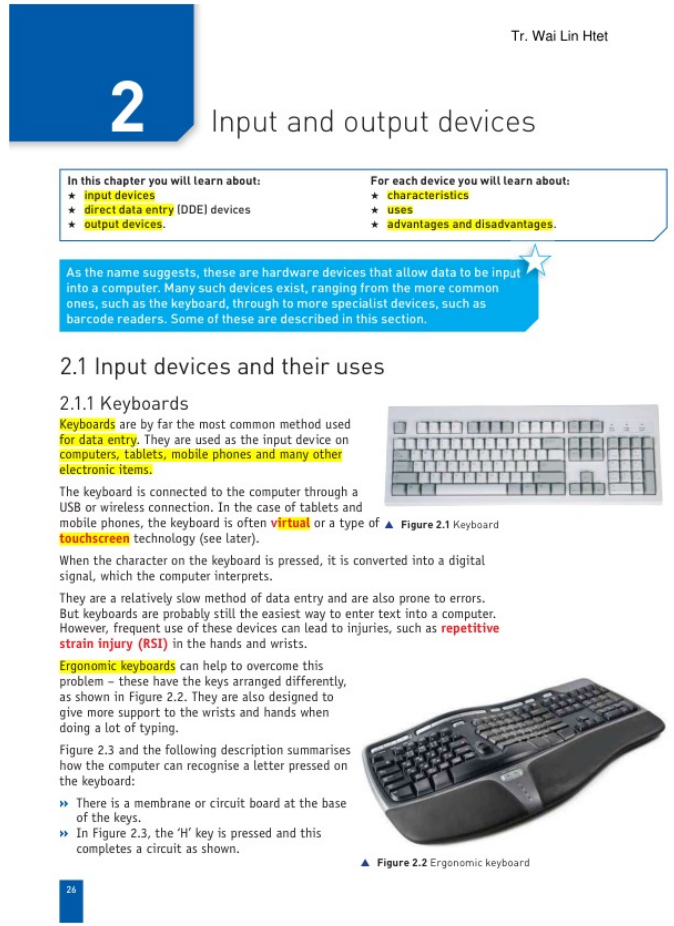
INPUT AND OUTPUT DEVICES

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Tr. Wai Lin Htet

2 Input and output devices

In this chapter you will learn about:
- input devices
- direct data entry (DDE) devices
- output devices.

For each device you will learn about:
- characteristics
- uses
- advantages and disadvantages.

As the name suggests, these are hardware devices that allow data to be input into a computer. Many such devices exist, ranging from the more common ones, such as the keyboard, through to more specialist devices, such as barcode readers. Some of these are described in this section.

2.1 Input devices and their uses

2.1.1 Keyboards

Keyboards are by far the most common method used for data entry. They are used as the input device on computers, tablets, mobile phones and many other electronic items.

▲ Figure 2.1 Keyboard

The keyboard is connected to the computer through a USB or wireless connection. In the case of tablets and mobile phones, the keyboard is often virtual or a type of touchscreen technology (see later).

When the character on the keyboard is pressed, it is converted into a digital signal, which the computer interprets.

They are a relatively slow method of data entry and are also prone to errors. But keyboards are probably still the easiest way to enter text into a computer. However, frequent use of these devices can lead to injuries, such as repetitive strain injury (RSI) in the hands and wrists.

Ergonomic keyboards can help to overcome this problem – these have the keys arranged differently, as shown in Figure 2.2. They are also designed to give more support to the wrists and hands when doing a lot of typing.

Figure 2.3 and the following description summarises how the computer can recognise a letter pressed on the keyboard:

- There is a membrane or circuit board at the base of the keys.
- In Figure 2.3, the 'H' key is pressed and this completes a circuit as shown.

