

Exercise walk-through

3.1.3

Input and output devices, and buffers

A-Level Computer Science

You must be able to

- explain why a computer needs input devices and output devices
- describe the principal operation of a laser printer and of a 3D printer
- describe the principal operation of a microphone and of a speaker
- describe the principal operation of a resistive and of a capacitive touchscreen
- describe the principal operation of a virtual reality headset
- explain what a buffer is, and why it is used

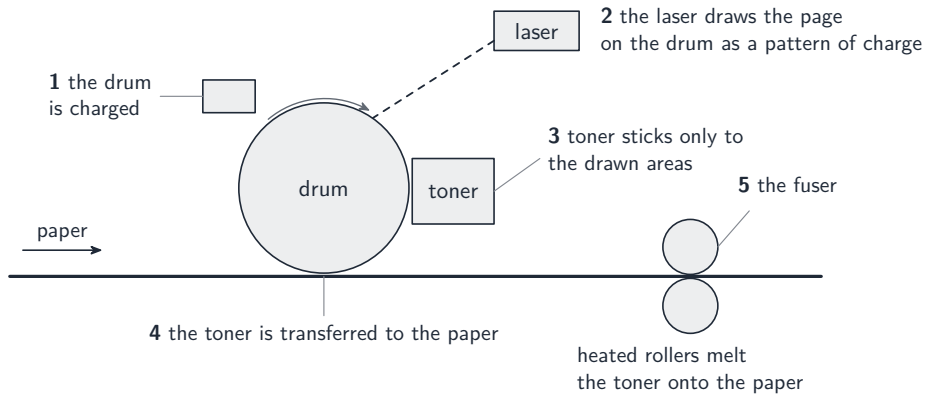
1

The method

Method — Laser printer

- 1 The rotating **drum** 感光鼓 is given an electrical **charge**.
- 2 A **laser** removes the charge at some points: the page is “drawn” as a pattern of charge.
- 3 Charged **toner** 墨粉 sticks only to the drawn areas.
- 4 The toner is **transferred** to the charged paper.
- 5 The **fuser** 定影器 (heated rollers) **melts** the toner onto the paper.
- 6 The charge is removed from the drum.

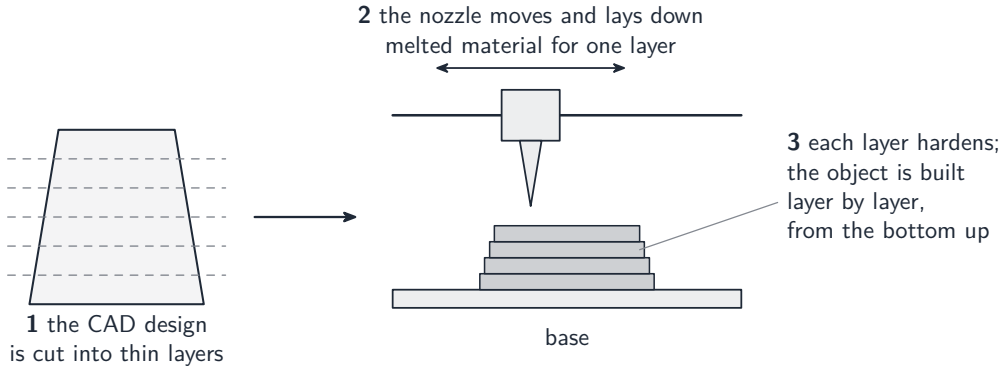
Method — Laser printer



Method — 3D printer

- 1 The object is designed with **CAD** software, and the design is cut into thin **layers**.
- 2 The **nozzle** 喷嘴 moves and lays down melted material for one layer.
- 3 The layer hardens, and the nozzle (or the base) moves by one layer's height.
- 4 The object is built **layer by layer**, from the bottom up: **additive manufacturing** 增材制造.

