Week 7

IGCSE Computer Science

Homework bundle for this week

本周作业合集

exercises.lol

Contents 目录

IGCSE Computer Science Name: _____ Score: _____

1. The ALU in a CPU:
   - ☐ performs calculations and logical comparisons
   - ☐ sends control signals to other parts
   - ☐ stores the running programs
   - ☐ connects to the internet
2. Which is an input device?
   - ☐ a barcode scanner
   - ☐ a projector
   - ☐ a speaker
   - ☐ a laser printer
3. RAM is volatile (it loses its data without power) and holds the running programs, while ROM is non-volatile and holds the start-up (boot) instructions.

   ☐ True ☐ False
4. Which is true of a MAC address compared with an IP address?
   - ☐ the MAC is fixed to the physical device; the IP is given by the network and can change
   - ☐ the MAC changes on every network
   - ☐ the IP never changes
   - ☐ they are the same thing
5. Which change would improve CPU performance?
   - ☐ increasing the clock speed or the number of cores
   - ☐ using a smaller cache
   - ☐ lowering the clock speed
   - ☐ removing a core
6. A capacitive touch screen works by:
   - ☐ sensing the electric charge of your finger
   - ☐ pressing two layers together
   - ☐ breaking a grid of light beams
   - ☐ reading a barcode

7. A MAC address is normally written in hexadecimal.

   ☐ True ☐ False

8. Cache is small, very fast memory near the CPU that holds often-used data, so the CPU waits less than it would reading from main memory.

   ☐ True ☐ False

9. A laser printer fuses toner powder onto paper with heat, an inkjet sprays tiny drops of ink, and a 3D printer builds an object up in layers.

   ☐ True ☐ False

10. A device's IP address can change depending on the network it is using.

    ☐ True ☐ False

3. Hardware

Answers · 答案

IGCSE Computer Science

1. **performs calculations and logical comparisons**

   The arithmetic logic unit does the maths and logic; the control unit manages the parts.

2. **a barcode scanner**

   A scanner brings data in. Projectors, speakers and printers are output devices.

3. **True**

   Volatile vs non-volatile is the key split: RAM forgets when powered off, ROM remembers.

4. **the MAC is fixed to the physical device; the IP is given by the network and can change**

   The MAC stays with the device (set by the maker, written in hex); the IP depends on the network and can change.

5. **increasing the clock speed or the number of cores**

   More cores, a larger cache and a higher clock speed all improve performance.

6. **sensing the electric charge of your finger**

   Capacitive screens detect the finger's charge (multi-touch, used in phones); resistive presses layers; infrared breaks beams.

7. **True**

   MAC addresses are written in hexadecimal (e.g. AC:DE:48:00:11:22).

8. **True**

   A bigger cache, more cores and a higher clock speed all raise performance — cache helps by cutting the wait for data.

9. **True**

   Three different output technologies: laser (toner + heat), inkjet (sprayed ink), 3D (layer-by-layer).

10. **True**

    IP addresses are assigned by the network, so the same device can have different IPs on different networks.

IGCSE COMPUTER SCIENCE • EXERCISE SHEET

3.1 Computer architecture

Name: _____ Class: _____ Date: _____ **Total: 28 marks**

KEY WORDS clock speed 时钟速度 • instructions 指令 • embedded system 嵌入式系统 • current instruction register 当前指令寄存器 • cache 高速缓存

Objective

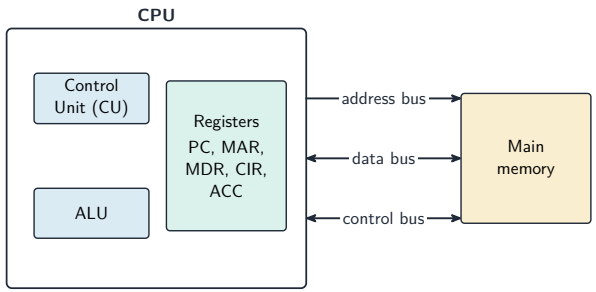
Build the skills to answer exam questions on **computer architecture** 计算机体系结构 — the CPU parts, the **fetch–execute cycle** 取指执行周期, **cache** 高速缓存, and CPU performance.

You must be able to:

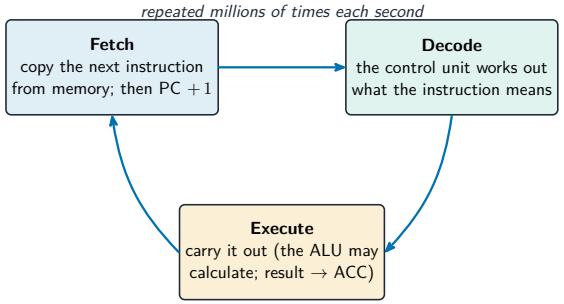
- name the CPU parts (ALU, CU, registers) and the buses
- describe the fetch–decode–execute cycle
- explain what affects CPU performance and what an embedded system is

1 Worked examples

The CPU and the cycle



The CPU holds the CU, ALU and registers; the address, data and control buses link it to memory



The CPU repeats: fetch the instruction, decode it, then execute it

- performance ↑ with more **cores**, a larger **cache**, and a higher **clock speed**.

Naming the parts, and describing the cycle in order

The CPU parts and what each one does. The **control unit (CU)** 控制单元 decodes instructions and sends control signals; the **arithmetic logic unit (ALU)** 算术逻辑单元 does the calculations and logic; **registers** 寄存器 hold data during processing. The named registers you must know:

Register	What it holds
program counter (PC)	the address of the **next** instruction
memory address register (MAR)	the address currently being read from or written to
memory data register (MDR)	the data or instruction just fetched, or about to be written
current instruction register (CIR)	the instruction being decoded and executed
accumulator (ACC)	the result of the ALU's work

The three buses: the **address bus** 地址总线 carries addresses (one direction only, CPU to memory); the **data bus** 数据总线 carries data and instructions (both directions); the **control bus** 控制总线 carries control signals such as read and write (both directions).

