



# OCR GCSE Computer Science



Your notes

## Primary & Secondary Storage

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Your notes

## The Need for Primary Storage

# The Need for Primary Storage

- Computer systems need both primary and secondary storage to operate
- Both types of storage play a crucial role in the operation of a computer system
- A quick comparison of primary and secondary storage shows:

Primary	Secondary
<b>Volatile</b> (with the exception of ROM)	<b>Non-volatile</b>
Small capacity	Large capacity

## Why do you need primary storage?

- A computer needs primary storage because **access times** are considerably **faster than secondary**
- This means the **time taken** to complete operations such as the **Fetch-Execute Cycle** is **dramatically reduced**
- Primary storage holds the **data** and **instructions** that the CPU needs to access whilst the computer is turned on
- Due to the fast access times, primary storage is used as **short term, working memory**, in hardware that is **directly connected to the CPU** such as **RAM**, and components that reside inside the CPU such as **Cache** and **Registers**
- Performance of primary storage means a much higher **cost** which limits the amount that is used
- For example, **RAM** is commonly purchased in 16 or 32 **gigabytes** whereas secondary storage such as a **hard drive** is in **terabytes**



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## RAM & ROM

# RAM

## What is RAM?

- RAM (Random Access Memory) is **primary storage** that is directly connected to the CPU and holds the **data** and **instructions** that are **currently in use**
- RAM is **volatile** which means the contents of RAM are lost when the power is turned off
- For the CPU to access the data and instructions they must be **copied from secondary storage**
- RAM is **very fast** working memory, much faster than secondary storage
- RAM is **read/write** which means data can be read from and written to
- In comparison to ROM, it has a much **larger capacity**



### Examiner Tips and Tricks

Just knowing what RAM is and what it stores is not enough, you must be able to apply your understanding of RAM to real world contexts where RAM is a component, e.g. TVs, game consoles and other smart devices



### Worked Example

A smart television allows the user to search the Internet and watch videos online.

The smart television uses RAM

Give **two examples** of data that the smart television could store in RAM [2]

#### How to answer this question

- Think about the main function of a smart television, watch channels, use apps to stream content and browse the web etc
- For each function, try to think of what data would have to be in the RAM whilst you were actually doing it (**in use!**)

#### Possible answers



- Current channel being watched
- Current volume
- Current video/file/tv program being watched
- Web browser/applications that are **running**
- Data being downloaded/buffered



### Examiner Tips and Tricks

Examiners will accept anything reasonable when answering these style of questions **BUT** brand names will not be awarded without giving an example

## ROM

### What is ROM?

- ROM (Read Only Memory) is **primary storage** that holds the **first instructions** a computer needs to **start up** (Bootstrap)
- ROM contains the **BIOS** (Basic Input Output System)
- ROM is a small **memory chip** located on the computers **motherboard**
- ROM is **fast** memory, much faster than secondary storage but **slower than RAM**
- ROM is **non-volatile** which means the contents of ROM are not lost when the power is turned off
- ROM is **read only** which means data can only be read from
- In comparison to RAM, it has a much **smaller capacity**



### Examiner Tips and Tricks

RAM & ROM are examples of primary storage, they can be referred to as Main Memory or Primary Memory in the exam



### Worked Example

Quinn has 512 kilobytes of ROM and 16 gigabytes of RAM in her computer



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1. Describe the purpose of the ROM in Quinn's computer [2]
2. Describe the purpose of the RAM in Quinn's computer [2]

**Answer**

## 1. ROM

- Store start-up instructions/bootstrap
- Used to start the computer

## 2. RAM

- Stores the parts of the OS / programs that are running
- Stores data currently in use
- ...for access by the CPU

**Guidance**

- Do not confuse the purpose with characteristics, describe **what it does**, not **what it is**



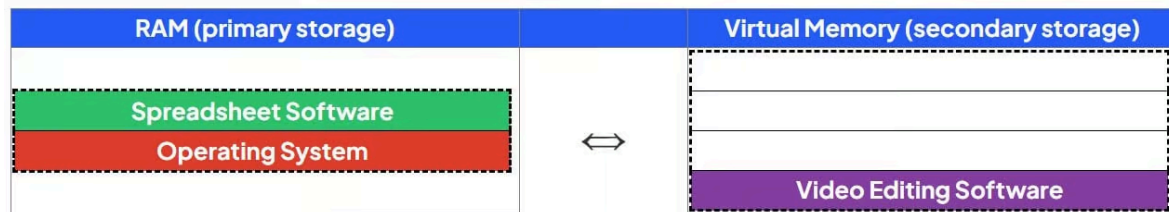
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## Virtual Memory

