

Exercise walk-through

3.1.2

Secondary storage: magnetic, solid state and optical

A-Level Computer Science

“Describe the principal operation of ...”

One mark for each correct point, so write short sentences in this order:

- 1 name the **parts**;
- 2 say **what happens**, step by step, with the technical words;
- 3 finish with the **result**: how a 1 or a 0 is stored or read, or what comes out.

Describing what the device is *for* earns nothing. “A hard disk stores files” is not its operation.

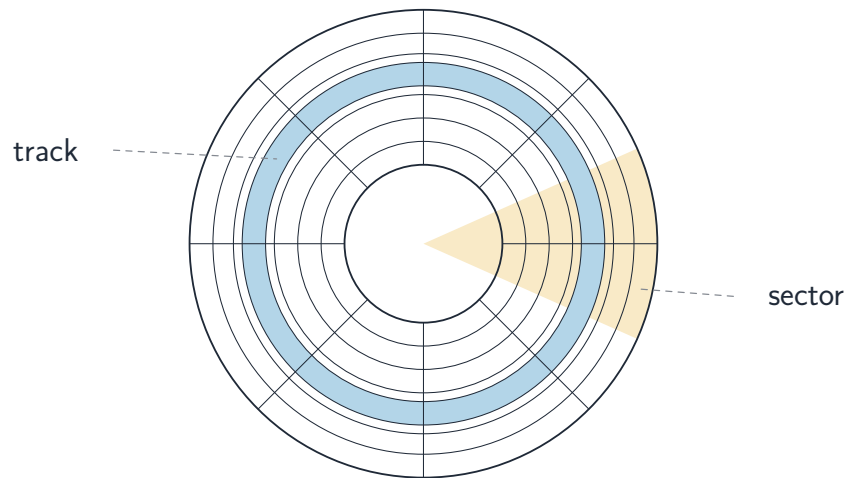
Magnetic hard disk

A **hard disk** stores bits as magnetised regions on spinning platters.

- a **read/write head** flies just above the surface
- data sits in concentric **tracks**, split into sectors
- cheap per GB, but mechanical – slower, and shock can crash the head



Tracks, sectors and the head



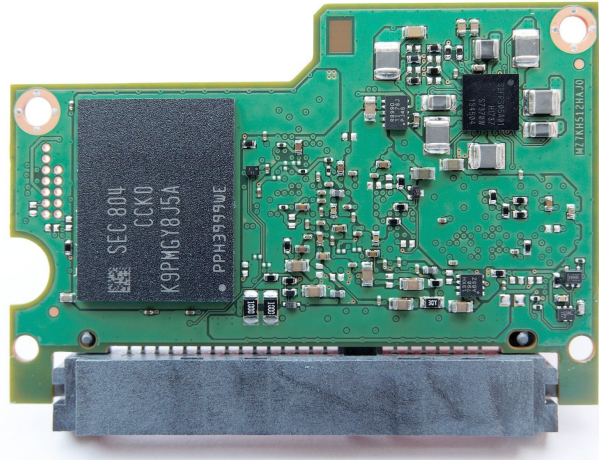
Access time is dominated by **seek** (moving the head to the track) and **latency** (waiting for the sector to arrive).

Data sits in concentric **tracks** divided into **sectors**; the head moves in and out while the platter spins, so access time is seek time plus rotational delay.

Magnetic hard disk: the marking points

- 1 One or more **platters**, each with a surface that can be **magnetised**.
- 2 The platters are on a **spindle** and spin at high speed.
- 3 Each surface is divided into **tracks**, and each track into **sectors**.
- 4 A **read/write head** on an **actuator arm** moves across the surface to the correct track.
- 5 **Write:** a current in the head makes a magnetic field that magnetises a tiny area in one of two directions, for 1 and 0.
- 6 **Read:** the magnetised areas pass under the head and produce a small changing current in it.

Solid-state and optical

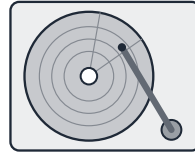


solid-state drive : flash, no moving parts

SSD: faster, tougher, lower power – but dearer per GB and cells wear out.

Exercise 2.1

2.1 Complete the description of a magnetic hard disk. Use words from the list. Each word is used once. [5]

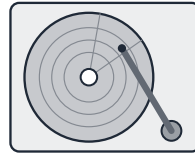


arm · magnetised · platters · sectors · tracks

A magnetic hard disk has one or more that spin at high speed. Each surface is divided into circular, and each of these is divided into The read/write head is on an that moves across the surface. To store a bit, a tiny area of the surface is in one of two directions.

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2.1

- the parts, from the outside in: **platters** spin; a surface has **tracks**; a track has **sectors**
- the head is on an **arm**
- a bit is an area **magnetised** in one of two directions

Exercise 2.2

2.2 Tick (✓) **one** box in each row to show which storage device the statement describes.[5]



hard disk



solid state



optical

Statement	hard disk	solid state	optical
A laser reads pits and lands.			
Electrons are trapped on a floating gate.			
A read/write head moves on an arm.			
It has one spiral track.			
It has no moving parts.			