The fetch-decode-execute cycle, in the order the marks are awarded:

1. The address in the **PC** is copied to the **MAR**.
2. The PC is **incremented** by one.
3. The instruction at that address is fetched along the **data bus** into the **MDR**.
4. The instruction is copied from the MDR to the **CIR**.
5. The CU **decodes** the instruction.
6. The instruction is **executed**, and any result is stored in the **ACC**.

Performance. More **cores** let the CPU work on more instructions at once; a larger **cache** 高速缓存 keeps frequently used instructions closer to the CPU, so fewer slow fetches from RAM are needed; a higher **clock speed** 时钟速度 means more cycles each second. An **embedded system** 嵌入式系统 is a computer built into a larger device to do one dedicated job, such as the controller in a washing machine or a set of traffic lights.

2 Practice

2.1 State the function of the ALU. [1]

2.2 Name the three stages of the fetch–execute cycle. [3]

2.3 Name the register that holds the address of the next instruction. [1]

2.4 Identify the bus that carries data in both directions, and the bus that carries addresses in one direction only. [2]

2.5 Explain how a larger cache improves the performance of a computer. [2]

3 Exam-style questions

3.1 Cache memory speeds up the CPU because it: [1]

- **A** stores data permanently
- **B** is very fast memory holding frequently used data
- **C** has no power needs
- **D** is part of secondary storage

3.2 A computer is upgraded.

(a) State two changes that would improve CPU performance. [2]

(b) State what is meant by an embedded system, with one example. [2]

3.3 A computer has a Von Neumann architecture with a single processor.

(a) Complete the table by giving the full name of each register and what it stores. [4]

Abbreviation	Full name	What it stores
PC		
MAR		
MDR		
ACC		

(b) Describe the fetch stage of the fetch–execute cycle, using the register names from part (a). [4]

(c) Identify the bus that would be used to send a “write” signal to memory, and explain why this bus is bidirectional. [2]

(d) The computer is upgraded from two cores to four. Explain why this does not always make a program run twice as fast. [2]

(e) Give one example of an embedded system and describe what makes it different from a general-purpose computer. [2]

Solutions

2.1 it carries out calculations and logical operations.

2.2 fetch; decode; execute.

2.3 The program counter (PC).

2.4 Data bus, both directions; address bus, one direction only, from CPU to memory.

2.5 Cache is very fast memory that holds frequently used instructions and data close to the CPU; the CPU then makes fewer slow fetches from RAM, so it spends less time waiting.

3.1 B. Cache is fast memory holding frequently used data.

3.2 (a) any two of: more cores; larger cache; higher clock speed.
(b) a small computer built into a device to do one fixed job; e.g. a washing machine or microwave.

3.3 (a) PC: program counter, holds the address of the next instruction. MAR: memory address register, holds the address being read from or written to. MDR: memory data register, holds the data or instruction fetched from that address. ACC: accumulator, holds the result of a calculation.
(b) The address in the PC is copied to the MAR; the PC is incremented; the instruction at that address is fetched into the MDR along the data bus; it is copied from the MDR into the CIR ready for decoding.
(c) The control bus; it must carry signals both ways, because the CPU sends commands such as read and write while devices send back signals such as an interrupt request.
(d) Not all programs can be split into parts that run at the same time, and cores must still share memory and wait for each other, so the extra cores are not always fully used.
(e) Any one of: a washing machine controller, traffic lights, a microwave, a car engine management unit. It is built into a larger device and runs one dedicated program that the user cannot change, rather than running many different applications.

6 A computer with a Von Neumann architecture has a central processing unit (CPU).

(a) Complete the statements about the operation of the CPU.

Use the terms from the list. **Not** all terms will need to be used. You should only use each term once.

accumulator arithmetic logic unit character set

control unit current instruction register cipher decoding set

instruction counter instruction set memory address register

memory data register memory instruction register next instruction register

program counter program register

The ..... stores the address of the next instruction to be fetched. This address is then sent to the ..... . This address is the location in RAM where the instruction can be found. The instruction is retrieved from RAM and immediately stored in the ..... . The instruction is then sent to the ..... where it is decoded by the ..... . The instruction is decoded using an ..... .

[6]

(b) Handling interrupts is one function of an operating system.

(i) An interrupt is sent to the CPU every time a key is pressed on the keyboard.

Give the name of this type of interrupt.

..... [1]

(ii) Give the name of the program that services the interrupt.

..... [1]

(iii) Give **one** other function of an operating system.

..... [1]

4 A computer with a Von Neumann architecture has a central processing unit (CPU) that performs the fetch–decode–execute (FDE) cycle.

(a) Complete and annotate the diagram to show how instructions are decoded and executed.

[5]

(b) The CPU is dual core and has a processor speed of 2.4 GHz.

Describe what is meant by a core.

.....

.....

.....

..... [2]

(c) Explain **two** ways that the performance of the CPU could be increased.

.....

.....

.....

.....

.....

.....

.....

[4]

5 A central processing unit (CPU) performs the fetch–decode–execute (FDE) cycle.

(a) Give the name of **two** registers that are used in the fetch stage of the cycle.

1 .....

2 .....
[2]

(b) Describe what happens at the decode stage of the cycle.

.....

.....

.....

.....

.....

..... [3]

(c) Give **one** register in the CPU that is used in the execute stage of the cycle.

..... [1]

(d) Buses are used in the CPU to transmit data through the FDE cycle.

Circle **three** buses that are used in the CPU.

fetch address register execute

data decode calculation

central value binary control
[3]

(e) A user changes their CPU from one with a dual core and a clock speed of 2.4 GHz to one with a dual core and a clock speed of 3.5 GHz.

Explain the effect this change will have on the performance of the CPU.

.....

.....

.....

.... [2]

6 A computer programmer uses assembly language to create a computer program for an embedded system in a washing machine.

(a) State what is meant by an embedded system.

.....

