

AQA Computer Science A-Level
4.7.4 External hardware devices
Concise Notes



Specification:

4.7.4.1 Input and output devices:

Know the main characteristics, purposes and suitability of the devices and understand their principles of operation.

Devices that need to be considered are:

- barcode reader
- digital camera
- laser printer
- RFID

4.7.4.2 Secondary storage devices:

Explain the need for secondary storage within a computer system.

Know the main characteristics, purposes, suitability and understand the principles of operation of the following devices:

- hard disk
- optical disk
- solid-state drive (SSD)

Compare the capacity and speed of access of various media and make a judgement about their suitability for different applications.



Input and output devices

Barcodes and barcode readers

Barcodes

- Printed diagrams that consist of light and dark portions
- Contain information which can be read by a computer using a barcode reader
- There are two main types: 1D and 2D
- Can have error detection and prevention methods such as parity bits and check digits built in

2D barcodes

- Can contain more information in the same amount of space as a 1D barcode
- Require more processing in order to extract their contents

Barcode readers

- Consist of a laser light source, a lens, photodiodes and a mirror
- The mirror directs light from the laser onto a printed barcode
- The light reflected by the barcode passes through the lens and is incident on the photodiode
- The photodiode turns light into electrical charge which can be measured and processed to form a digital signal
- Light portions of a barcode reflect the most light while dark sections absorb incident light
- The pattern of light and dark stripes in a barcode corresponds to binary 1s and 0s

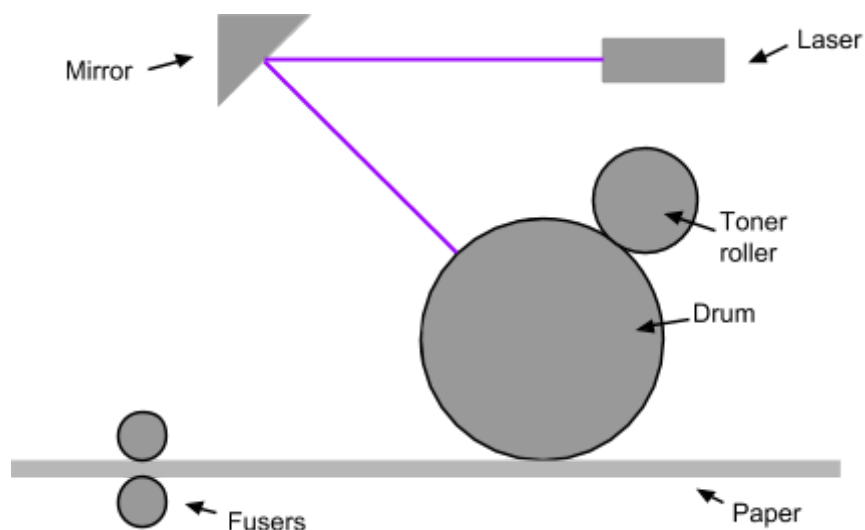
Digital cameras

- Consist of a lens that focuses light onto a sensor
- Sensors:
 - are usually CMOS (complementary metal oxide semiconductor) or CCD (charge coupled device)
 - convert incident light into electrical charge
 - consist of cells, each of which represents a pixel in the final image
- A shutter regulates the path of light between the lens and the sensor
- In colour cameras, there are multiple cells for each pixel, each of which has a filter that only allows in certain wavelengths of light
- A Bayer filter has the same number of green filters as red and blue combined and allows a camera to produce a closer approximation of what the human eye sees



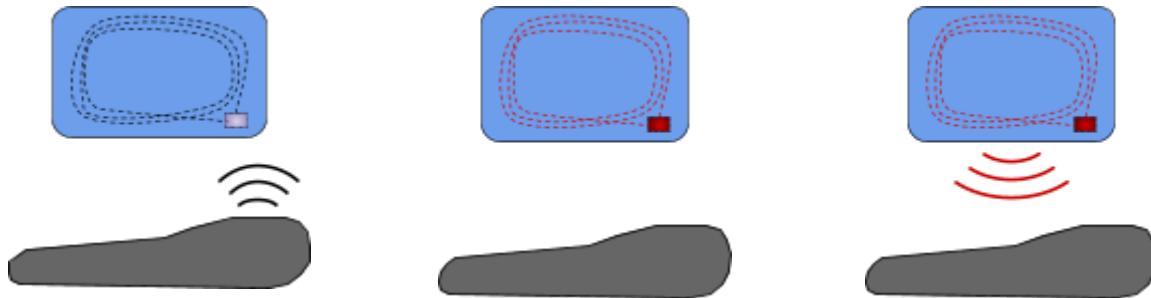
Laser printer

- An output device that produces images on paper from digital signals
- Print **whole pages at a time**
- Consist of a **laser light source**, a **mirror**, a **drum**, a **toner roller** and **fusers**
- The drum is **positively charged** all over
- The laser is directed at the drum's surface by the mirror to **discharge parts**, leaving behind an **impression of the page** in electrical charge
- The toner roller dispenses **negatively charged toner** onto the drum
- Toner is attracted to the positively charged portions of the drum and applied to the paper
- The paper is **heated** by fusers, fixing the toner to the paper
- Colour printers apply the same process with **four different colours** of toner: cyan, yellow, magenta and black (CYMK)