▲ Figure 2.2 Ergonomic keyboard

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LEARNING OBJECTIVES

- Identify input, direct data entry and output devices
- Describe how devices work and where they are used
- Explain advantages and disadvantages in context
- Choose appropriate devices in exam scenarios

THREE CATEGORIES

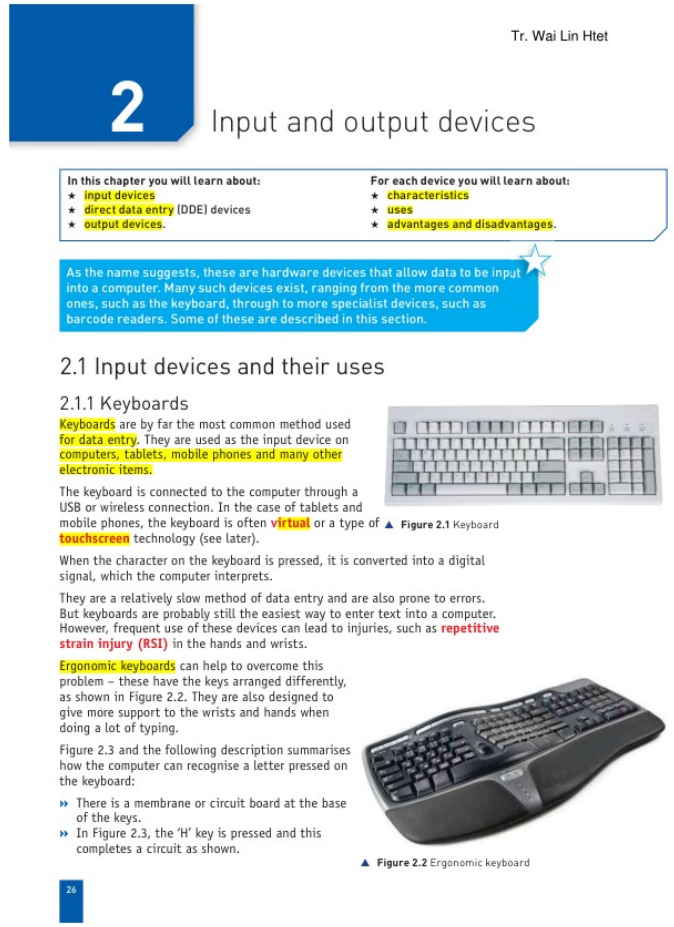
- INPUT: devices used to enter data and instructions
- DDE: captures data with little or no manual typing
- OUTPUT: communicates processed information or controls a process

INPUT DEVICES

- Characteristics • Uses • Advantages • Disadvantages

KEYBOARDS

- Used to enter text, numbers and commands
- USB, wireless and virtual keyboards
- Key press completes a circuit; CPU identifies character
- Ergonomic designs can reduce wrist strain



Tr. Wai Lin Htet

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▲ **Figure 2.2** Ergonomic keyboard

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KEYBOARDS • EXAM FOCUS

- State a realistic application of this device
- Explain WHY this device suits that application
- Give one context-specific advantage
- Give one relevant disadvantage

NUMERIC KEYPADS

- Used for PINs at ATMs, POS terminals and chip-and-PIN
- Faster than a full keyboard for entering numeric data
- Small keys may make input difficult

MOUSE

- Pointer controlled by movement; buttons select commands
- Optical mice detect reflected light
- Useful for menus, file management and image editing
- Requires a suitable flat surface

MOUSE • EXAM FOCUS

- State a realistic application of this device
- Explain WHY this device suits that application
- Give one context-specific advantage
- Give one relevant disadvantage

TOUCHPAD

- Integrated into many laptops
- Finger movement controls pointer; tap to select
- Portable and needs no separate mouse
- Dragging and precise pointer control can be harder

TRACKERBALL

- Rotate the ball without moving the device
- Useful where desk space is limited
- Can help users with restricted wrist movement
- Not standard equipment; may require training

REMOTE CONTROL

- Uses infrared signals to control other devices
- TV, multimedia and industrial equipment
- Operates from a distance
- Signal can be obstructed

JOYSTICK

- Stick and buttons control on-screen movement
- Games and flight simulators
- More realistic for some simulations
- Less suitable for precise pointer positioning

DRIVING WHEEL

- Wheel and pedals simulate steering, braking and acceleration
- Used in racing games and driving simulators
- More natural than keyboard steering
- Can be expensive; feedback may be limited

TOUCH SCREENS: INPUT

- Select options by touching screen icons
- Used at ATMs, kiosks, smartphones and tills
- Fast and intuitive for limited menu options
- Fingerprints and repeated use can be problems

