

A hard disk drive, which stores data magnetically on spinning platters read by a head on a moving arm.

M.2

A small card-shaped form factor and slot used mainly for SSDs; an M.2 SSD is either a SATA drive or an NVMe drive, and the slot must support that type.

Motherboard

The main circuit board of a computer, which connects every component and carries power and data between them.

NVMe

Non-Volatile Memory Express, a way for SSDs to communicate over fast PCIe lanes, making them several times faster than SATA SSDs.

PCIe

PCI Express, the high-speed connection used by graphics cards, NVMe SSDs and other expansion cards, in slots of different widths such as x1 and x16.

POST

The Power-On Self-Test, the check the firmware runs at switch-on to confirm that the CPU, RAM and graphics are working before the operating system starts.

RAM

Random Access Memory, the fast working memory that holds open programs and files and loses its contents when the power goes off.

SATA

Serial ATA, the interface and cables used to connect hard disks, SATA SSDs and optical drives; SATA III is limited to 6 Gb/s.

Secure Boot

A UEFI feature that lets only boot software signed with a trusted key start, which blocks malicious boot programs.

SMPS

The Switched-Mode Power Supply, which converts AC mains electricity into the low DC voltages, such as +12 V, +5 V and +3.3 V, that computer parts use.

SSD

A solid state drive, which stores data in flash memory chips and has no moving parts, so it is faster and tougher than a hard disk.

Thermal paste

A paste spread thinly between the CPU and its cooler to fill tiny air gaps so that heat flows into the heatsink.

TPM

The Trusted Platform Module, a security chip or firmware feature that stores encryption keys safely; Windows 11 requires TPM version 2.0.

TRIM

A command the operating system, such as Windows, sends to an SSD to say which blocks of data are no longer in use, helping the drive manage its free space and stay fast.

UPS

An Uninterruptible Power Supply, a battery-backed unit that keeps a computer running for a short time during a power cut so work can be saved and the PC shut down safely.



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