..... [1]

(b) Give the name of the translator that will be used for the program.

..... [1]

(c) The washing machine needs to display error codes on a small screen if there is a problem with the washing machine.

The error codes are stored as binary. The binary numbers are too long to be displayed on the washing machine.

State how the error codes could be reduced in length to be displayed on the screen.

..... [1]

(d) Give **one** benefit to the programmer of using assembly language to write the program.

.....

..... [1]

(e) The programmer uses an integrated development environment (IDE) to write the program.

A built-in translator to convert the program into machine code is one way that the IDE helps the computer programmer.

Describe **three** other ways the IDE can help the programmer.

.....

.....

.....

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.....

.....

..... [6]

6 The table contains names and descriptions of components in a central processing unit (CPU).

Complete the table by giving the missing component names and descriptions.

Component name	Description
.....	sends signals to manage the flow of data through the CPU
program counter	....
.....	stores the address of the data that is about to be fetched from random access memory (RAM) into the CPU
.....	transmits data between the RAM and the CPU
accumulator	....
.....	stores an instruction when it is being decoded

[6]

3 An instruction is fetched from random access memory (RAM) into the memory data register (MDR) to be decoded.

(a) Identify **two** other registers that are used in the fetch stage of the cycle.

1 .....

2 .....

[2]

(b) Complete and annotate the diagram to show how the data is decoded once it has been fetched into the MDR.

[4]

5 Instructions are processed by a central processing unit (CPU) in a computer.

(a) Complete the paragraph about fetching an instruction into the CPU to be processed.

Use the terms from the list.

Some of the terms in the list will **not** be used. You should only use a term once.

address arithmetic logic unit (ALU) binary control unit (CU)

current instruction register (CIR) data denary driver

fetch interrupt memory address register (MAR)

memory data register (MDR) random access memory (RAM)

read only memory (ROM) secondary storage signal

The program counter contains the ……

of the next instruction to be processed; this is then sent to the

…… using the address bus. The address is then

sent to the …… .

Once the address is received, the instruction stored at the location is

sent to the ……, using the

…… bus. The instruction is then

sent to the …… that is built into the

…… .

[7]

(b) The CPU uses an instruction set to decode the instruction.

State what is meant by an instruction set.

.....

..... [1]

8 A student has a computer that has a central processing unit (CPU).

(a) Describe the role of the CPU in the computer.

.....

.....

.....

..... [2]

(b) The CPU contains registers.

(i) State the purpose of a register.

.....

..... [1]

(ii) Give **three** registers that are built into the CPU.

1 .....

2 .....

3 .....

[3]

(c) One component in the CPU is the arithmetic logic unit (ALU).

Describe the purpose of the ALU.

.....

.....

.....

.....

.....

..... [3]

(d) The student wants to replace the CPU to increase the performance of the computer.

Explain why a different CPU can increase the performance.

.....

.....

.....

.....

.....

.....

..... [4]

2 A computer has a central processing unit (CPU).

The CPU includes the registers:
- Program counter (PC)
- Memory address register (MAR)
- Memory data register (MDR)
- Accumulator (ACC)
- Current instruction register (CIR).

(a) The table contains **five** statements about the role of registers in the fetch–decode–execute cycle of a CPU.

Letter	Statement
A	PC stores the address of the next instruction to be accessed
B	MAR stores the instructions of the program that is running
C	MDR stores the data passed to it from the PC
D	ACC stores the result of each calculation
E	CIR stores the instruction currently being executed

Two of the statements are **not** correct.

Identify the letter of each incorrect statement.

Suggest a corrected statement for each.

Incorrect statement 1 .....

Corrected statement .....

.....

.....

Incorrect statement 2 .....

Corrected statement .....

.....

.....

[4]

(b) The computer has a single core 3.5 GHz processor and an 8 kB cache.

(i) State what is meant by a 3.5 GHz processor.

.....

.... [1]

(ii) The CPU is changed to a dual-core 3.5 GHz processor.

Explain how the number of cores affects the performance of a CPU.

.....

.....

.....

..... [2]

(iii) The amount of cache is increased to 64 kB.

Explain how the amount of cache affects the performance of a computer.

.....

.....

.....

..... [2]

(c) The computer has both primary and secondary storage.

(i) Random access memory (RAM) is one example of primary storage.

Describe what is meant by RAM.

.....

.....

.....

..... [2]

(ii) Read only memory (ROM) is another example of primary storage. ROM often stores the start-up instructions for a computer.

Identify **one** other item of data that is commonly stored in ROM.

.....

..... [1]

(iii) Some computers make use of virtual memory.

State the purpose of virtual memory.

.....

..... [1]

1 A student uses a computer and several hardware devices to complete his schoolwork.

The computer has a central processing unit (CPU).

(a) The student uses a keyboard to complete his schoolwork.

Tick (✓) **one** box to show which type of device the keyboard is.

A input ☐

B memory ☐

C output ☐

D storage ☐

[1]

(b) The student uses a printer to print his schoolwork.

Tick (✓) **one** box to show which type of device the printer is.

A input ☐

B memory ☐

C output ☐

D storage ☐

[1]

(c) A component in the CPU sends signals to manage the fetch-decode-execute cycle.

State the name of this component.

..... [1]

(d) The CPU has a clock speed of 2.4 Ghz.

Describe what is meant by a 2.4 Ghz clock speed.

.....

.....

.....

..... [2]

(e) The CPU contains registers including the memory data register (MDR).

(i) Describe the role of the MDR in the fetch-decode-execute cycle.

.....

.....

.....

..... [2]

(ii) Identify **three** other registers contained in the CPU.

1 .....

2 .....

3 .....

[3]

3 A user's computer has a central processing unit (CPU) that has a clock speed of 2 GHz.

She wants to change it to a CPU that has a clock speed of 3 GHz.

(a) (i) State what is meant by clock speed.

.....

..... [1]

(ii) Explain the effect this change will have on the performance of the CPU.

.....

.....