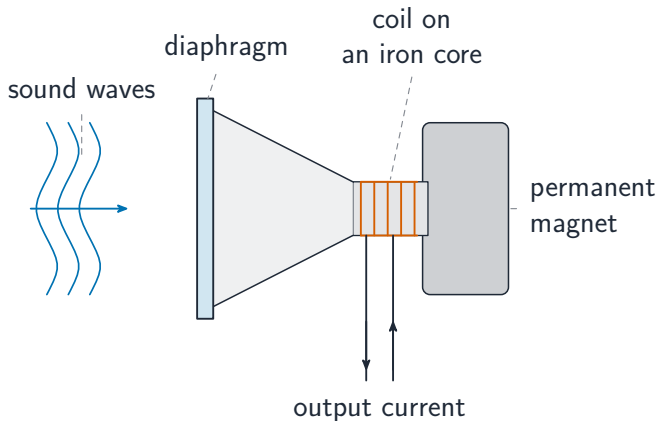
Method — 3D printer



Method — Microphone (input)

- 1 Sound waves make the **diaphragm** 膜片 vibrate.
- 2 The diaphragm moves a **coil** near a **magnet**, which produces a changing current.
- 3 The signal is **analogue**, so an **ADC** 模数转换器 changes it into binary.

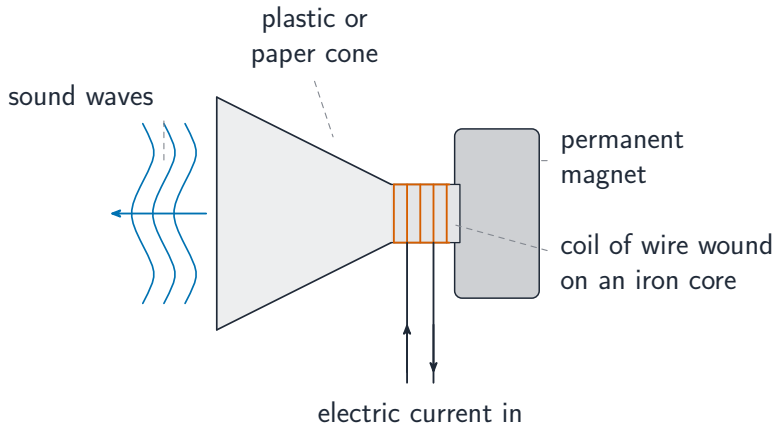
Method — Microphone (input)



Method — Speaker (output)

- 1 A **DAC** 数模转换器 changes the binary data into a changing current.
- 2 The current flows through a coil, which becomes an **electromagnet**.
- 3 The coil is pulled towards and pushed away from the magnet.
- 4 The coil moves the **cone**, and the vibrating cone makes sound waves.

Method — Speaker (output)



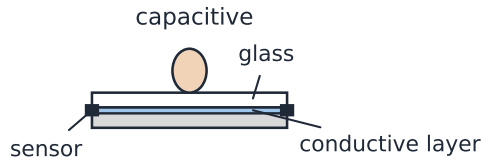
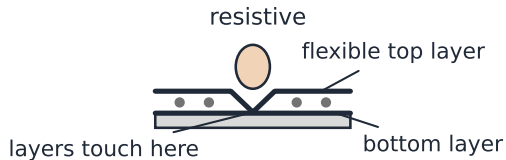
Method — Touchscreen

A touchscreen is an **input and output** device: it shows the image, and it finds the **position** of a touch. There are two types:

	resistive 电阻式	capacitive 电容式
layers	two conductive layers with a small gap	glass over a conductive layer that holds a charge
a touch	pressure pushes the layers together and completes a circuit	the finger takes a little charge, so the electric field changes
the position	calculated from the voltage at the point of contact	sensors at the corners measure the change
in use	works with a glove or a pen; cheaper	bare finger only; multi-touch; clearer

Method — Touchscreen

A touchscreen is an input and output device: it shows the image, and it finds the position of a touch.



Method — Virtual reality headset

- 1 Video is sent from the computer to the headset.
- 2 **Two** slightly different images, one for each eye, make the scene look **3D**; **lenses** focus them.
- 3 A **gyroscope** 陀螺仪 and an **accelerometer** 加速度计 detect the movement of the head.
- 4 The images are redrawn so that the view **follows the head**.

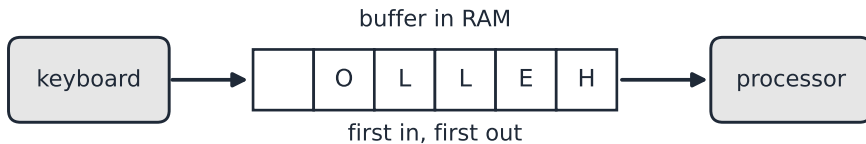
Method — Buffers

A **buffer** is a **temporary** storage area that holds data while it passes between two devices that work at **different speeds**. It is a **queue**: first in, first out.

