Chapter 5

1.3.3 & 1.3.4 Input, Output & Storage Devices

Learning Outcome	To Read	Have Read	To Revise	Have	Prepared
1.3.3: Input devices					
Describe the principles of operation (how each device works) of these input devices: 2D and 3D scanners, barcode readers, Quick Response (QR) code readers, digital cameras, keyboards, mice, touch screens, interactive whiteboard, microphones					
Describe how these principles are applied to real-life scenarios, for example: scanning of passports at airports, barcode readers at supermarket checkouts, and touch screens on mobile devices					
Describe how a range of sensors can be used to input data into a computer system, including light, temperature, magnetic field, gas, pressure, moisture, humidity, ph and motion					
Describe how these sensors are used in real-life scenarios, for example: street lights, security devices, pollution control, games, and household and industrial applications					
1.3.4: Output devices					
Describe the principles of operation of a range of output devices, including: inkjet, laser and 3D printers; 2D and 3D cutters; speakers and headphones; actuators;					

Learning Outcome	To Read	Have Read	To Revise	Have	Prepared
flat-panel display screens, including Liquid Crystal Display (LCD) and Light-Emitting Diodes (LED); and LCD projectors and Digital Light Projectors (DLP)					
Describe how these principles are applied to real-life scenarios, for example: printing single items on demand or in large volumes; use of small screens on mobile devices					

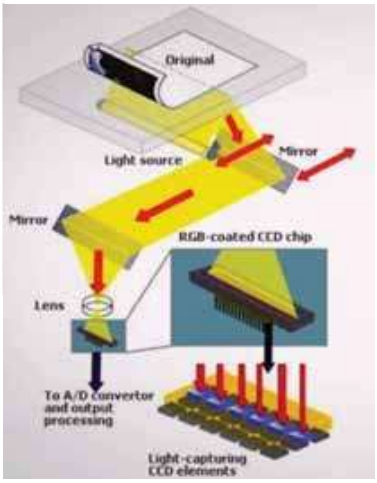
Input Devices:

Input devices allow us to enter raw data into a computer. The computer processes the data and then produces outputs that we can understand using an output device. Input devices can be manual or automatic.

There are two different categories of input device. They are:

- **Manual Input Devices** : With a manual input device the user must enter data into the computer by hand. e.g. mouse, keyboard, scanner.
- **Direct Data Entry (DDE) Devices** : A direct data entry device can transfer information automatically from a source document such as a form or barcode into the computer. The user does not need to manually enter the information. e.g. optical mark recognition, smart cards.

There are many different input devices available. Each input device is suitable for a different purpose. Below you will find descriptions of the most common manual input and direct data entry devices.



Manual Input Devices

With a manual input device the user must enter data into the computer by hand. e.g. mouse, keyboard, scanner.

Two-dimensional scanners

2D scanners are input devices used to make digital copies of documents or pictures, but can also be used to create a 2D image of other objects as well.

In a flatbed scanner the document is placed on a glass plate. A light is then shone on the piece of paper and a light sensor used to detect the light which is bounced back. Wand scanners, also known as hand-held scanners, work on the same principal except that the user will move the scanner across the document manually. They can be used in conjunction with a printer to create copies of documents.

How it works:

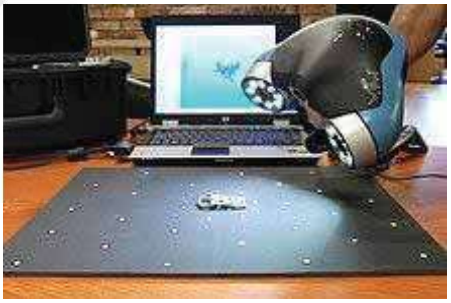
1	Cover is raised
2	Document is placed in on **glass panel** and cover is closed
3	A bright light illuminates the documents lamp like xenon which produce very bright white light
4	A scan head moves across the document. An image is produced.
5	The image is sent to a lens using series of mirrors. The lens focuses the document image.
6	The focused image fall onto a **charge couple device (CCD)** which consists of number of ICs
7	CCD is made up of **light-sensitive elements (pixels).**Each element of CCD creates an electric charge when *light* falls on it and the scanned image is converted into **digital form**.
8	Software produces **digital image** from electronic form

Optical character recognition (optical character reader) (**OCR**) is the mechanical or electronic conversion of images of typed, handwritten or printed text into machine-encoded text.

It is widely used as a form of data entry from printed paper data records, whether passport documents, invoices, bank statements, computerized receipts, business cards, mail, printouts of static-data, or any suitable documentation.

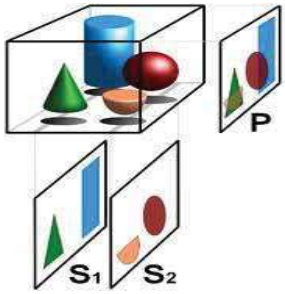
Scanner scans the document and then OCR converts it into machine readable form.

Three-dimensional scanners:



3D Scanners are used to scan objects and produce an electronic 3D image.

A **3D scanner** can be based on many different technologies, each with its own limitations, advantages and costs. Many limitations in the kind of objects that can be digitised are still present. for example, optical technology may encounter many difficulties with shiny, reflective or transparent objects. For example, industrial computed tomography scanning and structured-light 3D scanners can be used to construct digital 3D models, without destructive testing.



Tomography is a technique for displaying a representation of a cross section through a human body or other solid object using X-rays, radio frequencies, gamma imaging or ultrasound.

CT (COMPUTED TOMOGRAPHIC) Scanners are used to create a 3D image of a solid object.

Steps:

1. At first a series of 2D images of thin slices of object are taken.
2. Each 'slice' is then stored as a digital image in the computer memory.
3. Then these 2D 'slices' are combined to form a 3D image of object.

Imagine a CT scan as if you were looking at one end of a loaf of bread that has been cut into slices. By taking away each slice of bread, you can see the entire internal section of the loaf from one end crust to the other. A qualified professional will be able to look at each of these CT slices individually or 'add' them together to view 3-D images of the organ or body structure.

These cross-sectional images of the area being studied can then be examined on a computer monitor, printed or transferred to a CD. These images allow a qualified radiologist, a medical doctor who specializes in images of the body, to help physicians diagnose and treat medical conditions and/or assist in procedures by helping to accurately guide the placement of instruments or treatments.

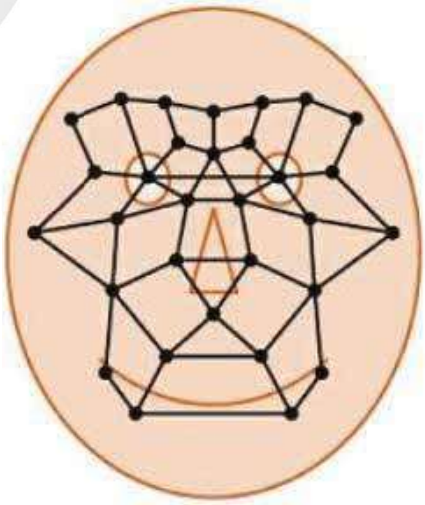
Application of 2D scanners at an airport

Passengers fly into an airport from other countries. The airport has a security system that uses:

• computers
• scanners
• digital cameras

To gain entry to the country, each passenger must have a passport or identification (ID) card. This must contain a recent photograph and other personal data.

- Passport or ID card is placed on a scanner that reads machine-readable characters and scans the photograph
- Camera takes an image of the passenger's face
- Facial recognition software/ biometric software used to scan face
- Face image converted to digital format/ data by the camera
- Digital image formed from scanned photo/ biometric data stored in passport
- Key features of the face are checked/ compared



The face shows several of the positions used by the face recognition software. Each position is checked when the software tries to compare two facial images. Data such as:

- distance between the eyes
- width of the nose
- shape of the cheek bones
- length of the jaw line
- shape of the eyebrows

are all used to identify a given face.

When the image from the passport and the image taken by the camera are compared, these key positions on the face determine whether or not the two images represent the same face.

Example Question:

Passengers fly into an airport from other countries. The airport has a security system that uses:

• computers • scanners • digital cameras

To gain entry to the country, each passenger must have a passport or identification (ID) card. This must contain a recent photograph and other personal data. The passenger must:

• place their passport or ID card on a scanner that reads machine-readable characters and scans the photograph

• look towards a camera that takes an image of the passenger's face

Describe how a computer checks whether the image just taken by the camera matches the scanned photograph.

