



4.7.4 External Hardware Components

1) Optical disk drives and USB flash drives are two ways of transferring files from one computer to another.

- a) Describe the principles of operation of an optical disk drive that is used to read data from an optical disk such as a CD-ROM or DVD-ROM.

[6 marks]

Reading mechanism

- Low power laser/light is shone at the disk...
- And focussed on a spot on the track
- Some light is reflected back from the disk
- The amount of light reflected is measured // detected by a light sensor
- The disc spins at a constant linear velocity // variable angular velocity

How data is represented

- Data is stored on a spiral track
- Continuation of land/pit reflects light whereas transitions between land and pit scatters light.
- Transitions indicate a 1 and continuation represents 0

- b) USB Flash Drives (a type of SSD) are a more popular choice for transferring files such as images and word processed documents than CD-Rs (a type of optical disk).

Explain why this is the case.

[1 mark]

- Flash drives can have a higher storage capacity
- Flash drives have faster access times
- No drive is required to use a flash drive
- Flash drives can be reused
- Flash drives are more compact
- Flash drives are not damaged by scratches





- 2) A warehouse stores products that are waiting to be delivered to supermarkets. The products are packed onto pallets. For example, a pallet might hold 120 boxes of washing powder. All of the products on one pallet are of the same type.

The individual products on the pallets could be identified by labelling them individually with barcodes or by attaching RFID (radio-frequency identification) tags to them.

Each barcode/RFID tag would store a representation of a ProductID number the uniquely identifies the type of product (e.g. 102546 might represent a specific brand and box size of washing powder) together with an ItemID number that is unique to the specific item (e.g. box number 1 of the washing powder, box number 2 of the washing powder etc).

Figure 1 shows an example of five boxes of washing powder loaded onto a pallet and their ProductID and ItemID values.

Figure 1

ProductID: 263456 ItemID: 1	ProductID: 112485 ItemID: 2	ProductID: 892844 ItemID: 3	ProductID: 421111 ItemID: 4
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Figure 2 shows an excerpt from the simple database table that stores the details of the products that the warehouse has in stock.

Figure 2

ProductID	Description	QuantityInStock
263456	Tomato Soup 455g tin	1250
112485	Small Dishcloths	500
892844	Digital Scales	200

Some pallets delivered to the warehouse will be of products that already exist in the database table. Other deliveries will be of pallets of items that don't exist in the table because the warehouse has not stocked them before.





- a) Explain why the warehouse owners might prefer the individual products to be identified using RFID tags.

[2 marks]

Reason (1 mark)

- A lot of individual products will need to be scanned simultaneously during a delivery

Explanation (1 mark)

- The RFID tags could be read without removing products from their pallet
- RFID tags can be read from a greater distance
- No need to manually scan each tag
- RFID tags can be read at a faster rate
- RFID tags are less easily damaged than barcodes
- Don't have to spend time locating barcodes on items

- b) Explain why the product manufacturers or supermarket owners might prefer the individual products to be identified using barcode labels.

[2 marks]

- Barcodes are cheaper than RFID tags // less electronic waste // barcodes only scan the item the scanner is pointed at // barcodes can include human-readable encoding of the same data
- Higher cost of RFID tags would be added on to the prices // barcodes can be scanned by existing equipment at checkouts // backup systems exist as barcodes can be keyed in

- c) Describe how an RFID reader would read the ProductID and ItemID values from RFID tags as pallets are delivered and explain how this data could be used to update the database table that stores details of the products that the warehouse has in stock.

You should include in your description references to the types(s) of SQL statements (e.g. INSERT, SELECT, UPDATE) that could be used and their purpose, but you do **not** need to write any SQL code.

[6 marks]

- RFID reader/scanner transmits a signal
- The signal activates/induces a current in the RFID tag
- The RFID tag transmits the contained data by radiowave
- RFID signals are processed into a format that is suitable for querying the database
- SELECT is used to check if a record for a product already exists in the database
- UPDATE is used to increase the stock level if the produce is already in the database
- INSERT is used to create a new record for a product if it is not already in the database





- 3) Explain why a laser printer with a built-in wireless network adapter is likely to be a suitable choice of printer for a small office.

[3 marks]

Why laser printer (max 2 marks)

- Toner is cheaper per page than ink
- Prints many pages per minute
- Toner will not dry out
- High resolution output

Why wireless adapter (max 2 marks)

- Easy to share printer between many devices
 - Can connect / print directly without need for cables
 - Printer can be managed remotely
 - WiFi should be fast enough for the number of users of a small office
 - WiFi should have sufficient range for a small office
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- 4) Describe the principles of operation of a laser printer.

[6 marks]

- Bitmap of the image is built in memory from page description
- Negative charge applied to (photosensitive) drum
- Laser beam is directed at the drum...
- Using a mirror
- Where the laser strikes the drum is discharged
- Negative charge is applied to the toner
- Toner sticks to the drum where the laser struck
- Paper is passed over the drum and toner transfer to it
- Positively charged transfer roller assists transfer of toner from drum to paper
- Heater fuses toner onto the paper
- For colour printing this is repeated with four different toners





- 5) Supermarkets often gather information about their customers and the purchases that they make. This information can be analysed by the supermarket and other companies for a range of purposes.

Some of the information is collected at the checkout, where the identity of the person is read from a loyalty or payment card using RFID (radio-frequency identification) and a barcode reader is used to identify the products being purchased.