SCANNERS

- Convert paper documents or photos into digital images
- Flatbed scanners use light to capture an image
- OCR can convert scanned text into editable text
- Scanning can be slow at high resolution

SCANNERS • EXAM FOCUS

- State a realistic application of this device
- Explain WHY this device suits that application
- Give one context-specific advantage
- Give one relevant disadvantage

DIGITAL CAMERAS

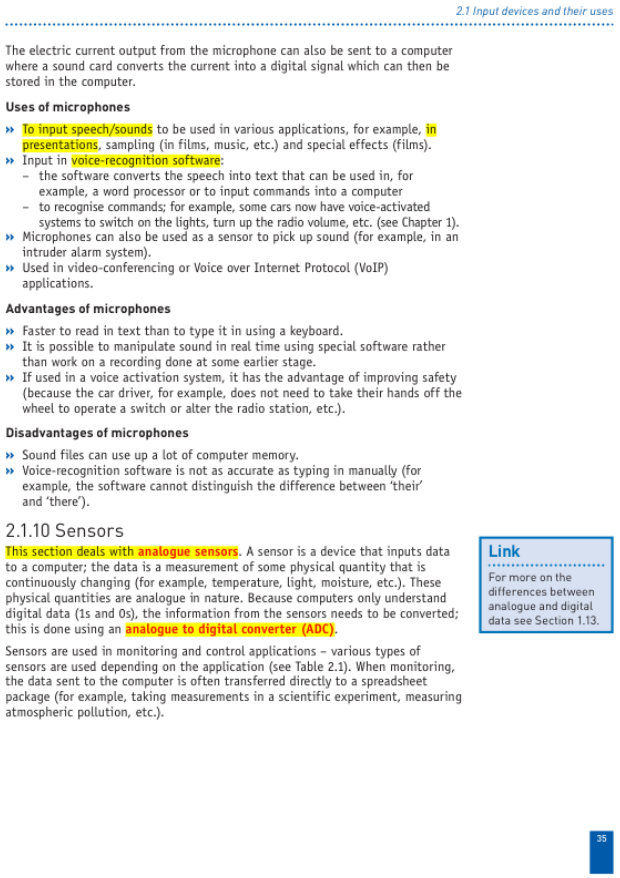
- Images stored on memory cards
- Transfer via card reader, USB or wireless connection
- Used in photography, medical work and reversing aids
- Images can require substantial storage

MICROPHONES

- Sound vibrations converted into an electrical signal
- Computer sound hardware converts analogue sound to digital
- Used for speech recognition, conferencing and recording
- Recognition may make errors; audio uses storage

SENSORS

- Measure changing physical quantities
- Examples: temperature, pressure, light, humidity and pH
- Analogue sensor output requires an ADC
- Used for monitoring and automatic control



2.1 Input devices and their uses

The electric current output from the microphone can also be sent to a computer where a sound card converts the current into a digital signal which can then be stored in the computer.

Uses of microphones

- To input speech/sounds to be used in various applications, for example, in presentations, sampling (in films, music, etc.) and special effects (films).
- Input in voice-recognition software:
  - the software converts the speech into text that can be used in, for example, a word processor or to input commands into a computer
  - to recognise commands; for example, some cars now have voice-activated systems to switch on the lights, turn up the radio volume, etc. (see Chapter 1).
- Microphones can also be used as a sensor to pick up sound (for example, in an intruder alarm system).
- Used in video-conferencing or Voice over Internet Protocol (VoIP) applications.

Advantages of microphones

- Faster to read in text than to type it in using a keyboard.
- It is possible to manipulate sound in real time using special software rather than work on a recording done at some earlier stage.
- If used in a voice activation system, it has the advantage of improving safety (because the car driver, for example, does not need to take their hands off the wheel to operate a switch or alter the radio station, etc.).

Disadvantages of microphones

- Sound files can use up a lot of computer memory.
- Voice-recognition software is not as accurate as typing in manually (for example, the software cannot distinguish the difference between 'their' and 'there').

2.1.10 Sensors

This section deals with analogue sensors. A sensor is a device that inputs data to a computer; the data is a measurement of some physical quantity that is continuously changing (for example, temperature, light, moisture, etc.). These physical quantities are analogue in nature. Because computers only understand digital data (1s and 0s), the information from the sensors needs to be converted; this is done using an analogue to digital converter (ADC).