- **Printer:** the computer sends the document quickly, then carries on with other work.
- **Keyboard:** key presses wait until the processor is ready, so none is lost.
- **Streaming video:** video is downloaded ahead, so it plays smoothly when the network slows down.

Method — Buffers

A buffer is a temporary storage area that holds data while it passes between two devices that work at...



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Practice

Practice 2.1 ■ 4 marks

State whether each device is an **input** device, an **output** device, or **both**.

Practice 2.1 (a)

microphone

Solution 2.1 (a)

Method: Touchscreen — p.12

Worked steps

sound goes **into** the computer → **input** **B1**

Practice 2.1 (b)

laser printer

Solution 2.1 (b)

Worked steps

the result comes **out** on paper → **output** B1

Practice 2.1 (c)

touchscreen

Solution 2.1 (c)

Worked steps

it shows the image and detects the touch → **both** B1

Practice 2.1 (d)

speaker

Solution 2.1 (d)

Worked steps

the result comes **out** as sound → **output** B1

Practice 2.2 ■ 5 marks

Name the device that contains each part.

Practice 2.2 (a)

a fuser

Solution 2.2 (a)

Method: 3D printer — p.6

Worked steps

the fuser melts toner → **laser printer** **B1**

Practice 2.2 (b)

a nozzle that lays down melted plastic

Solution 2.2 (b)

Worked steps

melted plastic from a nozzle → **3D printer** **B1**

Practice 2.2 (c)

a diaphragm that is moved by sound waves

Solution 2.2 (c)

Worked steps

a diaphragm moved by sound → **microphone** B1

Practice 2.2 (d)

two lenses, one in front of each eye

Solution 2.2 (d)

Worked steps

a lens for each eye → **virtual reality headset** B1

Practice 2.2 (e)

two conductive layers that are pushed together

Solution 2.2 (e)

Worked steps

two layers pushed together → **resistive touchscreen** B1

Practice 2.3 ■ 3 marks

The steps below describe how a laser printer prints a page. They are in the wrong order.

Write the letters in the correct order.

A The toner is transferred from the drum to the paper.

B The laser removes the charge from parts of the drum.

C The fuser melts the toner onto the paper.

D The drum is given an electrical charge.

E Toner sticks to the drawn areas of the drum.

Solution 2.3

- A The toner is transferred from the drum to the paper.
- B The laser removes the charge from parts of the drum.
- C The fuser melts the toner onto the paper.
- D The drum is given an electrical charge.
- E Toner sticks to the drawn areas of the drum.

Worked steps

- the drum is charged first, and the laser then draws on it: D, B **B1**
- toner sticks, then moves to the paper: E, A **B1**
- the fuser comes last: D, B, E, A, C **B1**

Practice 2.4 ■ 4 marks

Complete the sentences about sound devices.

A microphone produces an signal, so an is needed to change it into binary.

A speaker needs an analogue signal, so a changes the binary sound data into a changing

Solution 2.4

Method: Microphone (input) — p.8

Worked steps

- a microphone's signal changes continuously → **analogue**; the converter into binary is an **ADC** (analogue-to-digital converter) **B1** **B1**
- for the speaker the conversion goes the other way → a **DAC** (digital-to-analogue converter) produces a changing **current** (or voltage) **B1** **B1**

Practice 2.5 ■ 2 marks

State **two** differences between a resistive touchscreen and a capacitive touchscreen.

Solution 2.5

Method: Touchscreen — p.12

Worked steps

any **two** of:

- resistive detects **pressure** pushing two layers together; capacitive detects a **change in the electric field** when a finger touches the glass **B1**
- resistive works with a glove or any pen; capacitive needs a bare finger (or a special pen) **B1**
- capacitive allows multi-touch; resistive does not **B1**
- resistive is cheaper; capacitive gives a clearer image **B1**

Practice 2.6 ■ 2 marks

State what is meant by a **buffer**.

Solution 2.6

Worked steps

- a **temporary** storage area B1
- that holds data while it passes between two devices (or processes) that work at **different speeds** B1

3

Exam-style

Exam-style 3.1 ■ 8 marks

An office uses a laser printer.

Exam-style 3.1 (a) ■ 5 marks

Describe the principal operation of a laser printer.