.....

.....

.....[2]

Bar Code Reader/Scanner

A **barcode** (also **bar code**) is a machine-readable representation of information (usually dark ink on a light background to create high and low reflectance which is converted to 1s and 0s).

Barcodes — especially the Universal Product Code, UPC — have slowly become an important part of modern life. They are used in many places, and the technology is constantly improving.

Uses

- Barcode scanners are used in supermarkets and other shops where the goods are marked with a barcode; the barcodes are used to give information about the product, which enables automatic stock control, itemised billing, etc. to take place.
- They are used in libraries, to scan both users' library cards and barcodes on books, in order to keep track of books on loan.
- They are used as a safety function in many companies to ensure that electrical equipment is checked on a regular basis. Barcodes are placed on an item to identify it and a database holds all the information related to that barcode so it is possible to interrogate the system as part of a safety audit.

Advantages

- Scanning barcodes is much faster than keying in data manually and fewer mistakes are made.
- When barcodes are used as a way of recording data, they can improve safety.
- Barcodes enable automatic stock control.
- Barcode scanning is a tried and trusted technology.
- When an item price is changed, only the central database needs to be updated.
- There is no need to change the prices individually on each item.

Disadvantages

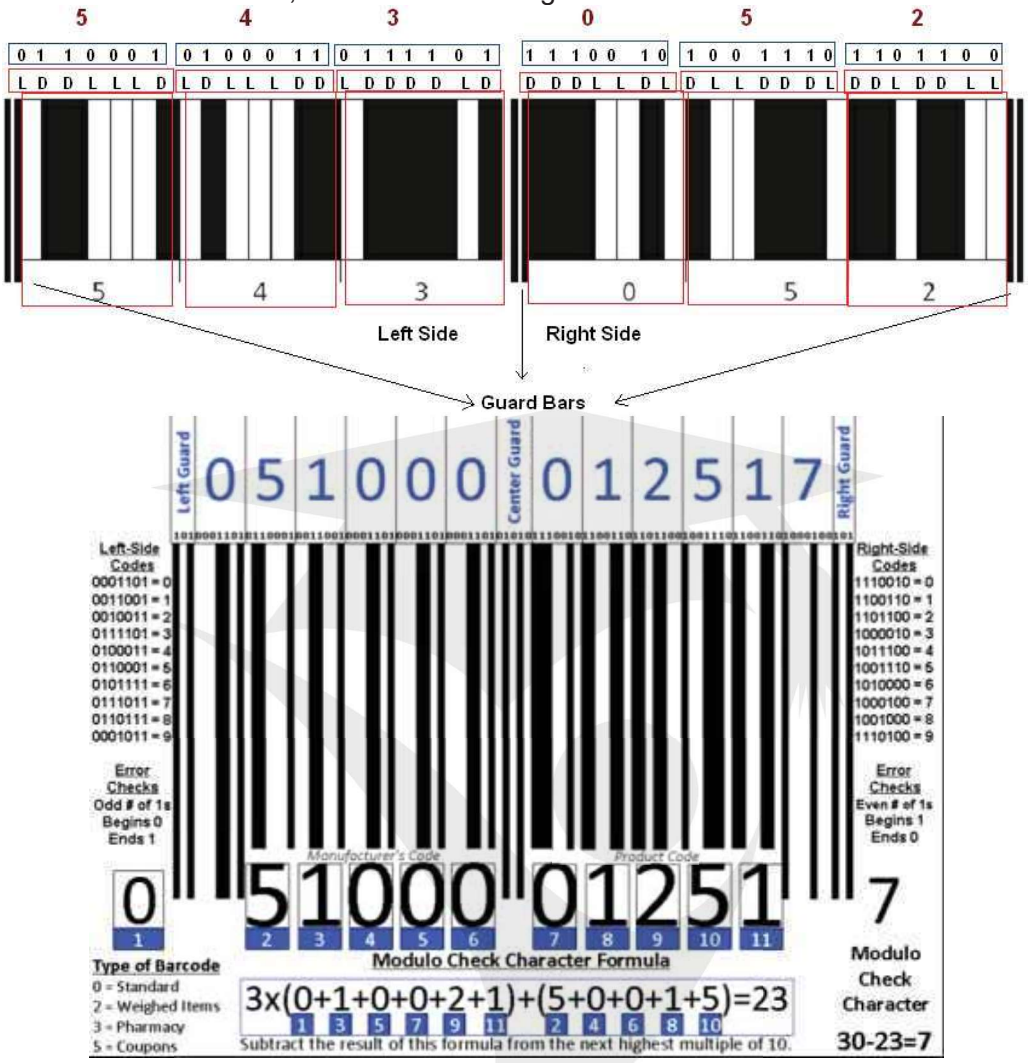
- Barcode scanning is a relatively expensive system to administer since every item in the shop needs a barcode and every barcode needs to be entered on to the central database. Also, there is a need to invest in the computer technology together with staff training, which can all be very expensive.
- The system is not fool proof – barcodes can be swapped around on items!

How it works

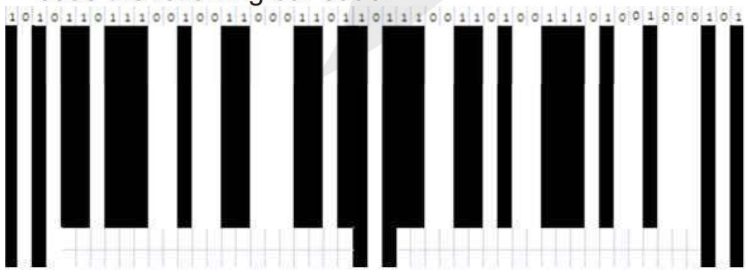
Stage	Description
1	The barcode is first read by a red laser or red **LED (LIGHT EMITTING DIODE)**.
2	Light is reflected back off the barcode; the dark areas reflect little or no light which allows the bars to be read.
3	The reflected light is read by sensors (photoelectric cells).
4	As the laser or LED light is scanned across the barcode, a pattern is generated which is converted into digital data – this allows the computer to understand the barcode.
5	For example: the digit '3' on the left generates the pattern **L D DDD L D** (where L = light and D = dark); this has the binary equivalent of **0 1 1 1 1 0 1** (where **L** =**0** and **D** = **1**
6	If barcode are not scanned correctly the bar code number is types in manually using keyboard

Left side code	Digit	Right side code
0001101	0	1110010
0011001	1	1100110
0010011	2	1101100
0111101	3	1000010
0100011	4	1011100
0110001	5	1001110
0101111	6	1010000
0111011	7	1000100
0110111	8	1001000
0001011	9	1110100

same method will be used for 3, 0 and 2 for following bar code:

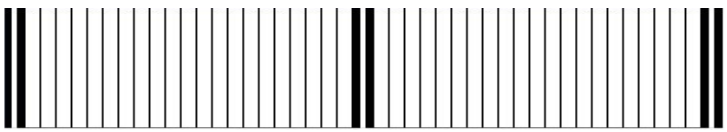


Using these codes, decode the following bar code.



..... [6]

Draw Barcode for 893246 [6]

