

3.1.3 Input and output devices, and buffers

Name: _____ Class: _____ Date: _____

Total: 51 marks

KEY WORDS laser printer 激光打印机 • toner 墨粉 • diaphragm 膜片 • touchscreen 触摸屏
• buffer 缓冲区

Objective

Learn to answer exam questions that ask you to **describe the principal operation** of an input or output device: a **laser printer** 激光打印机, a **3D printer**, a **microphone** 麦克风, **speakers** 扬声器, a **touchscreen** 触摸屏 and a **virtual reality (VR) headset** 虚拟现实头戴设备. You also learn why devices use a **buffer** 缓冲区. Storage devices were on sheet 3.1.2; sensors and control systems come on sheet 3.1.4.

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 Worked examples

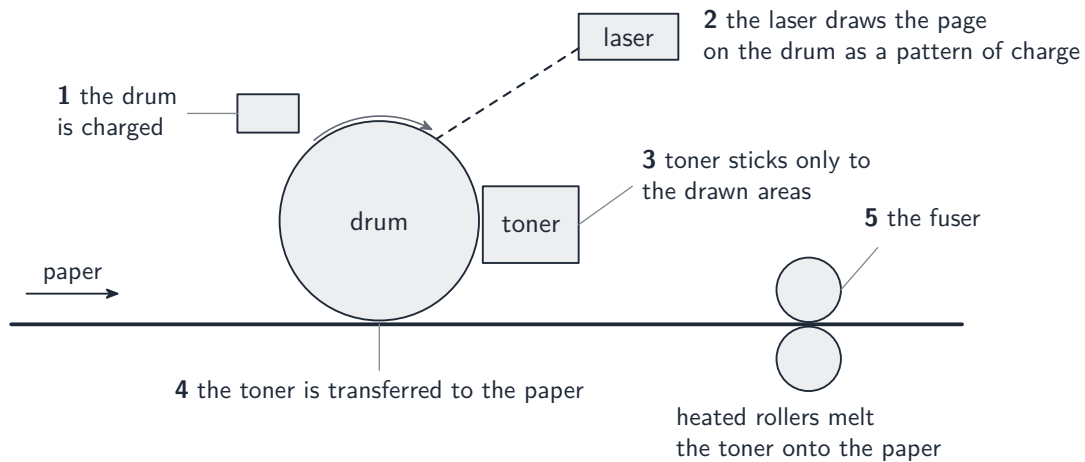
Study these first. Each one shows a **method** that a question later on this sheet needs.

- **Input device:** turns something from outside (a key press, a sound, a touch) into data.
- **Output device:** turns data into something a person can see, hear or hold.
- “**Describe the principal operation**” = the **parts**, **what happens** step by step, the **result**: one mark for each point.

■ Laser printer

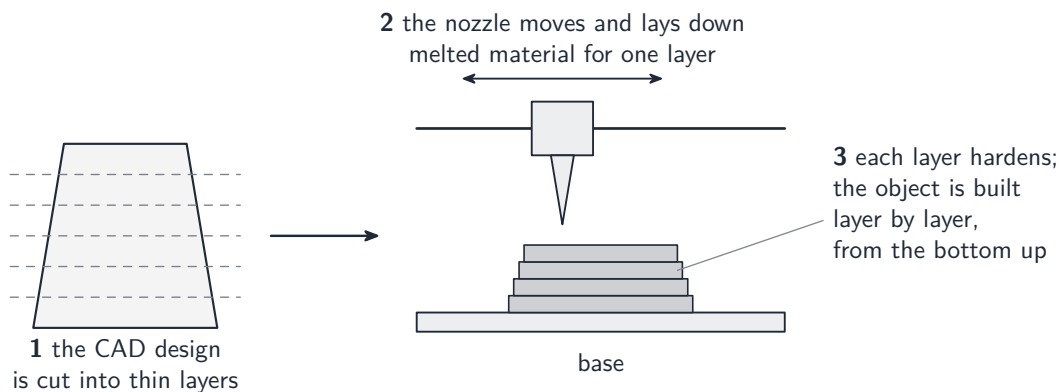
1. The rotating **drum** 感光鼓 is given an electrical **charge**.
2. A **laser** removes the charge at some points: the page is “drawn” as a pattern of charge.
3. Charged **toner** 墨粉 sticks only to the drawn areas.
4. The toner is **transferred** to the charged paper.