Solution 3.1 (a)

Worked steps

any **five** of:

- the rotating drum is given an electrical charge **B1**
- a laser beam scans across the drum and removes the charge at some points, drawing the page as a pattern of charge **B1**
- the drum is coated with charged toner, which sticks only to the drawn areas **B1**
- the (charged) paper rolls against the drum, and the toner is transferred to the paper **B1**
- the paper passes through the fuser, where heated rollers melt the toner onto it **B1**
- the charge is removed from the drum before the next page **B1**

Exam-style 3.1 (b) ■ 3 marks

Ten workers send documents to the printer at the same time.
Explain how a buffer is used when the documents are printed.

Solution 3.1 (b)

Worked steps

the computers send data much faster than the printer can print it **B1**

- each document is stored in the buffer, in the order in which it arrives, and the printer takes the data from the buffer when it is ready **B1**
- so each computer can carry on with other work without waiting, and no document is lost **B1**

Exam-style 3.2 ■ 4 marks

An engineer designs a new door handle and makes a test copy of it with a 3D printer.

Describe how the 3D printer produces the handle from the engineer's design.

Solution 3.2

Method: 3D printer — p.6

Worked steps

any **four** of:

- the design is made with CAD software (B1)
- the design is cut into many thin horizontal layers (B1)
- the nozzle moves over the base and lays down melted material in the shape of one layer (B1)
- the layer cools and hardens, and the nozzle (or the base) moves by one layer's height (B1)
- the handle is built layer by layer, from the bottom up (additive manufacturing) (B1)

Exam-style 3.3 ■ 7 marks

A student records a podcast with a microphone and listens to it through speakers.

Exam-style 3.3 (a) ■ 3 marks

Describe the principal operation of the microphone.

Solution 3.3 (a)

Method: Speaker (output) — p.10

Worked steps

sound waves make the diaphragm vibrate (B1)

- the diaphragm moves a coil near a permanent magnet, which produces a changing electrical current (B1)
- this analogue signal is changed into binary by an ADC (B1)

Exam-style 3.3 (b) ■ 4 marks

Describe how the speaker produces sound from the stored binary data.

Solution 3.3 (b)

Worked steps

any **four** of:

- a DAC changes the binary data into a changing (analogue) current, and an amplifier makes it stronger **B1**
- the current flows through a coil, which becomes an electromagnet **B1**
- as the current changes, the coil is pulled towards and pushed away from the permanent magnet **B1**
- the coil moves the cone, so the cone vibrates **B1**
- the vibrating cone produces sound waves **B1**

Exam-style 3.4 ■ 5 marks

A ticket machine at a railway station is used outdoors, in winter, by passengers wearing gloves.

Exam-style 3.4 (a) ■ 2 marks

State the most suitable type of touchscreen for the machine.
Justify your choice.

Solution 3.4 (a)

Method: Touchscreen — p.12

Worked steps

resistive B1

- it detects pressure, so it works when the passenger is wearing gloves; a capacitive screen needs a bare finger B1

Exam-style 3.4 (b) ■ 3 marks

Describe how this type of touchscreen finds the position of a touch.

Solution 3.4 (b)

Worked steps

the screen has two conductive layers with a small gap between them **B1**

- pressure pushes the top layer onto the bottom layer, which completes a circuit at that point **B1**
- the microprocessor calculates the coordinates of the touch from the voltage at the point of contact **B1**

Exam-style 3.5 ■ 7 marks

A museum lets visitors walk through an ancient city using a virtual reality headset.

Exam-style 3.5 (a) ■ 2 marks

Describe how the headset makes the city look three-dimensional.

Solution 3.5 (a)

Method: Virtual reality headset — p.14

Worked steps

a slightly different image is shown to each eye, on two screens or one split screen

B1

- lenses focus the images, and the brain joins the two images into one 3D view

B1

Exam-style 3.5 (b) ■ 3 marks

Describe how the view changes when the visitor turns their head.

Solution 3.5 (b)

Worked steps

sensors such as a gyroscope and an accelerometer detect the movement of the head

B1

- the sensor data is sent to the processor, which works out the new direction of view B1
- the images are redrawn at once, so the view of the city moves with the head

B1

Exam-style 3.5 (c) ■ 2 marks

The headset plays video that is streamed over a network. **Explain** why the video is buffered.

Solution 3.5 (c)

Worked steps

the speed of the network changes, but the video must play at a steady rate **B1**

- the buffer holds video that has been downloaded ahead of time, so the video keeps playing when the network slows down **B1**