Sensors are used in monitoring and control applications – various types of sensors are used depending on the application (see Table 2.1). When monitoring, the data sent to the computer is often transferred directly to a spreadsheet package (for example, taking measurements in a scientific experiment, measuring atmospheric pollution, etc.).

Link

For more on the differences between analogue and digital data see Section 1.13.

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SENSORS • EXAM FOCUS

- State a realistic application of this device
- Explain WHY this device suits that application
- Give one context-specific advantage
- Give one relevant disadvantage

LIGHT PENS

- Detect screen light changes to locate pointer position
- Used with CRT monitors in older CAD systems
- Small and straightforward
- Limited to compatible CRT displays

LIGHT PENS • EXAM FOCUS

- State a realistic application of this device
- Explain WHY this device suits that application
- Give one context-specific advantage
- Give one relevant disadvantage

DIRECT DATA ENTRY (DDE)

- Characteristics • Uses • Advantages • Disadvantages

MAGNETIC STRIPE READERS

- Read encoded data on card magnetic stripes
- Used for payments and access control
- Fast, with no manual typing
- Damage to the stripe can prevent reading

CONTACTLESS CARD READERS

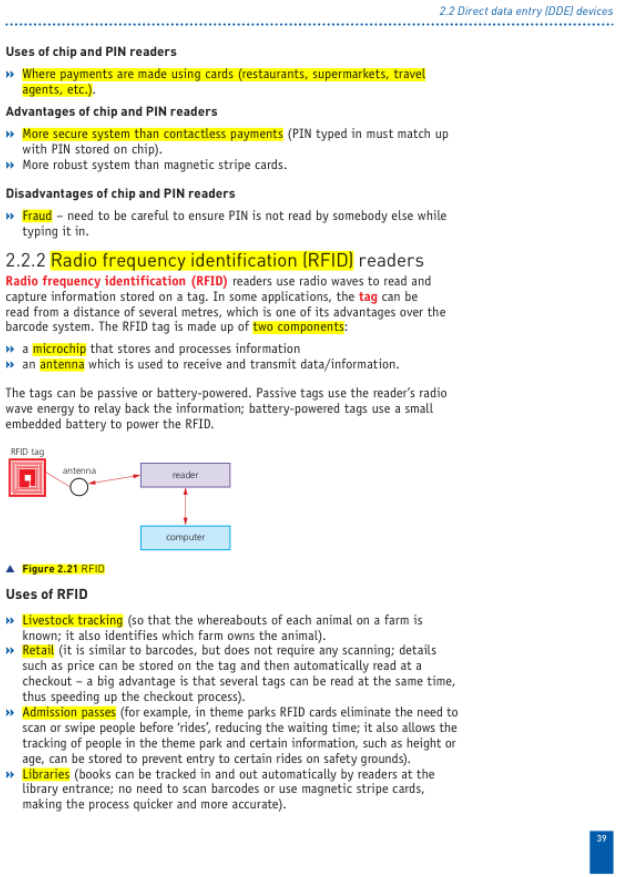
- Card communicates with reader using radio waves
- Hold card close to terminal to pay
- Quick transactions; no PIN for eligible transactions
- Security and transaction-limit considerations

CHIP AND PIN READERS

- Chip is read while customer enters PIN
- Used at payment terminals
- PIN verification improves security
- PIN can be observed if not shielded

RFID READERS

- Use radio waves to read tags
- Tags contain a microchip and antenna
- Used in retail, libraries, livestock and access passes
- Read multiple tags without line of sight



Uses of chip and PIN readers

- Where payments are made using cards (restaurants, supermarkets, travel agents, etc.).

Advantages of chip and PIN readers

- More secure system than contactless payments (PIN typed in must match up with PIN stored on chip).
- More robust system than magnetic stripe cards.

Disadvantages of chip and PIN readers

- Fraud – need to be careful to ensure PIN is not read by somebody else while typing it in.

2.2.2 Radio frequency identification (RFID) readers

Radio frequency identification (RFID) readers use radio waves to read and capture information stored on a tag. In some applications, the **tag** can be read from a distance of several metres, which is one of its advantages over the barcode system. The RFID tag is made up of two components:

- a microchip that stores and processes information
- an antenna which is used to receive and transmit data/information.