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A read/write head moves on an arm.			
It has one spiral track.			
It has no moving parts.			

2.2

- laser, pits and lands → **optical disc**
- trapped electrons on a floating gate → **solid state**
- a head on an arm → **magnetic hard disk**
- one spiral track → **optical disc** (a hard disk has many circular tracks)
- no moving parts → **solid state**

Exercises 2.3-2.4

2.3 State **two** reasons why a computer needs secondary storage.

[2]



2.4 Give **two** uses of **removable** storage.

[2]



Exercises 2.3-2.4

2.3 State **two** reasons why a computer needs secondary storage.

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2.3 any **two** of:

- RAM is volatile, so programs and files must be kept somewhere when the power is off
- secondary storage has a much larger capacity than primary memory
- it costs much less per GB than RAM

2.4 Give **two** uses of **removable** storage.

[2]



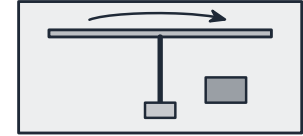
2.4 any **two** of:

- to move files from one computer to another
- to keep a backup copy in a different place
- to give software or films to other people

Exercise 2.5

2.5 The steps below describe how data is read from an optical disc. They are in the wrong order.

- **A** A light sensor detects the reflected light.
- **B** The changes in the reflected light are read as 1s and 0s.
- **C** A motor spins the disc.
- **D** The laser beam is focused on the spiral track of pits and lands.



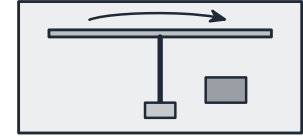
Write the letters in the correct order.

[2]

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- **A** A light sensor detects the reflected light.
- **B** The changes in the reflected light are read as 1s and 0s.
- **C** A motor spins the disc.
- **D** The laser beam is focused on the spiral track of pits and lands.



Write the letters in the correct order.

[2]

2.5

- the disc must spin and the laser must shine on the track before anything can be detected, so C then D come first
- then the sensor detects the reflection, and the changes are read as bits: **C, D, A, B**

Exercise 2.6

2.6 Explain why a solid state drive has a faster access speed than a magnetic hard disk. [2]



solid state
drive



magnetic
hard disk

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solid state
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magnetic
hard disk

2.6

- a hard disk must wait while the arm moves to the track and the platter turns to the sector
- a solid state drive has **no moving parts**: any cell is reached electronically, with almost no delay

Exercise 3.1 (a)

3.1 A photographer stores photographs on a magnetic hard disk.

(a) **Describe** the principal operation of a magnetic hard disk.

[5]



Exercise 3.1 (a)

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(a) **Describe** the principal operation of a magnetic hard disk.

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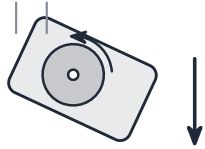
(a) any **five** of:

- it has one or more platters with a surface that can be magnetised
- the platters are on a spindle and spin at high speed
- each surface is divided into tracks and sectors
- a read/write head on an actuator arm moves across the surface to the correct track
- to write, a current in the head creates a magnetic field that magnetises an area in one of two directions, for 1 and 0
- to read, the magnetised areas passing under the head produce a changing current in it

Exercise 3.1 (b)

3.1 A photographer stores photographs on a magnetic hard disk.

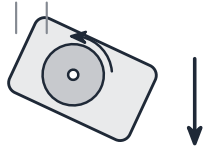
(b) The photographer drops the disk while it is running, and it stops working. **Explain** why a magnetic hard disk is damaged easily in this way. [2]



Exercise 3.1 (b)

3.1 A photographer stores photographs on a magnetic hard disk.

(b) The photographer drops the disk while it is running, and it stops working. **Explain** why a magnetic hard disk is damaged easily in this way. [2]



(b) the head moves very close to the surface of a platter that is spinning at high speed

- a knock can make the head touch the surface and scratch it, or damage the moving parts, so the data can no longer be read

Exercise 3.2 (a)

3.2 A smartphone stores its apps and photos in solid state (flash) memory.

(a) **Describe** how solid state (flash) memory stores data.

[4]



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3.2 A smartphone stores its apps and photos in solid state (flash) memory.

(a) **Describe** how solid state (flash) memory stores data.