.....

..... [2]

(b) The CPU contains a memory address register (MAR).

Describe the role of the MAR in the fetch–decode–execute cycle.

.....

.....

.....

..... [2]

(c) The CPU has a list of all the machine code commands it can process.

State the name of this list of commands.

..... [1]

4 A washing machine is an example of an embedded system.

(a) Give **two** characteristics of an embedded system.

1 .....

.....

2 .....

.....
[2]

(b) Circle **three** other examples of an embedded system.

freezer laptop

personal computer (PC) security light system smartphone

vending machine web server

[3]

IGCSE COMPUTER SCIENCE • EXERCISE SHEET

3.2 Input and output devices

Name: _____ Class: _____ Date: _____ **Total: 27 marks**

KEY WORDS input and output devices 输入输出设备 • barcode scanner 条形码扫描器 • speaker 扬声器 • touch screen 触摸屏 • actuator 执行器

Objective

Build the skills to answer exam questions on **input and output devices** 输入输出设备 — how common devices work and choosing a suitable device.

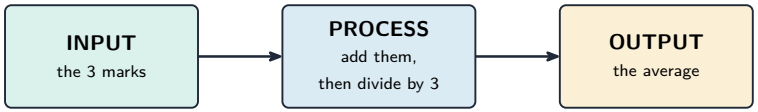
You must be able to:

- describe how input devices (scanner, sensor, touch screen) work
- describe how output devices (printers, actuator, speaker) work
- choose a suitable device for a task

1 Worked examples

■ Input and output

Input sends data in; output sends data out to the user



Input devices feed the processor, which drives output devices

- **input:** barcode scanner (reads reflected light), sensor (measures a quantity), touch screen.
- **output:** inkjet/laser/3D printer, monitor, speaker, **actuator** (signal → movement).

■ The stages, and where the addresses come from

A packet 数据包 has three parts: a **header** (the sender's and receiver's IP addresses, the packet number, and how many packets there are), the **payload** (the piece of the data), and a **trailer** (a way to tell the packet has ended, and an error-checking value such as a checksum).

Packet switching 分组交换, in the order the marks are given:

1. The data is split into equal-sized packets and each is numbered.
2. Each packet is sent separately and routers choose the route for each one, using the shortest or least congested path available at that moment.
3. Packets may take different routes and arrive out of order.
4. At the destination they are reassembled into the original order using the packet numbers.
5. Any packet that does not arrive is requested again.

Why it is used: there is no need to reserve a whole line for the transfer; if one route is busy or broken, packets take another; and many transfers share the same network. The drawback is that packets can be delayed or lost, which matters for real-time video or voice, and reassembly takes time.

Worked example. A 2 MB file is split into 2 KB packets. How many packets are needed, and what happens if packet 47 does not arrive? 2 MB = 2048 KB, so $2048 \div 2 = 1024$ packets. If packet 47 is missing, the receiver notices the gap in the numbering and asks the sender to transmit that packet again; the rest of the file does not need resending.

2 Practice

2.1 State whether a sensor is an input or an output device. [1]

2.2 State what an actuator does. [1]

2.3 Identify the three parts of a packet. [3]

2.4 Identify two pieces of information stored in a packet header. [2]

2.5 Explain why packets may arrive out of order. [2]

3 Exam-style questions

3.1 Which is an output device? [1]

- **A** keyboard
- **B** microphone
- **C** speaker
- **D** barcode scanner

3.2 A supermarket uses a barcode scanner at the checkout.

(a) Describe how a barcode scanner inputs data. [2]

(b) Name a suitable output device to print a paper receipt, and say why. [2]

3.3 A user downloads a 6 MB file. It is sent using packet switching in packets of 3 KB.

(a) Calculate the number of packets needed. [2]

(b) Identify the three parts of a packet and state what each contains. [3]

(c) Describe how the packets travel from the server to the user's computer. [4]

(d) Explain what happens if one packet fails to arrive. [2]

(e) Give one situation in which packet switching is a poor choice, and explain why. [2]

Solutions

2.1 an input device.

2.2 it turns an electrical signal into movement.

2.3 Header, payload, trailer.

2.4 Any two of: the sender's IP address; the receiver's IP address; the packet number; the total number of packets.

2.5 Each packet is routed separately, so different packets take different routes; routes differ in length and congestion, so packets arrive at different times.

3.1 C. A speaker is an output device.

3.2 (a) it shines light at the bars and reads the pattern reflected back; this is sent to the computer as the product code.
(b) an inkjet (or laser) printer; because it can print the receipt quickly on paper.

3.3 (a) 6 MB = 6144 KB; 6144 ÷ 3 = 2048 packets.
(b) Header: the sender's and receiver's IP addresses and the packet number. Payload: the piece of the file being carried. Trailer: a marker showing the end of the packet and an error-checking value such as a checksum.
(c) The file is split into numbered packets of equal size; each packet is sent separately, and routers choose a route for each one based on the shortest or least congested path; the packets may take different routes and arrive out of order; the receiving computer reassembles them into the correct order using the packet numbers.
(d) The receiver notices the missing number in the sequence and asks the sender to transmit that packet again, so only the lost packet is resent.
(e) Real-time video calls or live streaming, because a delayed or lost packet arrives too late to be useful and the picture or sound breaks up.

2 A student has an image file stored on their computer.

(a) The image file was taken by a digital camera.

Tick (✓) **one** box to show whether a digital camera is an example of an input, output, process or storage device.

A input ☐

B output ☐

C process ☐

D storage ☐

[1]

(b) The size of the image file is 3072 bytes.

(i) Give the size of the image file in kibibytes (KiB).

..... [1]

(ii) State the number of nibbles in 1 byte.

..... [1]

Working space

.....

.....

.....

.....

(c) The image file has a colour depth of 32 bits.

(i) State what is meant by a colour depth of 32 bits.

.....

..... [1]

(ii) The colour depth of the image file is changed to 64 bits.