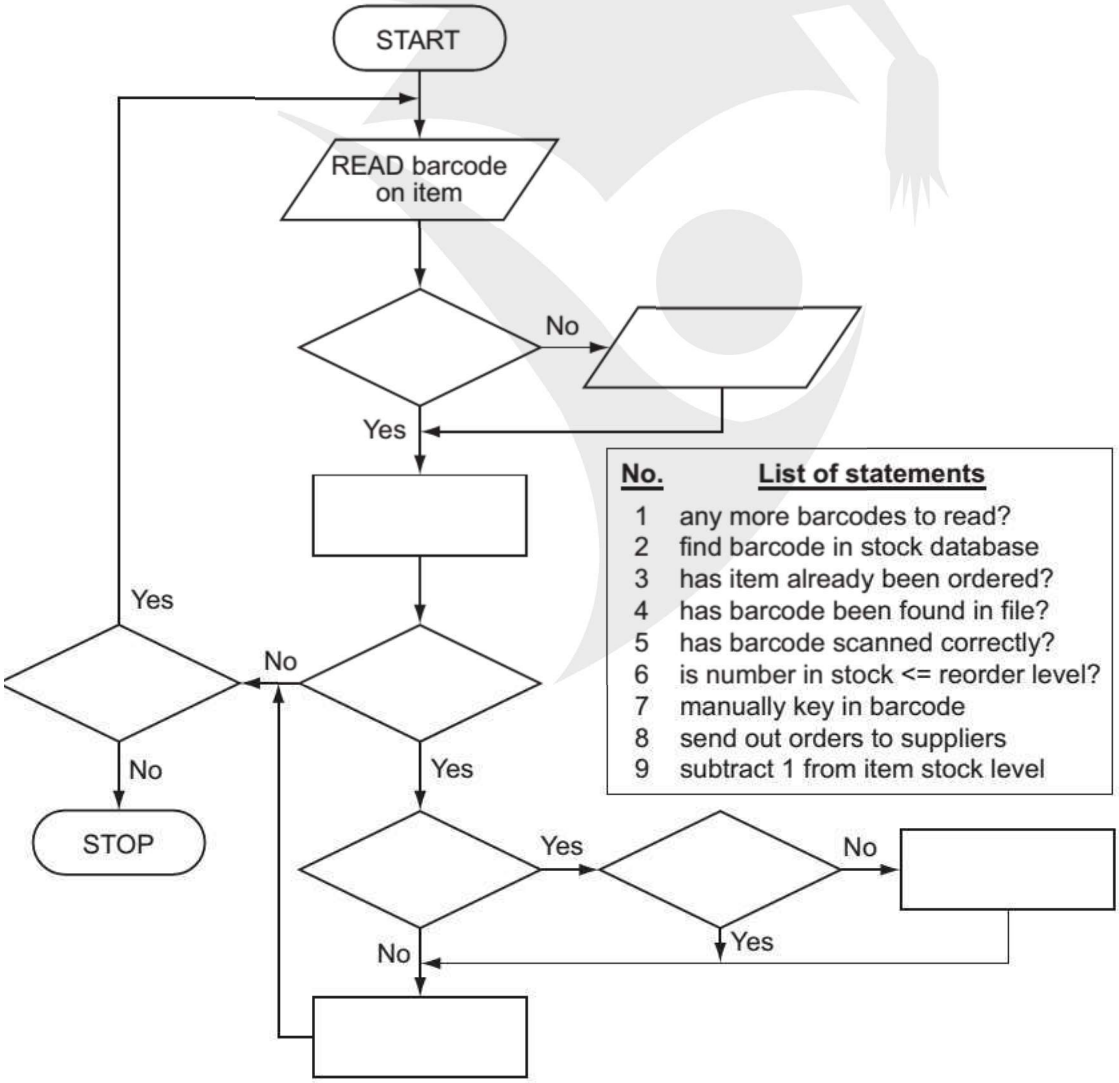


When barcode has been read, then what happens?

- The barcode number is looked up in the stock database (the barcode is known as the **KEY FIELD** in the stock item record); this key field uniquely identifies each stock item.
- When the barcode number is found, the stock item record is looked up.
- The price and other stock item details are sent back to the checkout (or **POINT OFSALE TERMINAL (POS)**).
- The number of stock items in the record is reduced by one each time the barcode is read.
- This new value for number of stock items is written back to the stock item record.
- The number of stock items is compared to the re-order level; if it is less than or equal to this value, more stock items are *automatically* ordered.
- Once an order for more stock items is generated, a flag is added to the record to stop re-ordering every time the stock item barcode is read.
- When new stock items arrive, the stock levels are updated in the database.

The following flowchart shows how barcodes are used at the point of sale in an automatic stock control system.

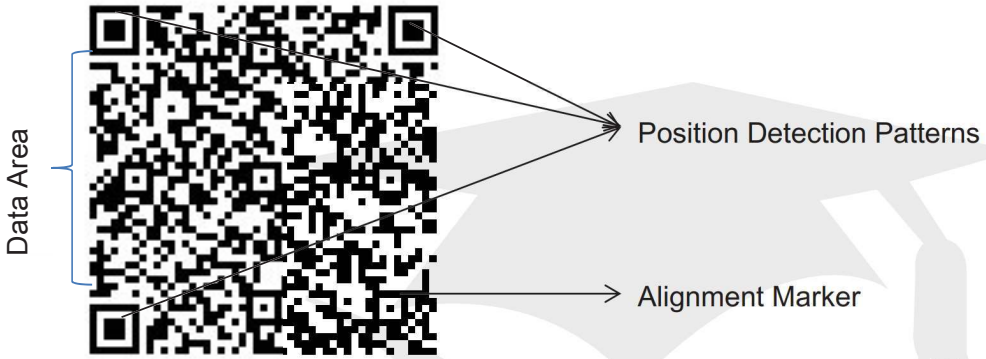
Select statements from the list below, using numbers only, to complete the flowchart.



Quick response (QR) codes

QR code (abbreviated from Quick Response Code) is the trademark for a type of matrix barcode (or two-dimensional barcode). A QR code uses four standardized encoding modes (numeric, alphanumeric, byte/binary, and kanji) to store data efficiently; extensions may also be used.

The Quick Response (QR code) system became popular due to its fast readability and greater storage capacity compared to standard UPC barcodes. A bar code can store up to 30 characters while in QR code 7000 digits can be stored.



Structure

A QR code consists of black squares arranged in a square grid on a white background.

1. The position detection pattern consists of three identical structures that are located in all corners of the QR Code except the bottom right corner.
2. Alignment marker supports the decoder software in compensating for moderate image distortions.
3. Data area has data, converted into a bit stream and then stored in 8 bit parts (called code words).

How it Works

- Camera on smart phones are used to Read/scan QR codes using **app**
- The **camera** is used to scan/capture the image of QR code
- Position direction patter and alignment marker are used to define the alignment
- Black squares reflect less light while white squares reflect more light
- The app on mobile device processes the image
- Each small square/pixel is converted to a binary value

The following QR Code at left stores web address http://www.inqilabpatel.com while QR Code at right stores contact information of Inqilab Patel

Applications

Applications include product tracking, item identification, time tracking, document management, and general marketing.

Keyboard

The keyboard is the piece of computer hardware used to input text, characters, and other commands into a computer or similar device.

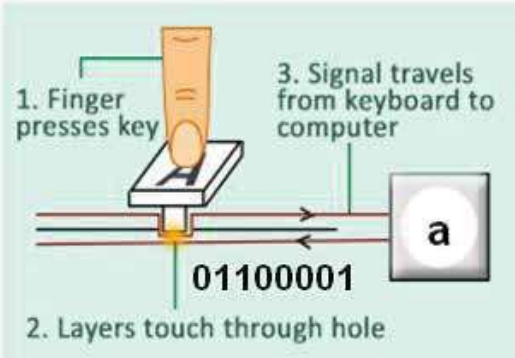
How it works

S No	Step
1.	Uses switches and circuits to translate keystrokes into signals the computer can understand
2.	The key matrix is a grid of circuits / three layers of plastic underneath the keys
3.	Each circuit is broken beneath the key / middle layer contains holes
4.	When key pressed, a circuit is made / completed and a signal is sent
5.	Processor compares location of signal from key matrix to a character map stored on ROM
6.	A character code for each key press is saved in a keyboard buffer

Each individual key is a switch. When a key is pressed it generates a specific binary code, based on ASCII. For example:

- Pressing **A** key produces binary code 01100001, representing lower case letter **a**,
- This binary code is sent to processor.

So processor recognises which key is pressed



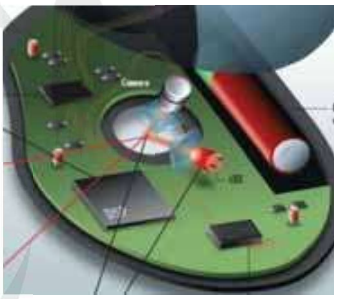
Drawback:

Keyboard is the easiest way to enter text into a computer but it has some drawbacks too, for example:

- It is a relatively slow method of data entry.
- It is prone to errors.
- Frequent use of it can lead to injuries, such as **REPETITIVE STRAIN INJURY(RSI)** in the hands and wrists.
  Ergonomic keyboards are designed to give more support to the wrists and hands when doing a lot of typing.

Pointing devices

Pointing devices are used to select objects on the screen and is usually used to control the functions of software. Mouse, tracker balls and touchpads are examples of pointing devices.



Mouse:

A **computer mouse** is a handheld hardware input device that controls a cursor in a GUI and can move and select text, icons, files, and folders.