[4]



(a) any **four** of:

- it is made of transistors arranged in a grid, using NAND (or NOR) flash technology
- each cell has a control gate and a floating gate
- a voltage moves electrons onto the floating gate, where they are trapped by an insulating layer
- trapped electrons represent 0, and no trapped electrons represent 1
- the electrons stay without power, so the data is kept
- data is erased and rewritten in blocks

Exercise 3.2 (b)

3.2 A smartphone stores its apps and photos in solid state (flash) memory.

(b) Give **three** reasons why solid state memory, not a magnetic hard disk, is used in a smartphone. [3]

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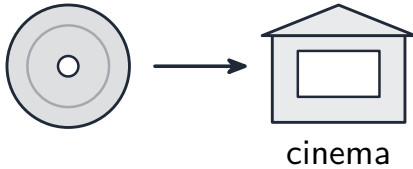
- no moving parts, so it is not damaged when the phone is dropped or shaken
- it uses less power, so the battery lasts longer
- it is smaller and lighter
- faster access, so apps open quickly
- it produces less heat and no noise

Exercise 3.3 (a)

3.3 A film company sends a finished film to cinemas on a Blu-ray disc.

(a) **Describe** how the data is read from the disc.

[4]

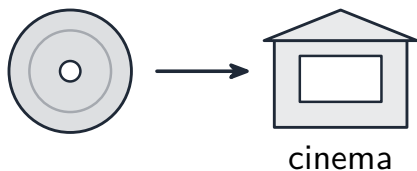


Exercise 3.3 (a)

3.3 A film company sends a finished film to cinemas on a Blu-ray disc.

(a) **Describe** how the data is read from the disc.

[4]



(a) any **four** of:

- a motor spins the disc
- a laser beam is focused on the disc's single spiral track
- the track is made of pits and lands, which reflect the light differently
- a light sensor detects the reflected light
- a change between a pit and a land is read as 1, and no change as 0

Exercise 3.3 (b)

3.3 A film company sends a finished film to cinemas on a Blu-ray disc.

(b) **Describe** how an optical disc **writer** stores data on a recordable disc. [2]

Exercise 3.3 (b)

3.3 A film company sends a finished film to cinemas on a Blu-ray disc.

- (b) **Describe** how an optical disc **writer** stores data on a recordable disc. [2]
- (b) a **higher-powered** laser heats spots on the dye (recording) layer
- the heated spots reflect light differently from the rest, so they are read like pits and lands

Exercise 3.4 (a)

3.4 A hospital must keep every patient's X-ray images for 30 years. The images take up 900 TB. They are looked at only occasionally, and they are kept on servers in a locked room.

(a) **State** the most suitable type of secondary storage for the servers. **Justify** your choice. [3]



Exercise 3.4 (a)

3.4 A hospital must keep every patient's X-ray images for 30 years. The images take up 900 TB. They are looked at only occasionally, and they are kept on servers in a locked room.

(a) **State** the most suitable type of secondary storage for the servers. **Justify** your choice. [3]



(a) **magnetic hard disk**

- 900 TB is a very large amount of data, and magnetic storage has the lowest cost per GB and very large capacities
- the images are opened only occasionally and the servers never move, so its slower access and lower robustness do not matter

Exercise 3.4 (b)

3.4 A hospital must keep every patient's X-ray images for 30 years. The images take up 900 TB. They are looked at only occasionally, and they are kept on servers in a locked room.

(b) A doctor carries a laptop between several hospitals and opens large image files on it all day. **State** the most suitable type of secondary storage for the laptop. **Justify** your choice. [3]



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3.4 A hospital must keep every patient's X-ray images for 30 years. The images take up 900 TB. They are looked at only occasionally, and they are kept on servers in a locked room.

(b) A doctor carries a laptop between several hospitals and opens large image files on it all day. **State** the most suitable type of secondary storage for the laptop. **Justify** your choice. [3]



(b) **solid state drive**

- the laptop is carried around, and a solid state drive has no moving parts, so it is not damaged by knocks
- it gives fast access to large files, and it uses less power, so the battery lasts longer

Exercise 3.4 (c)

3.4 A hospital must keep every patient's X-ray images for 30 years. The images take up 900 TB. They are looked at only occasionally, and they are kept on servers in a locked room.

(c) The hospital also copies the images onto removable storage every week. **Explain** why. [2]

Exercise 3.4 (c)

3.4 A hospital must keep every patient's X-ray images for 30 years. The images take up 900 TB. They are looked at only occasionally, and they are kept on servers in a locked room.

(c) The hospital also copies the images onto removable storage every week. **Explain** why. [2]

(c) it is a **backup**: if the servers fail, or are damaged by fire or stolen, the images are not lost

- removable storage can be kept in a **different place** from the servers

Exercise 3.4 (d)

3.4 A hospital must keep every patient's X-ray images for 30 years. The images take up 900 TB. They are looked at only occasionally, and they are kept on servers in a locked room.

(d) A manager suggests keeping all the images in RAM, “because RAM is faster”. Give **two** reasons why this is not suitable. [2]

Exercise 3.4 (d)

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(d) A manager suggests keeping all the images in RAM, “because RAM is faster”. Give **two** reasons why this is not suitable. [2]

(d) any **two** of:

- RAM is volatile, so every image would be lost when the power went off
- 900 TB of RAM would cost far too much
- a computer cannot hold that much RAM