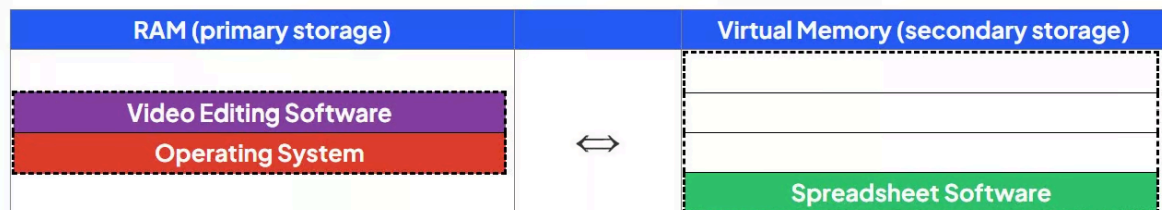
# Virtual Memory

## What is virtual memory?

- Virtual memory is an **extension of primary storage** (RAM) located on **secondary storage**
- In situations where RAM is close to being **full**, virtual memory can be used so that the computer **remains operational**
- Programs and data **not currently** being **executed** are transferred to virtual memory
- Programs and data are transferred back to RAM when they **are needed**
- Virtual memory is much **slower** than RAM and its use will impact negatively on system performance
- To avoid the use of virtual memory, **increase** the size of the **RAM**



- In the example above, the computer is turned on and the elements of the operating system are loaded into RAM
- The user opens some spreadsheet and video editing software but RAM is full
- The program not currently being used (video editing) is transferred to virtual memory



- When the user wants to use the video editing software again, it is transferred back from virtual memory to RAM



## Worked Example

A computer only has 4GB of RAM, Fynn says that virtual memory can be used instead of adding more RAM.

1. Explain how virtual memory can compensate for the lack of RAM in Fynn's computer **[3]**
2. Explain why it would be beneficial for Fynn to get more RAM instead of relying on virtual memory **[2]**

### How to answer these questions

1. What is the definition of virtual memory? how does it work?
2. What is the downside of using virtual memory? turn this into an advantage of adding more RAM

### Answers

- How can Virtual Memory compensate
  - Virtual Memory is used when RAM is full
  - ...part of the secondary storage used as (temporary) RAM
  - Data from RAM is moved to the secondary storage/Virtual Memory (to make space in RAM)
  - RAM can then be filled with new data
  - When data in Virtual Memory is needed it is moved back to RAM
- Benefit of more RAM
  - More RAM will improve the performance of the computer // More RAM will speed up the access to data
  - Virtual Memory is slower to access than RAM direct (because it has to go back to RAM first)
  - Moving data between RAM and VM takes processor time



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## The Need for Secondary Storage

### The Need for Secondary Storage

- Computer systems need both primary and secondary storage to operate
- Both types of storage play a crucial role in the operation of a computer system
- A quick comparison of primary and secondary storage shows:

Primary	Secondary
<b>Volatile</b> (with the exception of ROM)	<b>Non-volatile</b>
Small capacity	Large capacity

### Why do you need secondary storage?

- A computer needs secondary storage for **long term storage** of programs and data that are **currently not in use**
- Secondary storage is needed as ROM is read only and RAM is volatile
- Secondary storage holds the **programs** and **data** whilst the computer is turned off (**non-volatile**)
- Performance of secondary storage is **slower** than primary storage but **capacity** is much **higher** which makes it perfect for backup & archive of data files

### What are the characteristics of secondary storage?

- **Capacity** - What is the maximum amount of data that can be stored?
- **Speed** - How fast can data be read from and written to? (R/W)
- **Cost** - How much does it cost?
- **Portability** - How easy is it to move around? What is the physical size? Weight?
- **Durability** - How robust is the storage?
- **Reliability** - What is the probability that the device will consistently perform its function?







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## Worked Example

A games console has secondary storage.

State, using an example, why the games console needs secondary storage [2]

### How to answer this question

- The keyword is '**why**', why does a games console need secondary storage? give an example, do not just describe what secondary storage is!

### Answer

- To store data once the power is turned off / permanently // for non-volatile storage
- Examples could include:
  - Storing games
  - Save games
  - User data / profiles
  - Downloaded content / applications / updates



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## Common Types of Storage

- Storage devices are **non-volatile secondary storage**, that retain digital data within a computer system
- They provide a means of storing, accessing, and retrieving data, which can include software applications, documents, images, videos, and more
- There are 3 types of storage:
  - Magnetic**
  - Solid State**
  - Optical**

## Magnetic Storage

### What is magnetic storage?

- Magnetic storage is a type of non-volatile media that uses **magnets** (polarity) to store binary 0s and 1s

Advantages	Disadvantages
<b>Capacity</b> - High storage	<b>Durability</b> - Moving parts can get damaged if dropped
<b>Cost</b> - Low per gigabyte	<b>Portability</b> - Heavy & bulky making them less convenient for transport
<b>Speed</b> - Moderate read/write access	<b>Reliability</b> - Prone to mechanical failure
	<b>Noise</b> - Loud (spinning disks)

## Solid State Storage

### What is solid state storage?

- Solid state storage is a type of non-volatile media that uses **electronic circuits** to store binary 0s and 1s

Advantages	Disadvantages
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<b>Capacity</b> - Medium/high storage	<b>Cost</b> - Very high per gigabyte
<b>Speed</b> - Very fast read/write access	<b>Reliability</b> - Limited read/write cycles
<b>Durability</b> - No moving parts	
<b>Portability</b> - Small and no moving parts	
<b>Noise</b> - Silent	

## Optical Storage

### What is optical storage?

- Optical storage is a type of non-volatile media that uses **lasers** to burn the surface of a disk, creating pits and lands suitable for storing binary 0s and 1s

Advantages	Disadvantages
<b>Cost</b> - Very low per gigabyte	<b>Capacity</b> - Very low
<b>Durability</b> - No moving parts	<b>Speed</b> - Very slow read/write access
<b>Portability</b> - Small and no moving parts	<b>Reliability</b> - Prone to scratches
<b>Noise</b> - Silent	



### Worked Example

Zarmeen has purchased a new tablet computer. The tablet has an internal secondary storage device.