5. The **fuser** 定影器 (heated rollers) **melts** the toner onto the paper.
6. The charge is removed from the drum.



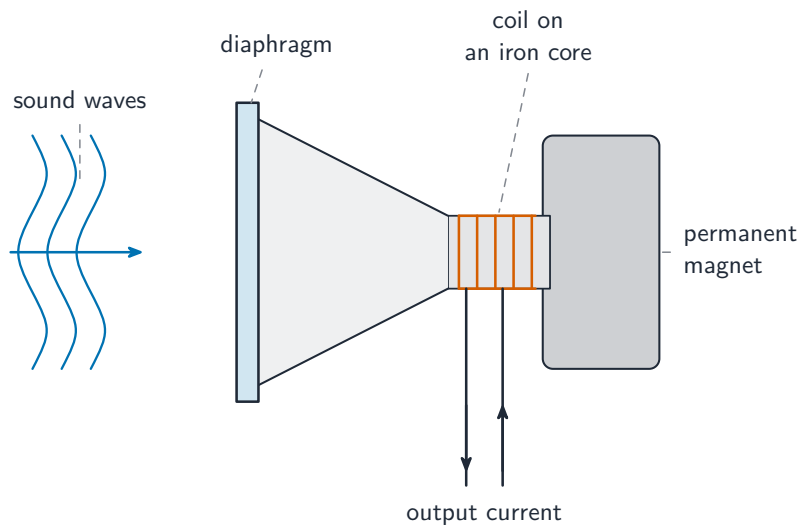
■ 3D printer

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.



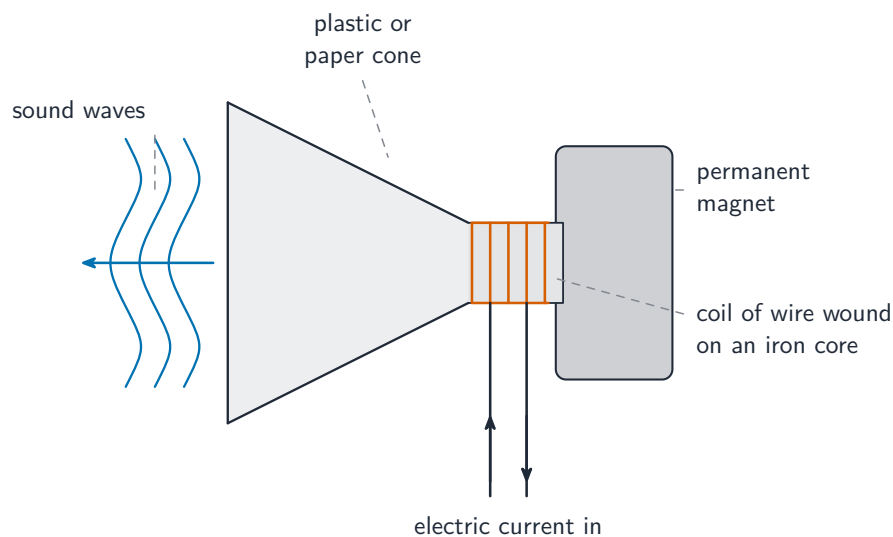
■ Microphone (input)

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.



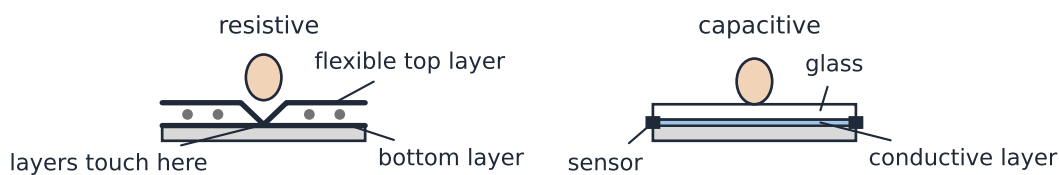
■ Speaker (output)

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.



