Main memory and secondary storage

3.1.1, 3.1.2 · Computers · revision notes

Why a computer needs both main memory (RAM) and secondary storage, how magnetic, optical and solid-state devices store data, and how to choose the right storage for a situation. Paper 1 questions range from 1-mark definitions to 4-mark 'Explain two reasons' questions and 6-mark 'Discuss' questions set in a context.

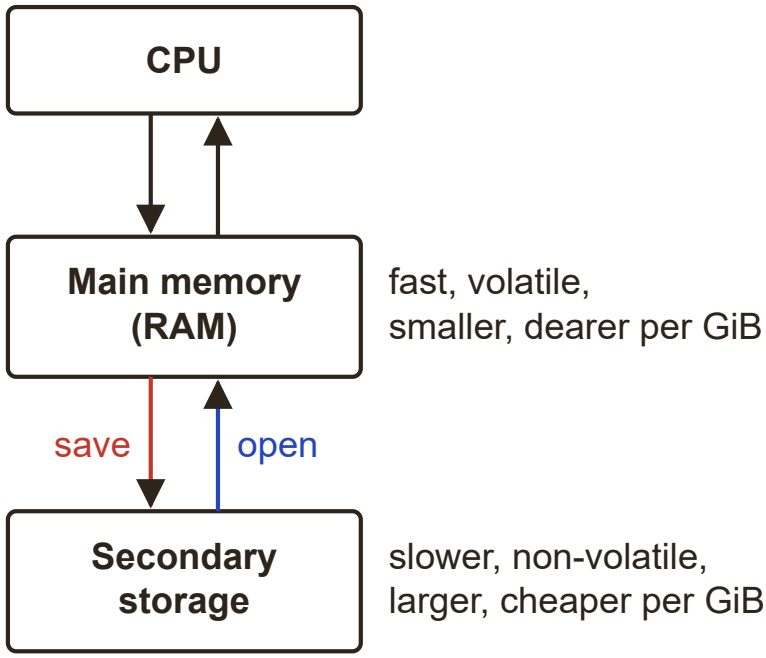
Key facts

- Volatile: loses its contents when the power is off (RAM)
- RAM: fast, smaller capacity, expensive per GiB, holds what is in use now
- Optical: laser + spiral track of pits and lands; changes in reflected light = 1 or 0
- SSD vs HDD: SSD faster, tougher, quieter, lower power; HDD cheaper per GiB
- Non-volatile: keeps its contents without power (all secondary storage)
- Magnetic: spinning platters + read/write head; areas magnetised in two directions = 1 or 0
- Solid state: flash memory cells trap electrical charge = 1 or 0; no moving parts
- Storage factors: capacity, speed, portability, durability, reliability, cost

Notes

Main memory and secondary storage

- **Main memory (RAM)** holds the operating system, programs and data in use now. The CPU fetches from it directly.
- RAM is **volatile**: its contents are lost when the power is turned off. It is fast but expensive per GiB, so a computer has far less RAM than secondary storage.
- **Secondary storage** is **non-volatile**: it keeps data without power. It holds the operating system, programs and files permanently.
- Opening a file copies it from secondary storage into RAM; saving copies it back.

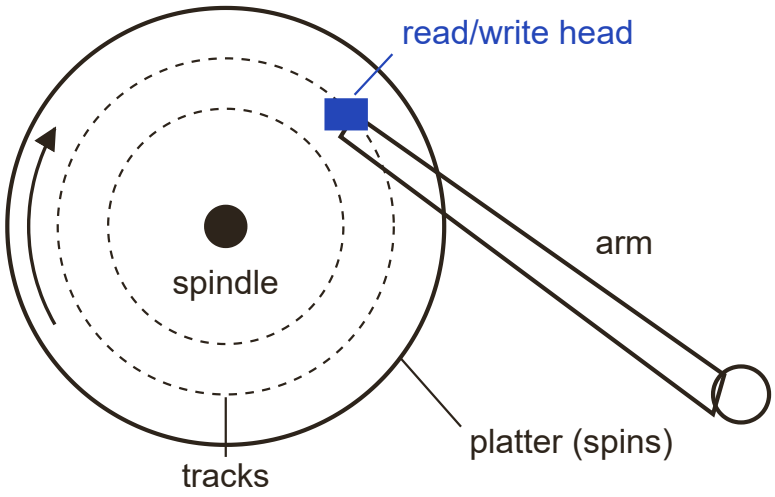


The CPU only works with main memory. Files move between RAM and secondary storage when you open and save them

- Secondary storage is much slower than RAM, but it has a much larger capacity and is cheaper per GiB.