Explain what effect this change has on the image file.

.....

....

.....

(d) The student uses lossless compression to compress the image file.

Explain how the image file is compressed using lossless compression.

.....

.....

.....

.....

.....

..... [3]

2 A student has a smartphone.

(a) Identify **two** input devices that can be built into the smartphone.

1 .....

2 .....
[2]

(b) Identify **two** output devices that can be built into the smartphone.

1 .....

2 .....
[2]

(c) The smartphone contains secondary storage.

(i) Explain the purpose of the secondary storage in the smartphone.

.....

.....

.....

..... [2]

(ii) Identify the most suitable type of secondary storage for the smartphone.

Explain your choice.

Secondary storage type .....

Explanation .....

.....

.....

.....

.....

.....

.....
[4]

4 A student has a smartwatch.

(a) The smartwatch has built-in input and output devices.

Identify **two** input devices that can be built into the smartwatch.

1 .....

2 .....

[2]

(b) Identify **one** output device that can be built into the smartwatch.

..... [1]

(c) The smartwatch has read only memory (ROM).

Explain why the smartwatch needs ROM.

.....

.....

.....

..... [2]

(d) The smartwatch uses a text message application that receives data from cloud storage.

(i) Describe what is meant by cloud storage.

.....

.....

.....

..... [2]

(ii) Explain **two** benefits of the application using cloud storage.

1 .....

.....

.....

.....

2 .....

.....

.....

.....

[4]

(e) The smartwatch only displays the time and text messages.

A student incorrectly describes this smartwatch as a general-purpose computer.

Explain why the student's description is incorrect.

.....

.....

.....

..... [2]

8 A robot vacuum cleaner uses sensors to navigate around obstacles in a room.

(a) Tick (✓) **one** box to show which sensor would be the most suitable for this purpose.

A proximity ☐

B flow ☐

C pressure ☐

D level ☐

[1]

(b) An expert system can be used to diagnose an error with a robot vacuum cleaner.

Circle **three** components that are part of an expert system.

knowledge base operating system firewall

server printer actuator inference engine

rule base encryption

[3]

(c) Explain how the robot vacuum cleaner can make use of machine learning.

.....

.....

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.....

.....

..... [3]

1 A student has a portable tablet computer.

(a) Identify **two** input devices that could be built into the portable tablet computer.

1 .....

2 .....

[2]

(b) Identify **one** output device that could be built into the portable tablet computer.

..... [1]

(c) Identify **one** type of storage device that could be built into the portable tablet computer.

..... [1]

6 A sensor is an input device that is used to capture data from its surrounding environment.

(a) Circle **three** other input devices.

touch screen hard disk drive (HDD) headphones

speaker microphone actuator

universal serial bus (USB) drive printer keyboard

[3]

(b) Sensors can be used in an automated system.

Give **two** benefits of using sensors in this type of system.

1 .....

.....

2 .....

.....

[2]

(c) The table contains different types of sensors and a use for each.

Complete the table by giving a suitable use for each type of sensor. The first one has been done for you.

type of sensor	use
acoustic	to monitor whether a water pipe has cracked and is leaking and dripping onto the floor
temperature	....
humidity	....
infra-red	....
magnetic field	....

[4]

5 A farm has an automated drinking system for its animals. The drinking system has a water bowl that contains the water. When the water bowl is empty, it is automatically refilled.

The system uses a sensor and a microprocessor.

(a) Identify the most appropriate sensor for this system.

..... [1]

(b) Describe how the sensor and the microprocessor are used to automatically refill the water bowl.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [6]

IGCSE COMPUTER SCIENCE • EXERCISE SHEET

3.3 Data storage

Name: _____ Class: _____ Date: _____ **Total: 31 marks**

KEY WORDS secondary storage 辅助存储 • primary storage 主存储器 • cloud storage 云存储 • magnetic 磁性 • optical 光学

Objective

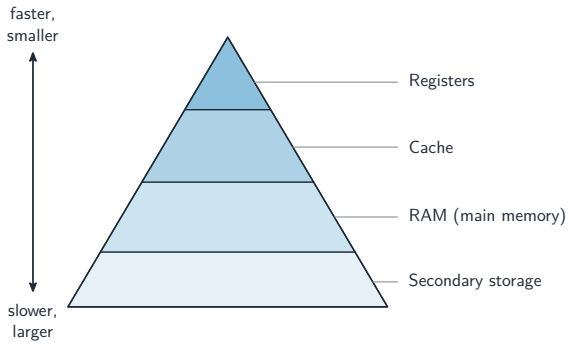
Build the skills to answer exam questions on **data storage** 数据存储 — **RAM/ROM** 内存, **secondary storage** 辅助存储, and **virtual memory** 虚拟内存.

You must be able to:

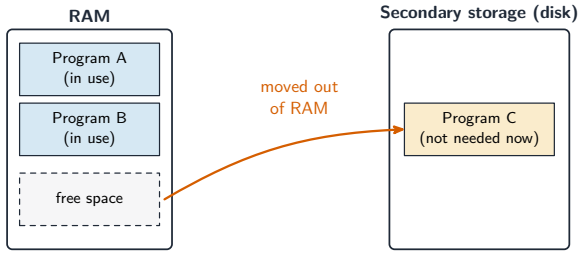
- compare RAM and ROM (volatile/non-volatile, read/write)
- describe magnetic, optical and solid-state secondary storage
- explain virtual memory

1 Worked examples

Memory and storage



Registers/cache: fast but small; secondary storage: slow but large



This frees RAM, so more programs can run than RAM alone could hold — but it is slower, because the disk is much slower than RAM.

When RAM is full, unused data is moved to disk to free RAM — slower, but runs more programs

- **RAM:** volatile, read/write. **ROM:** non-volatile, read-only (start-up).

■ Naming the storage, and choosing between types

Primary storage is directly addressable by the CPU. **RAM** 随机存取存储器 is volatile: it loses its contents when the power goes off, and it holds the programs, data and parts of the operating system currently in use. **ROM** 只读存储器 is non-volatile and holds the start-up instructions (the bootstrap or BIOS) that never change.