The storage device is a solid state device.

- Give **three** benefits of the tablet having a solid state device instead of a magnetic device [3]
- Give **two** drawbacks of the tablet having a solid state device instead of a magnetic device [2]

### Answers



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- Benefits
  - Faster access / read/write speeds
  - Smaller in physical size
  - More durable // no moving parts
- Drawbacks
  - More expensive (per gigabyte)
  - Smaller capacity (usually)
  - Limited number of read/write cycles

**Guidance**

- Portable is not enough on it's own
- No moving parts is not enough on it's own



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## Suitable Storage Devices

# Suitable Storage Devices

- Storage devices are non-volatile secondary storage, that retain digital data within a computer system
- There are 3 types of storage:
  - Magnetic**
  - Solid State**
  - Optical**
- Here are some of the devices commonly used for storage

Name of Device	Type of Storage	Storage Capacity	Cost
Hard Disk Drive (HDD)	Magnetic	500GB - 8TB (consumer-grade)	Low cost per GB
Solid-State Drive (SSD)	Solid State	128GB - 2TB (consumer-grade)	High cost per GB
USB Flash Drive	Solid State	8GB - 256GB (common sizes)	Moderate cost per GB
CD/DVD/Blu-ray Disc	Optical	CD: 700MB, DVD: 4.7GB - 9GB, Blu-ray: 25GB - 50GB	Low cost per disc

## How do I choose the right storage device?

- Choosing the right storage device depends on:
  - Capacity** - How much data needs to be stored?
  - Speed** - How quickly can the data be read from/written to?
  - Cost** - How much does it cost?
  - Portability** - Does the data need to be transported? What is the physical size? Weight?

- **Durability** – How robust is the media?
- **Reliability** – Does the device need to be accessed over and over again?
- In different scenarios, different storage devices are more suitable

## Scenario 1 – army laptop

- The army would like a new portable computer that can be used whilst 'in the field', it must be robust enough to withstand a few bumps and easy to transport to new places. Money is no object



- In this scenario a solid state device would be most suitable
- A solid state device has a high durability which means it can withstand any bumps or drops, it is small in size and weight which is perfect for a device that needs to be portable and because money is no object, the high cost is not a concern

## Scenario 2 – school backups

- A school wants to backup all students work twice a day and keep it safe in case of any emergencies. The cost of the device is very important as the school budget is tight and they want a device that can hold terabytes of data in one go to minimise the amount of devices they would need to buy



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- In this scenario a hard disk drive (HDD) would be most suitable
- A hard disk drive has the highest capacity and would limit the amount of devices they would need to buy, it is also relatively cheap per gigabyte compared to solid state. Reliability could be an issue but as this is being used for backing up data it will not be used constantly and would be less of a concern

### Scenario 3 – new game release

- An international game studio wants to distribute it's new release for the latest games consoles. This could potential involve many millions of copies being sold so the device would have to extremely portable and cheap enough to produce so that the company do not make a loss. The device needs to be durable enough to withstand being handled regularly



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- In this scenario a Blu-ray (optical) would be most suitable
- A Blu-ray disc is highly portable due to its size and weight and durable enough because it has no moving parts. The cost is low which is perfect in this scenario as the company could potentially be selling millions of copies



### Examiner Tips and Tricks

In the exam there could be more than one possible answer. As long as you can justify your decision based on the information given and what you know about the characteristics of storage device you can still get the full marks!



### Worked Example

A smart television has secondary storage.

1. Identify one appropriate type of secondary storage for the smart television. Justify your choice [4]

**How to answer this question**





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- Make sure to justify your choice of storage **type** based on a smart television, do not be tempted to justify why one storage type is better than another unless it relates directly to the use in a smart television

### Answers

- **Magnetic:**
  - Large storage capacity
  - ... for storing software/videos/HD
  - Television unlikely to be moved
  - ... therefore durability/portability not required
  - Cost to purchase is low
  - ... so the TV will be cheaper to manufacture/purchase
  - Device will fit in a tv // device is small
  - Longevity // reliable
- **Solid state:**
  - Large storage capacity
  - ... for storing software/videos/HD
  - Television may be moved
  - ... therefore durable/robust/portable
  - Fast data access
  - ... television will be more responsive
  - Cost to purchase is low
  - ... so the TV is not too expensive to manufacture/purchase
  - Run quieter
  - Compact // lightweight
  - ... so tv can be made smaller / lighter

### Guidance

- The question asks for a storage type, not a specific storage device
- If no type is given, max 3 marks for justification
- Optical is an inappropriate type