The more traditional type with a mechanical ball arrangement; connected to the computer through a USB port while the more modern type (optical mouse) that use red LEDs to detect movement in the *x-y* direction.

How optical mouse works:

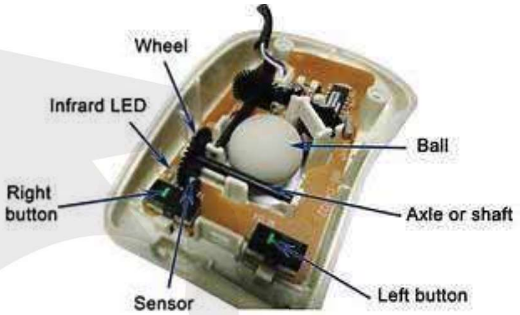
S No	Step
1	laser/light shines onto a surface through a (polished) ring at the base
2	the light is reflected from the surface through the ring
3	sensor detects reflected light
4	capturing details/photograph of surface (under the ring) at about 1500 times per second
5	as the mouse moves the sensor detects changes in the surface detail/photograph
6	These changes are translated into movement (change of x and y co-ordinates)
7	the computer/software updates the position of the cursor on the screen

How traditional mouse works:

When a traditional mouse is moved in a particular direction the corresponding wheels were then moved which could be detected and translated into motion.

Drawback

Mouse requires an area of desk space to allow movement. They often require a mouse mat since some surfaces, such as paper, prevent the correct operation of the device. To overcome this problem many designs of mouse have a scroll wheel to allow rapid movement up and down the screen.



Tracker ball

Tracker balls are upside down mouse.

How tracker ball works

A ball on the top of the tracker ball is moved to control a cursor on the screen.

Buttons are used to select icons and to carry out other functions like the buttons on a mouse.

Benefits over mouse

They don't need to move, the tracker ball doesn't need any desk space or special surface. The operator is also less likely to suffer from injuries such as RSI.

Touch pad

These are commonly built-in most laptop computers.

How touchpad works

Touch pad contains a tactile sensor which allows the user to control a cursor by simply moving a finger over the surface of the pad.

Buttons to the left and right of the pad act in the same way as buttons on a mouse. However, by simply tapping the surface this acts as a quick method of selection on many touch pads.

Digital camera

A digital camera is an input device that captures images (and sometimes video) digitally. Digital cameras use an image sensor chip to capture the image, rather than the film used by a traditional camera.

Benefits over traditional camera

- Digital cameras produce photographs for transfer to a computer directly or to print out by connecting directly to a printer.
- Many digital cameras also allow short video clips to be produced.
- Photographs can be uploaded directly into applications software such as word processors, desktop publishers, etc.
- Modern digital cameras simply link to a computer system via a USB port or by using Bluetooth (which enables wireless transfer of photographic files).

How digital camera works

Digital camera uses microprocessor, lenses, pixels and storage. The photograph is captured when light passes through the lens onto a light sensitive cell. This cell is made up of tiny elements known as pixels. The number of pixels determines the size of the file used to store the photograph (e.g. a 14- megapixel camera will need 42 megabytes to store each raw (uncompressed)photograph).

How captured images are converted into digital photo files

- Captured image is sent to DAC to convert it from analogue to digital (using ADC)
- Image is turned into pixels
- Each pixel is given a binary value
- Pixels form a grid (to create the image)
- Each pixel has a colour
- Pixels are stored in sequence (in a file)
- Meta data is stored (to describe the dimensions/resolution of the image), it stores the dimensions/colour depth .etc.
- For example JPEG

Role of microprocessor

Microprocessor can automatically carry out the following tasks:

- adjust the shutter speed
- focus the image automatically
- operate the flash automatically

- adjust the aperture size
- adjust the size of the image
- remove 'red eye' when the flash has been used

Factors effecting quality of photographs

The quality of the photograph also depends on many other factors, such as:

- the type of lens used
- the lighting

Mobile phone using digital camera

Mobile phones have caught up with digital cameras as regards number of pixels.

Drawback of camera in mobile phone

Mobile phones usually have poor lens quality and limited memory for the storage of photos.

Microphone:

A microphone is an input device used to enter sound into a computer.

The sound can be used for

- Voice over for a presentation
- Voice recognition for security system
- Speech recognition for speech-to-text software
- For disabled person.

How it works

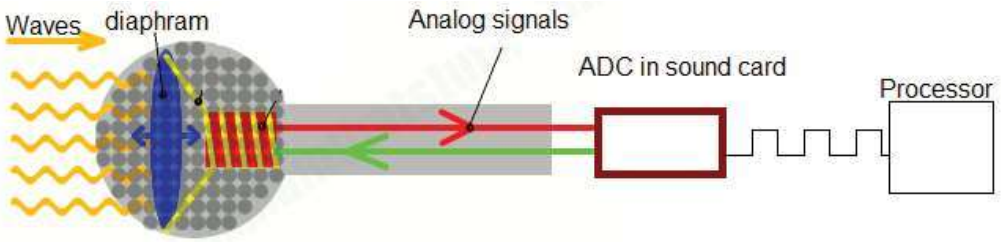
Microphone consists of a flexible diaphragm, a circuitry and an ADC (Analogue to Digital Converter).

The diaphragm vibrates due to incoming sound waves.

This vibration causes change in electrical signals of connected circuitry.

The electrical signal has to be converted to a digital signal by an analogue-to-digital converter before it can be processed by a sound (audio) card inside the computer.

How recorded sound is converted into digital audio file



A microphone converts sound waves into voltage changes.

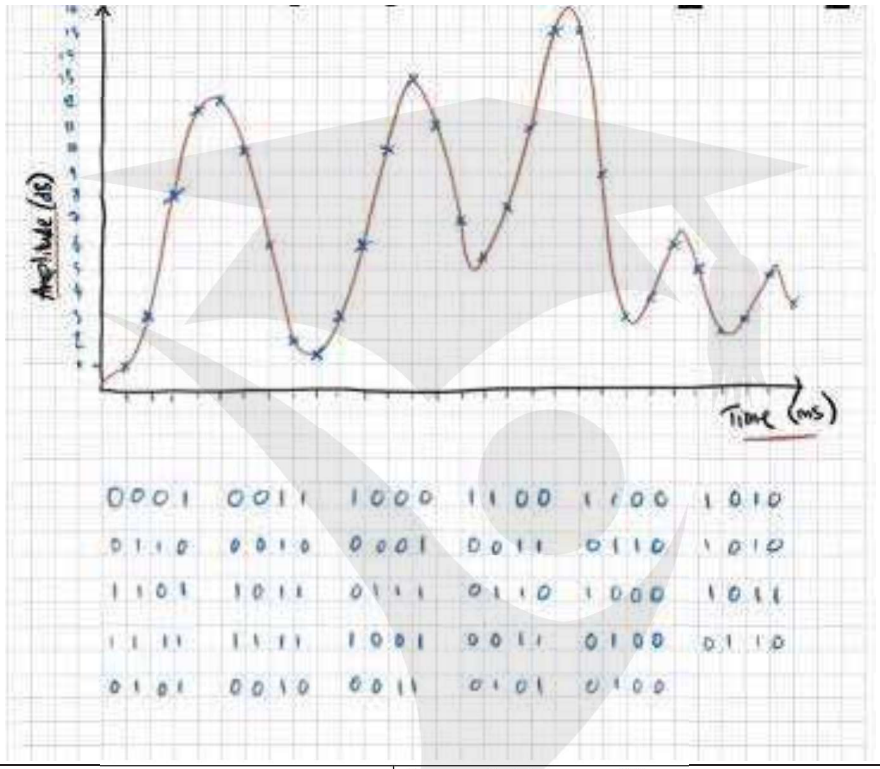
This voltage can be sampled at regular intervals (**the sample rate**)

ADC converts it into a binary number.

Sampling is therefore the process of measuring the sound level (as a voltage from a microphone) **at set intervals of time** (the sample interval) and storing the values as binary numbers.

An audio compact disk (CD) uses **16 bit rate** sampling which in theorygives**65,536**different levels of sound, enough for the playback quality.

For an audio compact disk (CD) the sampling rate is 44.1KHz or 44100 samples per second. At this sample rate, 1 minute of audio would use 10Mb of memory (using 16 bit rate sampling).