Secondary storage is non-volatile and not directly addressed by the CPU. The three technologies, with what each is best at:

Type	How it stores data	Good	Poor
magnetic 磁性 (hard disc drive)	magnetised sectors on spinning platters, read by a moving head	very large capacity, low cost per gigabyte	moving parts, so slower and easily damaged by knocks
optical 光学 (CD, DVD, Blu-ray)	pits and lands burned into a track, read by a laser	cheap, removable, good for distributing files	small capacity, slow, scratches easily
solid state 固态 (SSD, memory stick)	electrons trapped in NAND flash cells, no moving parts	fast, silent, robust, low power	costs more per gigabyte, limited number of write cycles

Virtual memory 虚拟内存 is space on secondary storage used as if it were RAM. When RAM is full, pages not in use are moved out to the virtual memory, freeing RAM for the current program; they are moved back when needed. It lets a computer run more (or larger) programs than RAM alone allows, but because secondary storage is much slower, heavy use of it slows the computer down.

Cloud storage 云存储 keeps data on remote servers reached over the internet. It gives access from any device and anywhere, automatic backup, and easy sharing; it needs an internet connection, may cost a subscription, and puts the security of the data in someone else's hands.

2 Practice

2.1 State whether RAM is volatile or non-volatile. [1]

2.2 Name the three types of secondary storage. [3]

2.3 Give one difference between RAM and ROM. [2]

2.4 Describe how data is stored on an optical disc. [2]

2.5 Explain what virtual memory is and why it is used. [3]

3 Exam-style questions

3.1 ROM is used to store: [1]

- **A** programs in use now
- **B** the start-up instructions
- **C** files permanently
- **D** virtual memory

3.2 A computer uses virtual memory.

(a) Explain what virtual memory is. [2]

(b) State one disadvantage of using virtual memory. [1]

3.3 State one difference between an SSD and an HDD. [1]

3.4 A school replaces the hard disc drives in its laptops with solid-state drives.

(a) Describe how a magnetic hard disc drive stores data. [2]

(b) Describe how a solid-state drive stores data. [2]

(c) Give three benefits of the solid-state drives for laptops that students carry between classes. [3]

(d) Give one drawback of solid-state storage compared with a magnetic hard disc. [1]

(e) The laptops have 4 GB of RAM. Explain how virtual memory allows a student to open more programs than the RAM can hold, and describe what the student would notice if many programs were open. [4]

(f) The school also stores the students' work in cloud storage. Give two benefits and one drawback of this. [3]

Solutions

2.1 volatile.

2.2 magnetic; optical; solid state.

2.3 RAM is volatile and loses its contents when the power is off, while ROM is non-volatile and keeps them; RAM holds the programs and data in use, while ROM holds the start-up instructions.

2.4 A laser burns pits into the reflective layer along a spiral track, leaving lands between them; a laser then reads the disc, and the change between a pit and a land represents the binary data.

2.5 Virtual memory is an area of secondary storage used as though it were RAM; when RAM is full, pages that are not currently needed are moved out to it, which allows more or larger programs to run than the RAM alone could hold.

3.1 B. ROM stores the start-up (boot) instructions.

3.2 (a) part of secondary storage used as extra (pretend) RAM; unused data is moved there to free RAM, so more programs can run.
(b) it is slower (secondary storage is slower than RAM).

3.3 an SSD has no moving parts / is faster (an HDD uses spinning magnetic disks).

3.4 (a) The surface is divided into tracks and sectors on spinning platters; a read-write head magnetises tiny areas, and the direction of magnetisation represents a 1 or a 0.
(b) It uses NAND flash memory with no moving parts; electrons are trapped in or released from cells (control gates), and the state of each cell represents a 1 or a 0.
(c) Any three of: faster to read and write, so the laptop starts up and loads files quickly; no moving parts, so it survives being carried and knocked; silent; lighter; uses less power, so the battery lasts longer.
(d) It costs more per gigabyte, so the same money buys less capacity (or: each cell has a limited number of write cycles).
(e) When the RAM is full, the operating system moves pages that are not currently in use out to virtual memory on the drive; that frees RAM for the program the student is using; the pages are moved back when they are needed again; because the drive is much slower than RAM, the student notices the laptop slowing down and the drive working constantly if too many programs are open.
(f) Any two benefits: the work can be reached from any device and any place with internet; it is backed up automatically; it is easy to share with a teacher; the school does not have to buy and maintain the storage. One drawback: it needs an internet connection, or the data's security depends on the provider, or there may be a subscription cost.

7 A student's computer has primary storage. One example of primary storage is random access memory (RAM).

(a) Identify **one** other example of primary storage.

..... [1]

(b) Explain why RAM is an example of primary storage and **not** secondary storage.

.....

.....

.....

.....

.....

..... [3]

(c) The student is editing a large video file for a project and during this process the RAM becomes full. This makes the computer crash.

Describe how virtual memory could be used in this process to stop the computer crashing.

.....

.....

.....

.....

.....

..... [3]

(d) The computer uses solid-state (flash memory) storage.

(i) Give **two** features of solid-state (flash memory) storage.

1 .....

.....

2 .....

.....
[2]

(ii) Give **two** examples of solid-state (flash memory) storage.

1 ....

2 ....
[2]

5 A computer uses both random access memory (RAM) and secondary storage.

(a) State the purpose of secondary storage.

.....

..... [1]

(b) One type of secondary storage is optical.

Circle **three** examples of optical storage.

read only memory (ROM) secure digital (SD) card compact disk (CD)

hard disk drive (HDD) digital versatile disk (DVD)

Blu-ray disk universal serial bus (USB) drive solid-state drive (SSD)

[3]

(c) Explain why a computer needs RAM.

.....

.....

.....

.....

.....

..... [3]

(d) The computer processes instructions using the fetch–decode–execute (FDE) cycle.