■ 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:



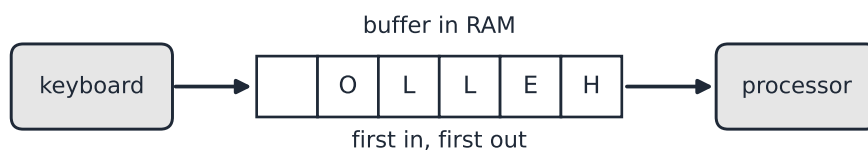
	resistive 电阻式	capacitive 电容式
layers	two conductive layers with a small gap	glass over a conductive layer that holds a charge
a touch	pressure pushes the layers together and completes a circuit	the finger takes a little charge, so the electric field changes
the position	calculated from the voltage at 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

■ 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**.

■ 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.

2 Practice

Now use the methods above. The first questions need one idea each.

2.1 State whether each device is an **input** device, an **output** device, or **both**. [4]

- (a) microphone
- (b) laser printer
- (c) touchscreen
- (d) speaker

2.2 Name the device that contains each part. [5]

- (a) a fuser
- (b) a nozzle that lays down melted plastic
- (c) a diaphragm that is moved by sound waves
- (d) two lenses, one in front of each eye
- (e) two conductive layers that are pushed together

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

Write the letters in the correct order. [3]

2.4 Complete the sentences about sound devices. [4]

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

2.5 State **two** differences between a resistive touchscreen and a capacitive touchscreen.[2]

2.6 State what is meant by a **buffer**. [2]

3 Exam-style questions

3.1 An office uses a laser printer.

(a) **Describe** the principal operation of a laser printer. [5]

(b) Ten workers send documents to the printer at the same time. **Explain** how a buffer is used when the documents are printed. [3]

3.2 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. [4]

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

(a) **Describe** the principal operation of the microphone. [3]

(b) **Describe** how the speaker produces sound from the stored binary data. [4]

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

(a) **State** the most suitable type of touchscreen for the machine. **Justify** your choice. [2]

(b) **Describe** how this type of touchscreen finds the position of a touch. [3]

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

(a) **Describe** how the headset makes the city look three-dimensional. [2]

(b) **Describe** how the view changes when the visitor turns their head. [3]

(c) The headset plays video that is streamed over a network. **Explain** why the video is buffered. [2]

Solutions

Each answer shows the steps, then the **result**.

2.1

- (a) sound goes **into** the computer → **input**
- (b) the result comes **out** on paper → **output**
- (c) it shows the image and detects the touch → **both**
- (d) the result comes **out** as sound → **output**

2.2

- (a) the fuser melts toner → **laser printer**
- (b) melted plastic from a nozzle → **3D printer**
- (c) a diaphragm moved by sound → **microphone**
- (d) a lens for each eye → **virtual reality headset**
- (e) two layers pushed together → **resistive touchscreen**

2.3

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

2.4

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

2.5 any two of:

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

2.6

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

3.1

- (a) any **five** of:

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

(b) the computers send data much faster than the printer can print it

- 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
- so each computer can carry on with other work without waiting, and no document is lost

3.2 any **four** of:

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

3.3

(a) sound waves make the diaphragm vibrate

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

(b) any **four** of:

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

3.4

(a) **resistive**

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

(b) the screen has two conductive layers with a small gap between them

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

3.5

- (a) a slightly different image is shown to each eye, on two screens or one split screen
 - lenses focus the images, and the brain joins the two images into one 3D view
- (b) sensors such as a gyroscope and an accelerometer detect the movement of the head
 - the sensor data is sent to the processor, which works out the new direction of view
 - the images are redrawn at once, so the view of the city moves with the head
- (c) the speed of the network changes, but the video must play at a steady rate
 - the buffer holds video that has been downloaded ahead of time, so the video keeps playing when the network slows down