Describe the principles of operation of the hardware used to collect the information

[6 marks]

How RFID works

- RFID tag contains (transmission) circuitry and antenna
- Memory on tag stores (customer) data
- RFID reader at the till transmits signal
- The signal activates/ induces current in the RFID tag
- RFID tag transmits /sends data by radio waves
- RFID tag on a card is a passive device
- RFID transmits over very short range

How barcode works

- A laser is directed at a bar code
- A mirror moves the beam across the bar code // user moves reader across the bar code
- The light is reflected back
- Black/white bands reflect different amounts of light (white more, black less)
- Light sensor / photodiode / CCD measures the amount of light reflected
- Light reflected is converted into an electrical signal

CMOS/CCD/camera

- Grid of (pixel) sensors // CMOS/CCD sensor
- Each sensor measures light intensity of a point
- Sensor outputs a voltage dependent upon light intensity
- Voltages turned into binary data // voltages passed through ADC
- Image processing software analyses image
- This identifies black/white bands in the barcode





6) A computer is fitted with a solid-state disk (SSD).

a) Explain why desktop computers usually have secondary storage devices.

[2 marks]

- To store data / programs whilst the computer is turned off
- ... as the contents of RAM are lost when the computer is turned off // RAM is volatile memory
- To transfer data / programs between computers
- Allows the storage of files that could be fit in RAM // RAM memory amount is more limited

b) Describe the principles of operation of an SSD.

[4 marks]

- Data is stored electronically // it has no moving parts
- Data is stored in floating gate transistors // data is stored in transistors that do not lose their charge when power is no longer applied // electrons are trapped between oxide layers
- Presence/absence of trapped electrons indicates 1/0
- NAND memory // flash memory // EEPROM memory is used
- Data is organised into pages / blocks
- A whole block of data must be written // it is not possible to write individual values
- A block must be erased before it can be overwritten
- Controller manages the organisation of the data // controller manages the reading and writing of data





7) A company uses a file server that stores files on magnetic hard disk drives. These files can be accessed by other computers through a network.

a) Describe how the data for a file would be stored on a magnetic hard disk and read from it by the file server.

[4 marks]

- Disk is coated in a magnetisable material // iron / cobalt-based material
- Magnetising a spot in one direction could represent 0 and the other direction could represent 1 // any plausible way of representing two values
- Disk divided into rings called tracks
- Tracks divided into sectors / blocks
- Read/write head moves in / out (radially) (to correct track)
- Wait until correct sector / block passes under read/write head
- Disk spins at high speed
- Read/write head senses magnetic field and converts to 0s and 1s

b) The company needs to purchase a second file server.

It is considering whether to purchase a file server with magnetic hard disk drives installed or a file server with solid-state disks (SSDs) instead. Each of the file servers has the same total storage capacity.

State **one advantage** and **one disadvantage** of purchasing the file server that uses SSDs.

[2 marks]

Advantage (1 mark)

- lower power consumption
- faster access times // faster transfer rate // lower latency NE. faster
- smaller (physically)
- generate less heat // require less cooling
- lower failure rate // less susceptible to damage from impact // not affected by magnetic fields

Disadvantage (1 mark)

- higher cost (per megabyte)
- higher error rate (over time) // more blocks become unusable over time in an SSD





8) The organisers of a marathon race have installed checkpoints at regular intervals along the course. The time at which each competitor passes a checkpoint is recorded.

a) Three input devices that could be used at each checkpoint to capture data automatically as competitors pass by are:

- Barcode reader
- Digital camera
- RFID reader

The race organisers decide to use RFID readers. Evaluate the suitability of all three devices and explain why RFID is the most appropriate choice.

[6 marks]

Digital camera

- **Advantage: no tag/code that can be lost / damaged**
- **Disadvantage: difficulties with taking a clear picture eg caused by blocked line of sight due to other competitors**
- **Disadvantage: high data storage requirements for the number of photos that will be needed in a large event**
- **Disadvantage: face recognition may not work eg due to costumed runners**
- **Disadvantage: face recognition software not always reliable**
- **Disadvantage: with a lot of competitors a lot of operators/cameras might be needed**

Barcode reader

- **Advantage: barcodes are very cheap**
- **Advantage: often smaller and lighter than an RFID tag so less of a burden to competitors**
- **Disadvantage: barcode could be obscured (e.g. by clothing)**
- **Disadvantage: difficult to scan a code that is being moved around and is not on a flat surface**
- **Disadvantage: some codes might be missed if a large number of competitors pass a checkpoint at roughly the same time**
- **Disadvantage: with a lot of competitors a lot of operators/barcode readers might be needed**
- **Disadvantage: scanner needs to be quite close to code / runners may need to stop to have their barcode scanned**
- **Disadvantage: barcode more likely to be damaged than RFID tag – when it is damaged it is unreadable**

RFID reader

- **Advantage: RFID can be read faster than the other devices and competitors may be going past the checkpoint quickly**
- **Advantage: tags potentially reusable – saving money in future years of the event**
- **Advantage: no line-of-sight issues**
- **Advantage: no need for runner to stop at checkpoint**
- **Disadvantage: potential for RFID dead spots**





The computer used by the race organisers has a built-in magnetic hard disk drive, a built-in solid-state disk and an optical disk drive.

- b) State **two** reasons why the computer has a magnetic hard disk and a solid-state drive instead of using only solid-state storage.

[2 marks]

- Because hard disk drives are cheaper (per unit of storage) than solid state drives // because SSDs are more expensive (per unit of storage) than hard disks
- Because hard disk drives have a higher capacity than solid state drives // because SSDs have a lower capacity than hard disk drives

- c) State **two** hardware components of a solid-state drive..

[2 marks]

- NAND (flash) memory
 - Controller
 - SATA interface
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