Draw and annotate a diagram to show the process of the **fetch** stage of the FDE cycle.

[4]

9 A company uses both solid-state and optical secondary storage.

(a) Explain why a computer needs secondary storage.

.....

.....

.....

..... [2]

(b) Describe **three** differences between solid-state and optical storage.

1 .....

.....

.....

.....

2 .....

.....

.....

.....

3 .....

.....

.....

..... [6]

4 The table contains statements about types of secondary storage.

Complete the table by writing the correct type of secondary storage for each statement.

type of secondary storage	statement
.....	Pits and lands are created on a reflective surface.
.....	NAND or NOR technology is used.
.....	Platters are spun that are divided into tracks and sectors.
.....	Electromagnets are used to read and write data.
.....	Transistors are used as control gates and floating gates.
.....	A red or blue laser is used to read and write data.

[6]

5 A computer uses both random access memory (RAM) and read only memory (ROM).

(a) Tick (✓) **one** box to show which statement is correct about RAM.

A It is non-volatile storage. ☐

B It stores the bootloader. ☐

C It stores data that is currently in use. ☐

D It is **not** directly accessible by the central processing unit (CPU). ☐

[1]

(b) ROM is a type of primary storage.

State the characteristic of ROM that makes it a type of primary storage.

.....

..... [1]

8 Storage can be described as being magnetic, solid-state or optical.

(a) Give **two** features of magnetic storage.

1 .....

.....

2 .....

.....

[2]

(b) Give **three** features of solid-state storage.

1 .....

.....

2 .....

.....

3 .....

.....

[3]

(c) Give **one** example of each type of storage.

Magnetic .....

Solid-state .....

Optical .....

[3]

13 Storage and memory are important components of a computer system.

(a) Primary storage is one type of storage in a computer system.

(i) Tick (✓) **one** box to show which is an example of primary storage.

A compact disk (CD) ☐

B hard disk drive (HDD) ☐

C random access memory (RAM) ☐

D solid-state drive (SSD) ☐

[1]

(ii) Give **one** characteristic of primary storage.

..... [1]

(b) Virtual memory can be created in a computer system.

Complete the description about virtual memory.

Use the terms from the list.

Some of the terms in the list will **not** be used. Some terms may be used more than once.

binary hard disk drive (HDD) hexadecimal operating system

pages random access memory (RAM) read only memory (ROM)

sectors software tracks virtual memory

Virtual memory is used when the ..... is full. It is created by partitioning the ..... . Data is divided into ..... that can be sent from ..... to the ..... to be temporarily stored until they are required.

[5]

3 Secondary storage devices are used to store data in a computer.

(a) Circle **three** components that are secondary storage devices.

central processing unit (CPU) compact disk (CD)

hard disk drive (HDD) random access memory (RAM) read only memory (ROM)

register sensor solid-state drive (SSD)

[3]

(b) Tick (✓) **one** box to show which statement about secondary storage is correct.

A It is directly accessed by the CPU. ☐

B It is magnetic storage only. ☐

C It is used to permanently store software and data files. ☐

D It is volatile. ☐

[1]

IGCSE COMPUTER SCIENCE • EXERCISE SHEET

3.4 Network hardware

Name: _____ Class: _____ Date: _____ **Total: 26 marks**

KEY WORDS control 控制 • network interface card 网络接口卡 • router 路由器 • network hardware 网络硬件 • sensor 传感器

Objective

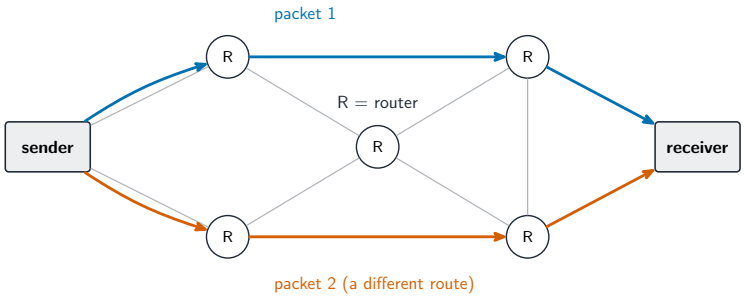
Build the skills to answer exam questions on **network hardware** 网络硬件 — the **NIC** 网络接口卡, **MAC** and **IP addresses**, and the **router** 路由器.

You must be able to:

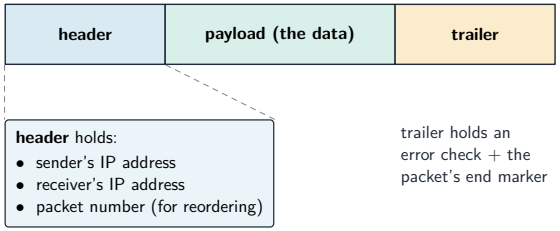
- state the function of a NIC
- compare a MAC address and an IP address
- describe the function of a router

1 Worked examples

■ Network hardware



A router connects networks and forwards packets using their IP addresses



Network hardware routes data split into packets

- **NIC:** lets a device join a network; holds a built-in MAC address.
- **MAC:** identifies one physical device, set by the maker, does not change.
- **IP:** given by the network, can change.

■ Input, output and sensors: name the device, then say what it does

An **input device** 输入设备 puts data into a system; an **output device** 输出设备 presents the result. A **sensor** 传感器 is an input device that measures a physical quantity continuously and sends readings to a microprocessor.

Sensor	What it measures	A typical use
temperature	how hot or cold	central heating, an oven, a greenhouse
light	brightness	automatic street lights, a phone screen
infrared / motion	movement or a broken beam	burglar alarm, automatic door
pressure	force per unit area	a car seat sensor, a burglar alarm mat
humidity / moisture	water in air or soil	a greenhouse, a washing machine
pH	acidity	a pond or a chemical process
proximity	how close an object is	parking sensors, a robot

How a monitoring or control system works. The sensor sends readings continuously; the **analogue-to-digital converter (ADC)** turns them into digital values the microprocessor can use; the microprocessor **compares** each reading with a stored value. In a **monitoring** 监控 system it only warns or records. In a **control** 控制 system it also acts, sending a signal (through a **digital-to-analogue converter** and an actuator) to change something, so the process repeats in a loop.