Voice Recognition	Speech Recognition
In voice recognition system, the user's voice is detected and then converted into digital.	In Speech Recognition the spoken words are recognised and shown on a screen, input into a word processor or used in other application.
A few words spoken produce a digital wave pattern. Software compares this wave pattern to wave patterns stored in memory to see if they match. If they match, then the person has been correctly identified.	Speech recognition is language dependent
This technology can be used in security systems.	It is used to give commands by speaking to computer or in speech-to-text software

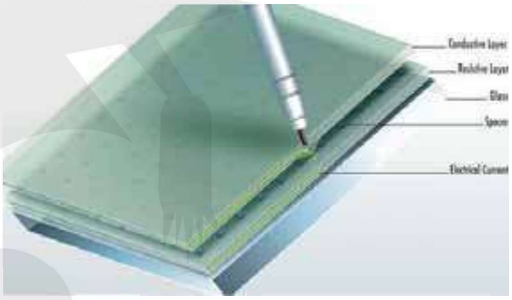
Touch Sensitive Screens

The majority of mobile phones use touch screens. The majority of mobile phones use touch screens.
Three common technologies are used by different mobile phone manufacturers:

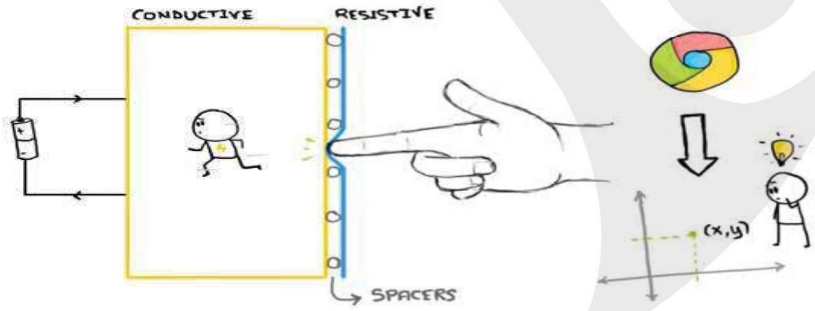
- resistive
- capacitive
- infrared

Resistive

The screen on a tablet PC using the resistive system includes a glass panel covered with a thin metallic layer made of a substance, such as indium tin oxide, that conducts electricity.

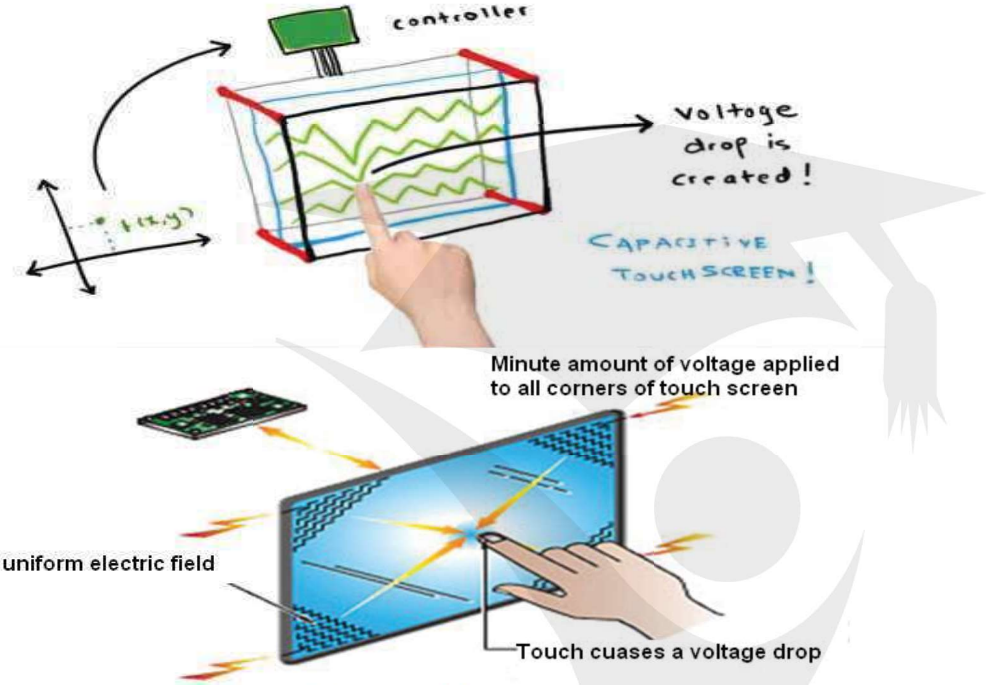


Spacers on the layer support a metallic layer that resists the flow of electricity.
When you touch the screen with your finger or a stylus, the two layers make contact, changing the electrical field produced by the layers. This permits the computer to calculate the coordinates of the contact.



Capacitive

In a **capacitive system,** a transparent material that stares an electrical charge covers the screen's glass panel. When you touch the monitor, some of the charge is transferred to your finger and the capacitive layer's charge decreases. Circuits at each corner of the screen constantly measure the change in the charge reaching them. From those measurements, the computer calculates where the touch occurred.



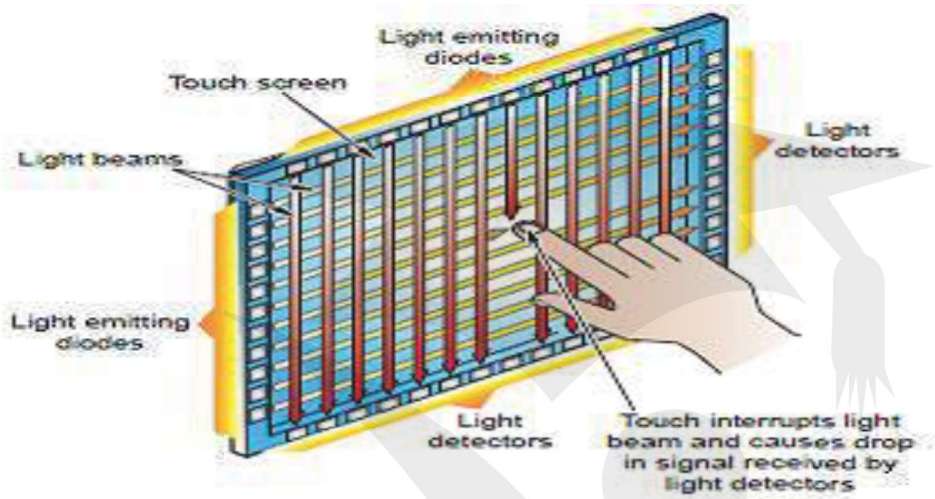
How touch is registered in capacitive screen:

- The screen has conductive layer
- An electrostatic/electric field is created on the screen
- **Sensor(s)** (around the screen) monitor the electrostatic field
- When touched (electrostatic) charge is transferred to finger
- Location of touch is **calculated** // Co-ordinates used to **calculate** touch

Infra-Red

Infrared touch screens are based on light-beam interruption technology. Instead of an overlay on the surface, a frame surrounds the display. The frame has light sources, or light emitting diodes (LEDs) on one side and light detectors on the opposite side, creating an optical grid across the screen.

When an object touches the screen, the invisible light beam is interrupted, causing a drop in the signal received by the photo sensors.



How touch is registered in infra-red screen:

- Infrared rays are sent across screen (from the edges) and captured by sensors at the opposite side
- Infrared rays form a grid across the screen
- Infrared ray is broken when someone touches screen by a finger blocking a beam
- This signal is converted into digital by ADC
- **The digital signal is sent to processor which calculate** (on where beam is broken) to locate the 'touch'
- Co-ordinates are used to locate the touch

Differences between touch screens

	Resistive	Capacitive	Infra Red
Hardware	The screen of resistive system includes a glass panel covered with a thin metallic layer made of a substance that conducts electricity. Spacers on the layer support a metallic layer that resists the flow of electricity.	In a **capacitive system,** a transparent material that stares an electrical charge covers the screen's glass panel.	Infrared touch screens are based on light-beam interruption technology. Instead of an overlay on the surface, a frame surrounds the display. The frame has light sources, or light emitting diodes (LEDs) on one side and light detectors on the opposite side, creating an optical grid across the screen.
How it works	When you touch the screen with your finger or a stylus, the two layers make contact, changing the electrical field produced by the layers. This permits the computer to calculate the coordinates of the contact.	➢ The screen has conductive layer ➢ An electrostatic/electric field is created on the screen ➢ **Sensor(s)** (around the screen) monitor the electrostatic field ➢ When touched (electrostatic) charge is transferred to finger ➢ Location of touch is **calculated** // Co-ordinates used to **calculate** touch	➢ Infrared rays are sent across screen (from the edges) and captured by sensors at the opposite side ➢ Infrared rays form a grid across the screen ➢ Infrared ray is broken when someone touches screen by a finger blocking a beam ➢ This signal is converted into digital by ADC ➢ **The digital signal is sent to processor which calculate** (on where beam is broken) to locate the 'touch' ➢ Co-ordinates are used to locate the touch
Finger Touch	can use stylus/ finger/ gloved finger/pen	Can't use gloved finger	can use stylus/ finger/ gloved finger/pen
Visibility in sunlight	poor visibility in sunlight	good visibility in sunlight	Fairly good
Cost	Inexpensive	Medium cost	Expensive
Durability	− vulnerable to scratching − wears through time	Durable	Good durability

Touch screen technologies can be described as resistive or capacitive.