The tags can be passive or battery-powered. Passive tags use the reader's radio wave energy to relay back the information; battery-powered tags use a small embedded battery to power the RFID.

▲ **Figure 2.21** RFID

Uses of RFID

- Livestock tracking (so that the whereabouts of each animal on a farm is known; it also identifies which farm owns the animal).
- Retail (it is similar to barcodes, but does not require any scanning; details such as price can be stored on the tag and then automatically read at a checkout – a big advantage is that several tags can be read at the same time, thus speeding up the checkout process).
- Admission passes (for example, in theme parks RFID cards eliminate the need to scan or swipe people before 'rides', reducing the waiting time; it also allows the tracking of people in the theme park and certain information, such as height or age, can be stored to prevent entry to certain rides on safety grounds).
- Libraries (books can be tracked in and out automatically by readers at the library entrance; no need to scan barcodes or use magnetic stripe cards, making the process quicker and more accurate).

RFID READERS • EXAM FOCUS

- State a realistic application of this device
- Explain WHY this device suits that application
- Give one context-specific advantage
- Give one relevant disadvantage

OPTICAL MARK RECOGNITION (OMR)

- Detects the position of pencil or pen marks
- Used for multiple-choice exams and surveys
- Fast and accurate for fixed-response forms
- Requires correctly completed specially designed forms

OPTICAL MARK RECOGNITION (OMR) • EXAM FOCUS

- State a realistic application of this device
- Explain WHY this device suits that application
- Give one context-specific advantage
- Give one relevant disadvantage

OPTICAL CHARACTER RECOGNITION (OCR)

- Converts printed text images into editable electronic text
- Used for passports, archives and number plates
- Faster than retyping documents
- Poor handwriting may cause recognition errors

OPTICAL CHARACTER RECOGNITION (OCR) • EXAM FOCUS

- State a realistic application of this device
- Explain WHY this device suits that application
- Give one context-specific advantage
- Give one relevant disadvantage

BARCODE READERS

- Read encoded patterns of bars
- Used in supermarkets, libraries and stock control
- Fast data entry and automatic stock updates
- Damaged or swapped barcodes can cause problems

BARCODE READERS • EXAM FOCUS

- State a realistic application of this device
- Explain WHY this device suits that application
- Give one context-specific advantage
- Give one relevant disadvantage

QR CODE SCANNERS

- Read square two-dimensional codes
- Store URLs, contact details and boarding passes
- Smartphone cameras can scan them
- Malicious QR codes may direct users to unsafe sites

QR CODE SCANNERS • EXAM FOCUS

- State a realistic application of this device
- Explain WHY this device suits that application
- Give one context-specific advantage
- Give one relevant disadvantage

OUTPUT DEVICES

- Characteristics • Uses • Advantages • Disadvantages

CRT MONITORS

- Use electron beams and a phosphor screen
- Mainly specialist legacy applications
- Support light pens
- Heavy, bulky and power-hungry

LCD AND LED SCREENS

- LCD uses liquid crystals and backlighting
- LED backlighting improves efficiency and brightness
- Common in laptops, tablets and monitors
- Viewing angle, motion blur or stuck pixels can be limitations