Worked example. Describe how a greenhouse keeps its temperature at 25 °C. The temperature sensor sends readings continuously; the ADC converts each to digital; the microprocessor compares the reading with the stored value of 25 °C; if the reading is above it, the microprocessor sends a signal to open the window (or start a fan); if it is

below, it closes the window and turns on the heater; the process repeats continuously.

2 Practice

2.1 State the function of a network interface card (NIC). [1]

2.2 State the function of a router. [1]

2.3 Identify a suitable sensor for each: an automatic door, a greenhouse watering system, a burglar alarm. [3]

2.4 State the purpose of an analogue-to-digital converter in a monitoring system. [1]

2.5 Explain the difference between a monitoring system and a control system. [2]

3 Exam-style questions

3.1 A MAC address is best described as: [1]

- **A** given by the network and changeable
- **B** a unique number set by the maker, identifying a device
- **C** the same as a packet number
- **D** a web address

3.2 A device connects to a network.

(a) State two differences between a MAC address and an IP address. [2]

(b) Explain how a router uses the IP address in a packet. [2]

3.3 A car park uses a computer system to manage its spaces.

(a) Identify a suitable sensor to detect a car arriving at the barrier, and a suitable input device to read the driver's ticket. [2]

(b) Identify a suitable output device to tell drivers how many spaces are free. [1]

(c) Describe how the microprocessor uses the sensor readings to decide whether to raise the barrier. [4]

(d) Explain why the system needs an analogue-to-digital converter. [2]

(e) State whether this is a monitoring system or a control system, and justify your answer. [2]

(f) The car park adds a camera that reads number plates. Give the name of this technology and describe one benefit for the car park. [2]

Solutions

2.1 it lets a device join a network and send/receive data.

2.2 it connects different networks and forwards packets towards the right network.

2.3 Automatic door: infrared or motion (or pressure) sensor; greenhouse watering: moisture or humidity sensor; burglar alarm: infrared, pressure or motion sensor.

2.4 It converts the analogue readings from the sensor into digital values that the microprocessor can process.

2.5 A monitoring system only records the readings or gives a warning; a control system also sends signals that change the process, so the readings themselves change.

3.1 B. A MAC address is a unique number set by the maker.

3.2 (a) a MAC address is set by the maker and does not change; an IP address is given by the network and can change.
(b) the router reads the receiver's IP address in the packet header; and forwards the packet towards that network.

3.3 (a) A pressure sensor in the road, or an infrared sensor across the entrance; a barcode or magnetic-stripe reader, or a keypad, for the ticket.
(b) An LED display (or a monitor / screen) showing the number of free spaces.
(c) The sensor sends readings continuously to the microprocessor; the ADC converts them to digital; the microprocessor compares the reading with the stored value that means "a car is waiting", and checks that the count of free spaces is above zero; if both are satisfied it sends a signal to the actuator to raise the barrier and subtracts one from the free-space count.
(d) The sensor produces a continuously varying analogue signal, but the microprocessor can only work with digital values, so the signal must be converted.
(e) A control system, because the microprocessor does not only record the data: it sends a signal that operates the barrier and changes what happens.
(f) Automatic number plate recognition, a form of optical character recognition; any one benefit: drivers do not need a ticket, so entry is faster; the car park can charge automatically or detect a stolen car.

5 A computer is connected to a network.

(a) The computer has a network interface card (NIC) that has a media access control (MAC) address.

(i) One purpose of the NIC is to provide the computer with a MAC address.

Describe the other purposes of the NIC.

.....

.....

.....

..... [2]

(ii) Identify **three** characteristics of a MAC address.

1 .....

.....

2 .....

.....

3 .....

.....

[3]

(b) The network allocates an internet protocol (IP) address to the computer.

(i) Tick (✓) **one** box to identify a valid IPv4 address.

A 110:255:2:1 ☐

B 1.30.2FF.A9 ☐

C 3.162.74.3 ☐

D 8.0.257.6.8 ☐

[1]

(ii) Identify the device in a network that can automatically assign an IP address to a computer, each time the computer connects to the network.

..... [1]

(c) A user accesses the world wide web using a web browser.

(i) Define the term world wide web.

.....

..... [1]

(ii) The uniform resource locator (URL) for a website includes the protocol hypertext transfer protocol secure (HTTPS).

Explain how HTTPS makes the transmission of data secure.

.....

.....

.....

.....

.....

.....

.....

..... [4]

(iii) The protocol is one part of a URL.

Give the other **two** parts of a URL.

1 .....

.....

2 .....

.....

[2]

7 A computer has both a media access control (MAC) address and an internet protocol (IP) address.

(a) Tick (✓) **one** box to show which of the statements is correct about the MAC address.

A It is assigned by the manufacturer. ☐

B It is assigned by a router. ☐

C It can be static or dynamic. ☐

D It is made up of three different parts. ☐

[1]

(b) An IP address can have an IPv4 or IPv6 format.

(i) Give an example of an IP address that has an IPv4 format.

..... [1]

(ii) Give **two** characteristics of the IPv6 format.

1 .....

.....

2 .....

..... [2]

6 A user wants to connect their computer to a network.

(a) **(i)** Identify the component in the computer that is needed to access a network.

..... [1]

(ii) Identify the type of address that is allocated to the component by the manufacturer, which is used to uniquely identify the device.

..... [1]

(b) A dynamic internet protocol (IP) address is allocated to the computer when it is connected to the network.

(i) Identify the device on the network that can connect multiple devices and automatically assign them an IP address.

..... [1]

(ii) Describe what is meant by a dynamic IP address.

.....

.....

.....

.....

.....

..... [3]