Magnetic storage (hard disk drive)

- Data is stored on **platters** coated in magnetic material, which spin at high speed.
- A **read/write head** on a moving arm magnetises tiny areas of the surface in one of two directions, which represent 1 and 0. To read, the head detects the direction of each area.

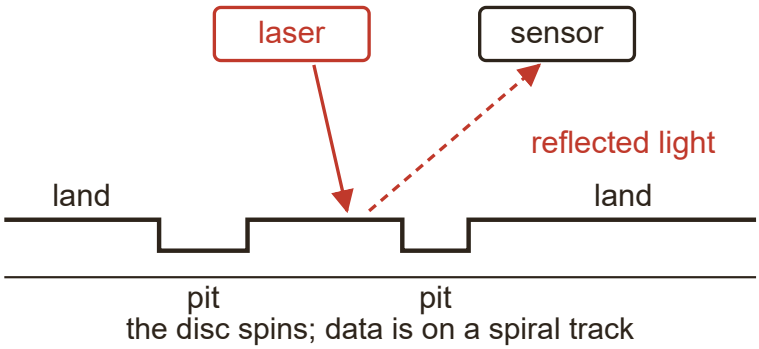


Inside a hard disk drive: the head magnetises tiny areas of the spinning platter in one of two directions

- Large capacity and low cost per GiB, but the moving parts make it slower, noisier and easier to damage if it is knocked.

Optical storage (CD, DVD, Blu-ray)

- Data is stored as **pits** and **lands** along a spiral track on the disc.
- A **laser** shines on the spinning disc. Pits and lands reflect the light differently, and a sensor turns the changes in reflected light into 1s and 0s.

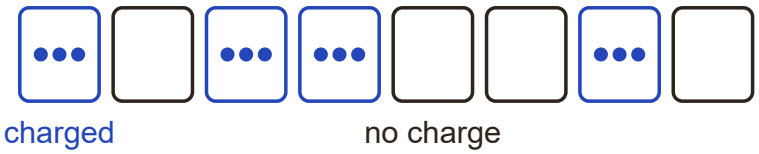


Pits and lands reflect the laser differently; the sensor reads the changes as binary

- Discs are cheap and portable, but have a low capacity, are slow and can be scratched. A Blu-ray disc holds more than a DVD, which holds more than a CD.

Solid-state storage (SSD, USB flash drive, memory card)

- Uses **flash memory**: millions of tiny cells that can trap an electrical charge. A charged or uncharged cell represents 1 or 0.



the charge stays when the power is off: no moving parts

Each flash cell either traps a charge or does not: the two states represent 1 and 0

- The charge stays when the power is off, so it is non-volatile. There are **no moving parts**: data is read and written electronically.
- Very fast, robust, silent, light and low power, but more expensive per GiB, and each cell can only be rewritten a limited number of times.

Choosing storage

- Compare **capacity**, **speed**, **portability**, **durability**, **reliability** and **cost** per GiB.
- Always link a feature to the user's need. For example, a laptop that is carried around needs storage with no moving parts.

How to answer each type of question

Describe how data is stored on a device 3 to 4 marks **Grade 6**

1. Name the technology: magnetised areas, pits and lands, or flash memory cells.
2. Say what represents 1 and 0.
3. Say how the data is read (head, laser and sensor, or electronically).
4. Add a feature such as moving parts or non-volatility if there are marks left.

Example. Describe how data is stored on a solid-state drive (SSD). (3)

Model answer. Any three from: an SSD uses flash memory made of millions of tiny cells (1); each cell can trap an electrical charge or have no charge (1); charged and uncharged cells represent 1 and 0 (1); the charge stays when the power is off, so the data is kept (non-volatile) (1); data is read and written electronically, with no moving parts (1).

Explain why a computer needs both RAM and secondary storage

2 marks | Grade 4

1. Say that RAM is volatile, so its contents are lost when the power is off.
2. Link it: secondary storage is non-volatile, so it keeps the operating system, programs and files permanently.

Example. Explain why a computer needs secondary storage as well as main memory. (2)

Model answer. Main memory (RAM) is volatile, so everything in it is lost when the computer is switched off (1). Secondary storage is non-volatile, so the operating system, programs and files are kept permanently and can be loaded again next time (1).

Explain why a type of storage suits a situation

2 to 4 marks | Grade 6

1. Pick a feature of the storage that matters in this situation.
2. Link it with 'so' to an effect for this particular user.
3. For 'two reasons', repeat with a different feature.