Six statements are given about resistive and capacitive technology.

Tick (✓) to show if the statement applies to **Resistive** or **Capacitive and/or Infrared** technology.

[6]

Statement	Resistive (✓)	Capacitive (✓)	Infrared (✓)
This touch screen has multi-touch capabilities			
This touch screen cannot be used whilst wearing gloves			
This touch screen is made up of two layers with a small space in between			
This touch screen uses the electrical properties of the human body			
This touch screen is normally cheaper to manufacture			
This touch screen has a quicker response time			

Interactive White Board:

An **interactive whiteboard** (**IWB**) is a large interactive display in the form factor of a whiteboard. It can either be a standalone touchscreen computer used independently to perform tasks and operations, or a connectable apparatus used as a touchpad to control computers from a projector.

How interactive whiteboard Works

A device driver is usually installed on the attached computer so that the interactive whiteboard can act as a Human Input Device (HID), like a mouse.

The computer's video output is connected to a digital projector so that images may be projected on the interactive whiteboard surface.

The user then calibrates the whiteboard image by matching the position of the projected image in reference to the whiteboard using a pointer as necessary.

After this, the pointer or other device may be used to activate programs, buttons and menus from the whiteboard itself, just as one would ordinarily do with a mouse.

If text input is required, user can invoke an on-screen keyboard or, if the whiteboard software provides for this, utilize handwriting recognition.

Thus, an IWB emulates both a mouse and a keyboard. The user can conduct a presentation or a class almost exclusively from the whiteboard.

In addition, most IWBs are supplied with software that provides tools and features specifically designed to maximize interaction opportunities. These generally include the ability to create virtual versions of paper flipcharts, pen and highlighter options, and possibly even virtual rulers, protractors, and compasses—instruments that would be used in traditional classroom teaching.

Uses for interactive whiteboards may include:

- Running software that is loaded onto the connected PC, such as a web browsers or other software used in the classroom.
- Capturing and saving notes written on a whiteboard to the connected PC
- Capturing notes written on a graphics tablet connected to the whiteboard
- Controlling the PC from the white board using click and drag, mark up which annotates a program or presentation
- Using OCR software to translate cursive writing on a graphics tablet into text
- Using an Audience Response System so that presenters can poll a classroom audience or conduct quizzes, capturing feedback onto the whiteboard

Automatic Data Capture Devices

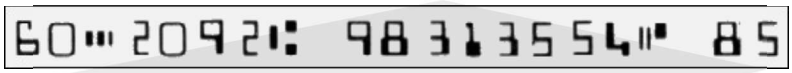
Direct data entry devices are used when large volumes of data must be entered into the computer quickly without human involvement.

Magnetic Stripe Reader

Magnetic stripes are built into many plastic cards such as cheque guarantee or credit cards. To be read the card is swiped through a machine which quickly and accurately reads the pattern of magnetism.

Magnetic Ink Character Recognition (MICR)

The MICR system reads characters printed in a special magnetic ink on bank cheques.

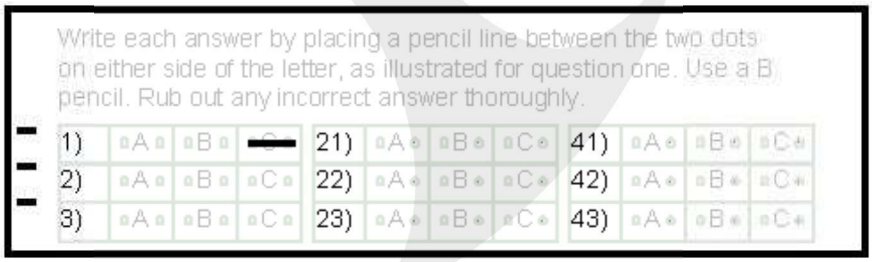


The information printed on the cheque using MICR is :

- A unique number for the cheque.
- A code that identifies the bank and branch that issued the cheque.
- The number of the account that the cheque relates to.

Optical Mark Recognition (OMR)

An optical mark reader reads marks made by pencil on a printed form into the computer. OMR systems are used by examination boards to collect the answers to multiple choice examinations and to purchase lottery tickets. Here is an example answer grid for an examination:



Turnaround Documents Optical mark recognition and optical character recognition are often used together in a turnaround document. A **turnaround document** is a document which:

- Has some information printed onto it by a computer?
- Has more information added to it by a human?

Is fed back into a computer to transfer the added information into the computer.

Here is a turnaround document that a gas company could use to record meter readings.

Try yourself 2): Name each input device described below:

It reads parallel dark and light lines which represent a string of characters. …….. Used for entry of numbers and arithmetic symbols only. ……

Users select options by simply making finger contact with its surface ……

It has buttons to make selections and a small wheel to allow scrolling……

Monitoring System

In monitoring systems microprocessor just examine sensors' reading and report their results.

Control System

A control system is a type of computer system that manages, commands and directs other devices or systems. There are open and closed loop control systems. They usually take an input, process it and get an output.

A control system consists of Sensors, ADC, Processor, DAC and Actuator.

Sensors and **actuators** are devices that are used for automatic input and control in real-time systems.

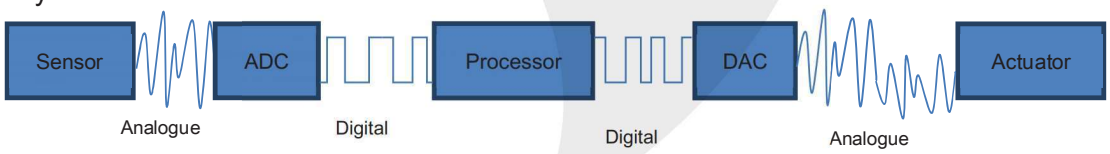
Sensors is an input device which measures a specific physical quantity (input) and send the data to processor. There are different types of sensors like, heat, infra-red, humidity, pressure, acoustic, gas, bar code etc.

The signals generated by sensors are generally in analogue form and needed to be converted into digital form so as processor can understand it. **ADC (Analogue-to-Digital Converter)** is used to convert these analogue signals into digital signals.

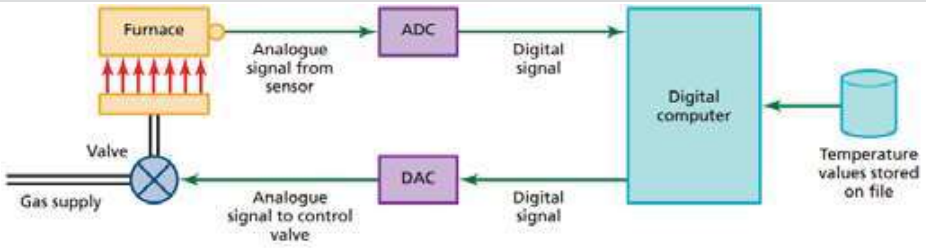
Actuators is a hardware device that receives a signal from a computer and adjusts the setting of a controlling device.

The processor sends digital signals, which are converted into analogue signals using **DAC (Digital-to-Analogue Converter)** so as actuator can act upon it.

Actuator is responsible for powering and moving a motor in machinery, such as a robot arm in a factory.