TOUCH SCREENS: OUTPUT

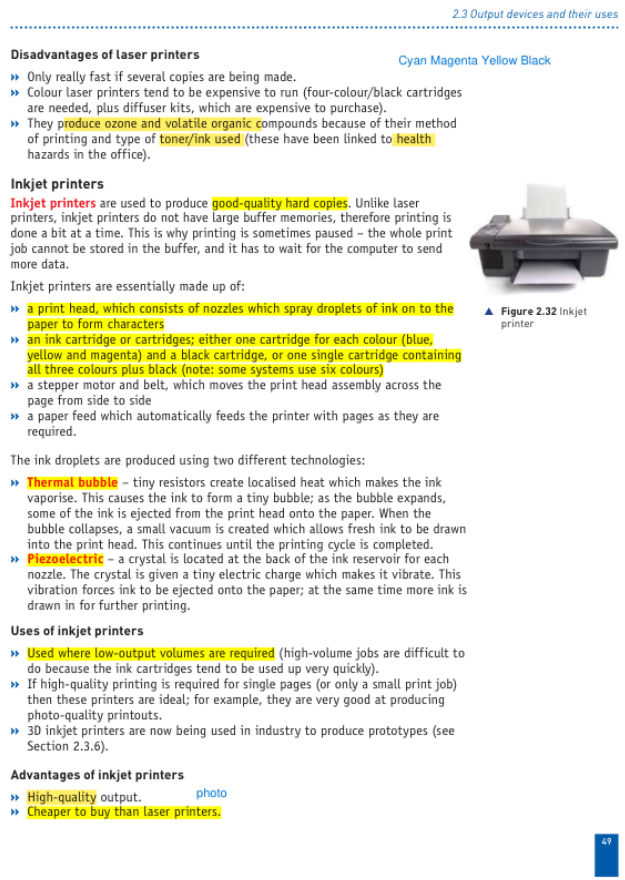
- Display information while also accepting touch input
- Used in ticket machines, ATMs and kiosks
- The displayed choices respond to user selections
- Not ideal for entering large amounts of data

MULTIMEDIA PROJECTORS

- Project a computer image onto a large screen
- Used for presentations and training
- Allow a group to view the same content
- Can be expensive and require suitable lighting

LASER PRINTERS

- Use toner and an electrostatic process
- Suitable for high-volume office printing
- Fast and high-quality text output
- Colour consumables and initial cost can be high



2.3 Output devices and their uses

Disadvantages of laser printers

- Only really fast if several copies are being made.
- Colour laser printers tend to be expensive to run (four-colour/black cartridges are needed, plus diffuser kits, which are expensive to purchase).
- They produce ozone and volatile organic compounds because of their method of printing and type of toner/ink used (these have been linked to health hazards in the office).

Cyan Magenta Yellow Black

Inkjet printers

Inkjet printers are used to produce good-quality hard copies. Unlike laser printers, inkjet printers do not have large buffer memories, therefore printing is done a bit at a time. This is why printing is sometimes paused – the whole print job cannot be stored in the buffer, and it has to wait for the computer to send more data.

Inkjet printers are essentially made up of:

- a print head, which consists of nozzles which spray droplets of ink on to the paper to form characters
- an ink cartridge or cartridges; either one cartridge for each colour (blue, yellow and magenta) and a black cartridge, or one single cartridge containing all three colours plus black (note: some systems use six colours)
- a stepper motor and belt, which moves the print head assembly across the page from side to side
- a paper feed which automatically feeds the printer with pages as they are required.

▲ **Figure 2.32** Inkjet printer

The ink droplets are produced using two different technologies:

- **Thermal bubble** – tiny resistors create localised heat which makes the ink vaporise. This causes the ink to form a tiny bubble; as the bubble expands, some of the ink is ejected from the print head onto the paper. When the bubble collapses, a small vacuum is created which allows fresh ink to be drawn into the print head. This continues until the printing cycle is completed.
- **Piezoelectric** – a crystal is located at the back of the ink reservoir for each nozzle. The crystal is given a tiny electric charge which makes it vibrate. This vibration forces ink to be ejected onto the paper; at the same time more ink is drawn in for further printing.

Uses of inkjet printers

- Used where low-output volumes are required (high-volume jobs are difficult to do because the ink cartridges tend to be used up very quickly).
- If high-quality printing is required for single pages (or only a small print job) then these printers are ideal; for example, they are very good at producing photo-quality printouts.
- 3D inkjet printers are now being used in industry to produce prototypes (see Section 2.3.6).

Advantages of inkjet printers

- High-quality output.
- Cheaper to buy than laser printers.

photo

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LASER PRINTERS • EXAM FOCUS

- State a realistic application of this device
- Explain WHY this device suits that application
- Give one context-specific advantage
- Give one relevant disadvantage

INKJET PRINTERS

- Spray tiny droplets of ink onto paper
- Useful for home and photographic printing
- Compact and good colour output
- Ink replacement can be costly

INKJET PRINTERS • EXAM FOCUS

- State a realistic application of this device
- Explain WHY this device suits that application
- Give one context-specific advantage
- Give one relevant disadvantage