Example. A delivery driver uses a handheld device to record deliveries. The device uses solid-state storage.
Explain **two** reasons why solid-state storage is suitable for this device. (4)

Model answer.

It has no moving parts (1), so it will not be damaged if the device is dropped or shaken in the van (1). It uses very little power (1), so the battery lasts for the driver's whole working day (1).
Also accept: small and light (1), so the device is easy to carry (1).

Calculate how many storage devices are needed

2 marks | Grade 6

1. Convert everything to the same unit (1 TiB = 1024 GiB).
2. Divide the amount of data by the capacity of one device.
3. Round up to a whole number of devices.

Example. A photographer has 1.5 TiB of photos. Each disc she buys can store 100 GiB.
Calculate the number of discs needed to store all the photos. (2)

Model answer.

1.5 × 1024 = 1536 GiB (1)
1536 ÷ 100 = 15.36, so 16 discs (1)

6-mark 'Discuss': choosing storage

6 marks **Grade 8**

1. Cover the options in the question, with advantages and disadvantages of each.
2. Link every point to the scenario (who uses it, where, what data, what budget).
3. Finish with a justified conclusion. The answer is marked by levels, so quality and balance count, not just the number of points.

Example. A design company is buying laptops for its staff. Staff travel to meet clients and open very large design files during meetings. The company has a limited budget.
Discuss whether the laptops should use magnetic or solid-state storage. (6)

Model answer.

Solid-state storage has no moving parts, so it is less likely to be damaged when the laptops are carried to meetings. It has much faster access times, so the laptops start quickly and large design files open without a delay in front of a client. It also uses less power and is lighter, so the battery lasts longer and the laptops are easier to carry. However, solid-state storage costs more per GiB, so with a limited budget each laptop may have a smaller capacity, which matters because the design files are large. A magnetic hard disk would give more capacity for the money, but its spinning platters and moving head make it slower and easier to damage when travelling. Overall, solid-state storage is the better choice because the laptops are portable and speed matters when presenting; older projects could be kept on cheaper magnetic storage in the office.
(Top level, 5 to 6 marks: points about both options, each explained and linked to the staff's needs, with a justified conclusion.)

Don’t lose marks

- Calling RAM 'storage' or calling the hard disk 'memory'. Keep main memory and secondary storage separate.
- Saying an SSD uses magnets or a laser, or that a hard disk is read by a laser.
- Writing 'cheaper' or 'faster' without saying what it is compared with, e.g. 'cheaper per GiB than an SSD'.
- Rounding down when working out how many discs or drives are needed.
- Using 1000 instead of 1024 when converting between TiB, GiB and MiB.
- Giving a feature with no link to the scenario, e.g. 'SSDs are fast' with no reason why speed matters here.

More tips

Memory tricks

- **M**agnetic = magnets and moving parts. **O**ptical = light from a laser. **S**olid state = stored charge, no moving parts.
- Volatile sounds like 'vanish': switch off and the data vanishes.
- When counting discs or drives, always round **up**: 15.36 discs means 16 discs.
- Every 'explain why it is suitable' point = feature + 'so' + effect for this user.

Exam technique

- 'Explain two reasons' for 4 marks means two features, each with a linked consequence.
- Read the context carefully: a portable device, a large archive, sending copies to customers and a tight budget all point to different answers.
- In a 6-mark 'Discuss', cover advantages and disadvantages of more than one option and finish with a justified conclusion.
- Be specific: 'no moving parts, so it will not be damaged if dropped' earns more than 'more durable'.

What each grade needs

What you need to be able to do, from the first marks up to the top grade.

Grade 3 — **Define volatile and non-volatile**
Volatile memory (RAM) loses its contents when the power is off; non-volatile storage keeps them.

Grade 3 — **Give examples of each type of storage**
Magnetic: hard disk drive; optical: CD, DVD, Blu-ray; solid state: SSD, USB flash drive, memory card.

Grade 4 — **Explain why secondary storage is needed**
RAM is volatile, so the operating system, programs and files must be kept permanently on non-volatile storage.

Grade 5 — **Describe how magnetic and optical storage work**
Magnetised areas on spinning platters read by a moving head; pits and lands on a disc read by a laser.

Grade 6 — **Describe how solid-state storage works**
Flash memory cells trap an electrical charge (or not) to store 1s and 0s, with no moving parts.

Grade 6 — **Compare storage by capacity, speed, cost, durability**
For example, an SSD is faster and tougher than a hard disk drive but costs more per GiB.

Grade 8 — **Justify a storage choice for a scenario**
Weigh the user's needs against the features of each type of storage and reach a reasoned conclusion.

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