For example in a furnace, a sensor is used to measure temperature in the furnace and it sends readings in analogue form (small electric currents/voltages). This data is converted into digital by an ADC and is fed to a computer, which compares the input temperature with the required temperature stored on a file. If any action is needed (furnace temperature is too low or too high) then a digital signal is sent out from the computer. This signal is converted into an electric current/voltage (i.e. analogue) so that the valve can be regulated (i.e. opened or closed to control the gas supply and hence the furnace temperature).



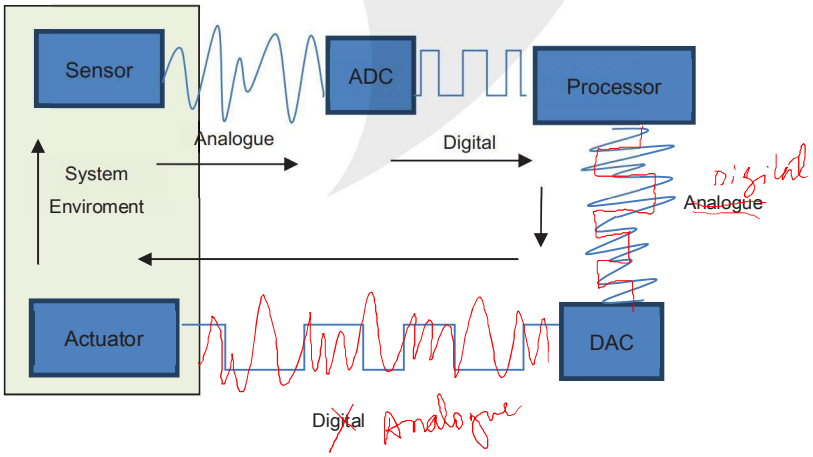
Feedback System

Control systems can be open loop or closed loop.

Open loop Feedback systems will just consider the input and then keep repeating the same task given the input, e.g. a microwave heats for a given time period without actually checking the temperature of the food.

Closed loop Feedback systems on the other hand will also take into account other factors, including the output itself. A furnace is a closed-loop feedback system.

Above furnace system is a closed-loop feedback system. In this system temperature sensor measures temperature in the furnace and it sends readings to processor, which compares the input temperature with the required temperature stored on a file. If any action is needed (furnace temperature is too low or too high) then a digital signal is sent out from the processor. Actuator regulates the valves (i.e. opened or closed to control the gas supply and hence the furnace temperature). Then sensor again measures the temperature which is actually itself the output of the system. On the basis of new readings processor decides new actions. Means new actions depends upon the results of previous actions.

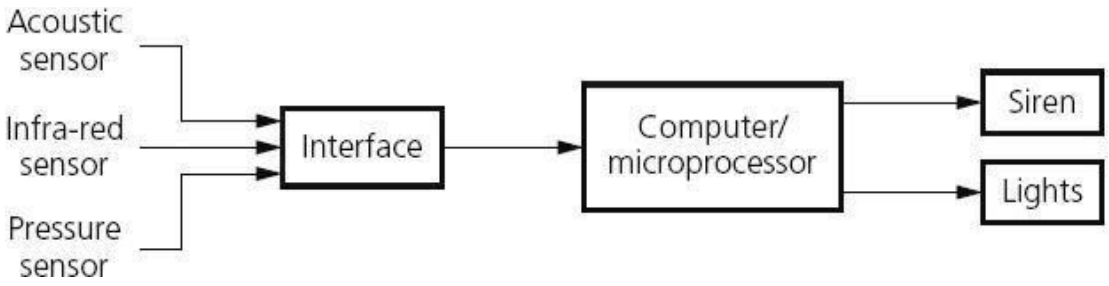


Sensors (general) in control and measuring applications

infra-red/motion	automatic doors, burglar alarm systems
Temperature sensor	Automatic washing machines, automatic cookers, central heating controllers, computer-controlled greenhouses, scientific experiments and environmental monitoring, oven.
Sound/acoustic	Burglar alarm, Leak detection system, Disco lighting
Moisture/humidity	Clothes drier, Environmental control
Pressure sensor	Burglar alarms, automatic washing machines, robotics, production line control, scientific experiments and environmental monitoring
carbon dioxide/ oxygen/gas	pollution monitoring in a river , greenhouse environment (growth control), confined area (e.g. space craft) Fish tank/Aquarium
Light sensor	Computer controlled greenhouses, burglar alarm systems, robotics, production line control, scientific experiments and environmental monitoring
Graphics tablet	Inputting freehand drawings or retouch photographs
Optical Mark Reader	Inputting pencil marks on a form such as a school register, candidate exam answers, any application involving input of a choice of options
Optical Character Reader	Inputting text to a computer ready for processing by another software package such as word processors, spread sheets, databases etc.
Bar code Reader	Inputting code numbers from products at a POS terminal, library books and membership numbers

Monitoring applications

Burglar alarm system



A burglar alarm monitoring system will carry out the following actions:

- The system is activated by keying in a password on a keypad.
- The infra-red sensor picks up the movement of an intruder in the building.
- The acoustic sensor picks up sounds such as footsteps or breaking glass.
- The pressure sensor picks up the weight of an intruder coming through a door or through a window.
- The sensor data is passed through an ADC if it is in an analogue form to produce digital data.
- The computer/microprocessor will sample the digital data coming from these sensors at a given frequency (e.g. every five seconds); the data is compared with the stored values by the computer/microprocessor.
- If any of the incoming data values are outside the acceptable range, then the computer sends a signal to:
  - a siren to sound the alarm, or
  - a light to start flashing.
- A DAC is used if the devices need analogue values to operate them.
- The alarm continues to sound/lights continue to flash until the system is reset with a password.

Monitoring of patients in a hospital

- A number of sensors are attached to the patient; these measure vital signs such as: temperature, heart rate, breathing rate, etc.
- These sensors are all attached to a computer system.
- The sensors constantly send data back to the computer system.
- The computer samples the data at frequent intervals.
- The range of acceptable values for each parameter is keyed in to the computer.
- The computer compares the values from the sensors with those values keyed in.
- If anything is out of the acceptable range, a signal is sent by the computer to sound an alarm.
- If data from the sensors is within range, the values are shown in either graphical form on a screen and/or a digital read out.
- Monitoring continues until the sensors are disconnected from the patient.