PLOTTERS

- Produce large drawings and designs
- Used for CAD and architectural plans
- Suitable for large-format precise output
- Can be expensive and take up space

3D PRINTERS

- Build physical objects layer by layer
- Used for prototypes, custom parts and medical models
- Enables complex custom designs
- Printing can be slow and materials costly

SPEAKERS

- Convert electrical signals into sound
- Used for music, alerts and accessibility
- Useful for audible warnings
- Can disturb others and may require amplification

OCR VS OMR

- OCR recognises characters; OMR recognises positions of marks
- OCR suits editable text; OMR suits multiple-choice forms
- OMR is usually more accurate for correctly completed forms
- OCR allows more flexible responses

BARCODE VS RFID

- Barcode normally requires a visible scan
- RFID can be read without line of sight
- RFID can read multiple tags together
- RFID tags and infrastructure can cost more

INPUT VS OUTPUT: TOUCH SCREEN

- INPUT: user touches a displayed choice
- OUTPUT: screen displays menus and results
- One device can perform both roles

SENSORS AND ADC

- Physical measurement → analogue signal
- ADC converts signal into digital data
- Computer processes data and may control an output device
- Monitoring records readings; control responds automatically

CHOOSE THE BEST DEVICE

- Multiple-choice exam papers → OMR
- Editable printed text → OCR
- Supermarket item codes → barcode reader
- Automatic greenhouse temperature → temperature sensor
- Large architectural drawings → plotter

EXAM PRACTICE

- Questions adapted from Chapter 2 content and exam-style topics
- Answer each question before revealing the model answer
- Use precise device terminology and context-specific reasons

EXAM QUESTION 1

- Name a suitable printer for high-volume office letters.

- Think • Identify • Explain

MODEL ANSWER 1

- Laser printer — fast for producing many copies of text.

- Exam tip: connect the feature to the application.

EXAM QUESTION 2

- Which device produces a large drawing on plastic sheeting?

- Think • Identify • Explain

MODEL ANSWER 2

- Plotter — suitable for large-format drawings.
- Exam tip: connect the feature to the application.

EXAM QUESTION 3

- State two advantages of RFID over barcodes.

- Think • Identify • Explain

MODEL ANSWER 3

- No line-of-sight scan needed; multiple tags can be read together.

- Exam tip: connect the feature to the application.

EXAM QUESTION 4

- Explain the difference between OCR and OMR.

- Think • Identify • Explain

MODEL ANSWER 4

- OCR recognises characters and creates editable text; OMR detects the position of marks on a form.

- Exam tip: connect the feature to the application.

EXAM QUESTION 5

- Why is an ADC needed with an analogue sensor?

- Think • Identify • Explain

MODEL ANSWER 5

- Sensors produce analogue readings; an ADC converts these to digital data for the computer.

- Exam tip: connect the feature to the application.

EXAM QUESTION 6

- Give two disadvantages of touch screens.

- Think • Identify • Explain

MODEL ANSWER 6

- The surface becomes dirty; limited options / unsuitable for entering large amounts of text.

- Exam tip: connect the feature to the application.

EXAM QUESTION 7

- Identify three sensors suitable for a burglar alarm.

- Think • Identify • Explain

MODEL ANSWER 7

- Pressure, light and sound sensors are examples listed in the chapter for intruder alarms.

- Exam tip: connect the feature to the application.

EXAM QUESTION 8

- State one advantage and one disadvantage of contactless cards.

- Think • Identify • Explain

MODEL ANSWER 8

- Advantage: faster payments. Disadvantage: potential unauthorised transactions / payment limits.

- Exam tip: connect the feature to the application.

EXAM QUESTION 9

- Explain why a trackerball may be preferred to a mouse.

- Think • Identify • Explain

MODEL ANSWER 9

- It needs less desk space and may be easier for users with limited wrist movement.

- Exam tip: connect the feature to the application.

EXAM QUESTION 10

- Describe a use of a QR code.
- Think • Identify • Explain

MODEL ANSWER 10

- It can encode a web address or electronic boarding pass, read by a smartphone camera.

- Exam tip: connect the feature to the application.

CHAPTER 2 RECAP

- Input devices capture user data and measurements
- DDE reduces manual entry
- Output devices present results or act in control systems
- Always justify device choices with the scenario

THANK YOU

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