RFID

- Stands for radio frequency identification
- A method of transferring information **wirelessly** between a **tag** and a **reader**
- RFID tags:
 - contain a **chip** with a small amount of memory
 - contain a coil of wire, attached to the chip, which acts as an **antenna**
 - are usually **passive**, inducing enough power from the reader to operate the chip
 - can be **active**, containing a small power supply like a battery
- Active tags can be used much further away from readers than passive tags
- The reader emits **radio waves** which are picked up by the tag's antenna
- The power induced from these waves is enough to power a passive tag's chip
- The chip uses its antenna to emit a radio wave, containing the chip's information
- This wave is picked up by the reader which **decodes** the information



Secondary storage devices

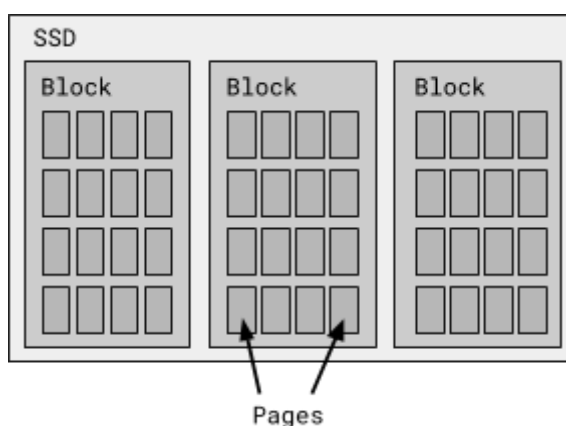
- Volatile RAM and ROM are a computer's **primary** storage
- Secondary storage, which is **non-volatile**, is used to store files and applications

Hard disk drives

- Consist of a number of circular **platters** made from a magnetic material
- Typically come in capacities of between 500GB and 5TB
- Are susceptible to **damage from movement**
- Above each platter hovers an **actuating arm** on which a **read/write head** is mounted
- The read/write head changes the magnetic **polarity** of parts of the platter
- The actuating arm allows the read/write head to access **all parts** of each platter
- Data is written in **concentric tracks**, each of which is further divided into **sectors**
- The platter rotates **thousands of times per minute**, allowing for good read and write speeds
- Can have their capacity increased, while remaining the same size, by:
 - adding **more platters**
 - **decreasing the width** of tracks

Solid-state drives

- Consist of **non-volatile NAND flash memory cells** and a **controller** that manages the structure of data on the drive
- Memory cells are formed of **floating gate transistors** which store information by **trapping electrical charge**
- Data is stored in **pages**, which are combined to form **blocks**



- Are **not capable of overwriting** data so must **completely erase** the entirety of a page before writing **new information** to it
- Have **no moving parts** so are:
 - capable of **far higher read and write speeds** than HDDs
 - suitable for use in **portable devices** like phones and tablets



Optical disks

- Include CDs, DVDs and Blu-rays
- Store information which can be read **optically** by a laser
- Can be either read-only, recordable or rewritable
- Have **just one continuous track** which **spirals** out from the center of the disk

Read-only disks

- Store data using pits and lands
- Pits are burnt into the disk by a **high-power laser** which **permanently deforms** the surface
- A **low-power** laser beam is passed over the surface of an optical disk
 - When the laser is incident on a land, the light from the beam **reflects back** onto a **photodiode**
 - When the laser is incident on a pit, the light from the beam is scattered in different directions
- The pattern of reflections and scatters can be converted into a **digital signal**

Recordable and rewritable disks

- A pattern of reflections and scatters is created by a **dye** on the disk's surface
 - If there is no dye, the laser beam is reflected off of the optical disk's surface
 - If there is dye, the laser beam is **absorbed** by the dye and not reflected at all
- Recordable optical disks use a **photosensitive dye** which **changes from opaque to transparent** under a **high-power** laser
- Rewritable optical disks use a phase-change dye that can be converted multiple times between transparent and opaque, depending on the temperature it is heated to



Comparison of secondary storage devices

	Hard-disk drive	Solid-state drive	Optical disk
Typical capacity	High capacity. Typically between 500GB and 5TB.	Relatively low capacity. Typically under 1TB.	Very low capacity. Blu-rays have the highest capacity at 25GB.
Read / write speeds	Good speeds. $\approx 100\text{MB/s}$	Very high speeds. $\approx 500\text{MB/s}$	Relatively low speeds. $\approx 30\text{MB/s}$
Latency	High	Very low	High
Portability	Bulky, heavy and easily damaged by movement.	Lightweight and rarely damaged by movement.	Very small and lightweight, can be damaged by scratches and dirt.
Power consumption	High	Low	High
Suitability	Good for desktop PCs and servers.	Good for laptops, phones and tablets.	Good for sharing and distributing small volumes of data.