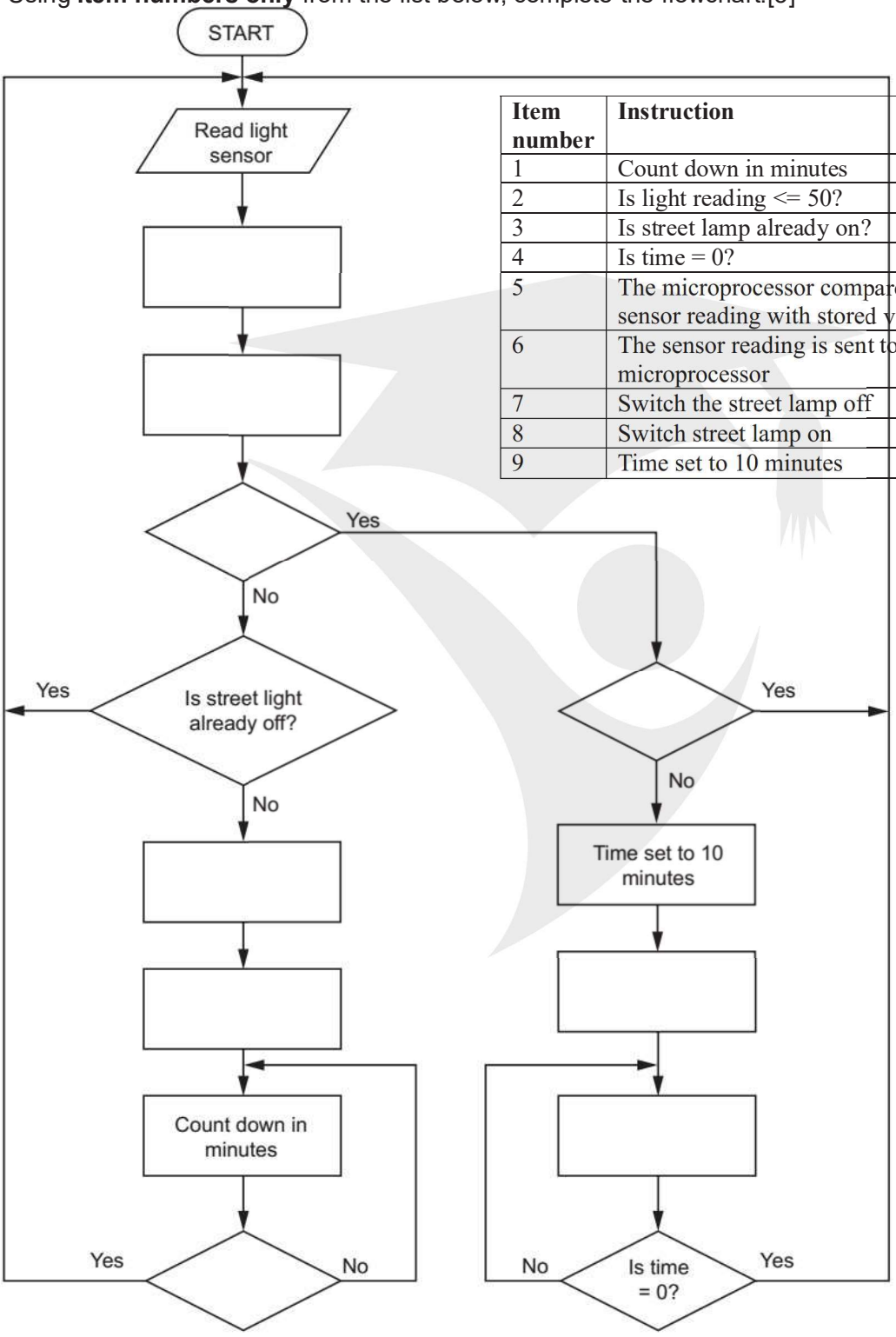
Control of street lighting

1. sensor sends signal/data to the microprocessor
2. signal/data converted to digital/using ADC
3. microprocessor compares value to a stored value
4. if input value < stored value …
    a. signal sent from microprocessor to actuator
    b. and light is switched on/off
5. whole process continues in an infinite loop
6. *To Avoid frequent on/off switches:*
7. microprocessor continues to keep light on/off for a pre-determined period
8. after pre-determined period, sensor output is again sampled

Controlling Security Lights

– infrared / motion / pressure (sensor) // sensor detects movement/pressure
– signals/data sent (continuously) to microprocessor
– converted from analogue to digital (using ADC)
– microprocessor compares value with those stored in memory
– if sensor value does not match the stored value(s) …
– … signal sent to switch on the light
– … signal sent to keep the light on
– … light remains on for a period of time (30 seconds)
– if sensor value matches the stored value(s) …
– … light will remain off
– … will turn off after period of time (30 seconds)
– works in a continues loop

The following flowchart shows how a light sensor and microprocessor are used to switch a street lamp on or off. When the sensor reading is <= 50 light units, the lamp is turned on automatically. Several of the instructions have been omitted from the flowchart.
Using **item numbers only** from the list below, complete the flowchart:[5]



Item number	Instruction
1	Count down in minutes
2	Is light reading <= 50?
3	Is street lamp already on?
4	Is time = 0?
5	The microprocessor compares the sensor reading with stored values
6	The sensor reading is sent to the microprocessor
7	Switch the street lamp off
8	Switch street lamp on
9	Time set to 10 minutes

ANTI-LOCK BRAKING SYSTEMS (ABS) on cars use magnetic field sensors to stop the wheels locking up on the car if the brakes have been applied too sharply.

- When one of the car wheels rotates too slowly (i.e. it is locking up), a magnetic field sensor sends data to a microprocessor.
- The microprocessor checks the rotation speed of the other three wheels.
- If they are different (i.e. rotating faster), the microprocessor sends a signal to the braking system:
    - and the braking pressure to the affected wheel is reduced
    - the wheel's rotational speed is then increased to match the other wheels.
- Checking the rotational speed using these magnetic field sensors is done several times a second and the braking pressure to all the wheels can be constantly changing to prevent any of the wheels locking up under heavy braking; this is felt as a 'judder' on the brake pedal as the braking system is constantly switched off and on to equalise the rotational speed of all four wheels.
- If one of the wheels is rotating too quickly, braking pressure is increased to that wheel until it matches the other three.

Candidate Example Response

Question 7a

Example Candidate Response – high	Examiner Comments
7 (a) An office has an automated lighting system. When movement is detected in the office the lights are switched on. If movement is not detected for a period of 2 minutes the lights are switched off. The system uses a sensor and a microprocessor. Describe how the automated lighting system uses a sensor and a microprocessor. An ~~light~~ infra-red sensor (1) can be used. The data from the ~~light~~ sensor is transmitted to a microprocessor. (2) An ADC converts analogue data to digital data. (3) The microprocessor compares the data from the sensor with the stored value. (4) If there is a movement detected, (5) it will send a signal to the light to switch on. If no light detected for 2 minutes, it will send a signal to the light to switch off. This is a continuous process (6) and works in an infinite loop. [6]	(1) The first mark is awarded for a correct sensor. (2) The second mark is awarded for data transmitted to a microprocessor. (3) The third mark is awarded for the conversion of data from analogue to digital. (4) The fourth mark is awarded for the comparison of the data to a stored value. (5) The reference to movement detected is too vague for the condition tested. The candidate needs to state if the data value to greater than or less than the stored value. (6) The fifth mark is awarded for stating the process is continuous. **Total mark awarded = 5 out of 6**

How the candidate could have improved their answer

The candidate did not give a proper comparison of the data from the sensor and the data stored; they just stated that 'if movement is detected'. If the candidate had indicated that it would mean movement had been detected, for example, the value received was outside the range of the stored values, then another mark could have been awarded.

Example Candidate Response – middle

7 (a) An office has an automated lighting system. When movement is detected in the office the lights are switched on. If movement is not detected for a period of 2 minutes the lights are switched off. The system uses a sensor and a microprocessor.

Describe how the automated lighting system uses a sensor and a microprocessor.

The signals are converted into digital using (ADC) Analogue to digital converte[1] These signals are then[2] to microprocesser. Then the microprocessor compare the data with the Stored value[3] If both data are equa[4] lights will switch 'ON' and if the recieved data is not equal[5] to Stored Value, lights will remain switch 'OFF'. All these signals are sent by sensor to the microprocesser. Light sense[6] is used in this case.

[6]

Examiner Comments

1 The first mark is awarded for converting the analogue data to digital data.

2 The candidate is missing saying the signals are sent to the microprocessor.

3 A second mark is awarded for the comparison of the data to a stored value.

4 A third mark is awarded for the outcome of the comparison.

5 The candidate is missing stating the microprocessor sends a signal to switch the lights on.

6 This is not a correct sensor for this scenario.

Total mark awarded = 3 out of 6

How the candidate could have improved their answer

- The candidate stated that the signals were then to the microprocessor. If they had said they were sent, another mark could have been awarded. The candidate should have checked that they did not miss any vital words from their response.
- When a candidate stated that an action occurred, such as the lights were turned on, they needed to make sure they provided a method for how this had occurred, for example, a signal was sent by the microprocessor to turn the lights on.

Example Candidate Response – low	Examiner Comments
7 (a) An office has an automated lighting system. When movement is detected in the office the lights are switched on. If movement is not detected for a period of 2 minutes the lights are switched off. The system uses a sehsor and a microprocessor. Describe how the automated lighting system uses a sensor and a microprocessor. Sensor Used : Motion sensor (1) First the sensor decteats if there is any movement in the room. once movement is detected it converts that information (2) from analog to digital (through and ADC converter) and the microprocesser compaires the recorded value with the set criteriea (3) if the criteriea is met (4) the lights are switched on if not, it continues to repeat the same process (5) ~~NW~~. [0]	(1) The first mark is given for a correct sensor. (2) At this stage in the process, the sensor will not send information; it will be just raw data. Therefore, the conversion mark is awarded. (3) The candidate is given the benefit of the doubt and is awarded a mark for comparing the value to set criteria, implying that the criteria is a stored value. (4) This is too vague as it does not say how the criteria is met. (5) The continuous process mark is not awarded, as the candidate only has this happening if the lights are not switched on. **Total mark awarded = 2 out of 6**

How the candidate could have improved their answer

- The candidate needed to be aware that data and information were different. If the candidate had stated the data was converted from analogue to digital, a mark could have been awarded for this.
- The candidate needed to make sure they stated that the whole process was continuous and not just part of it.

Common mistakes candidates made in this question

Candidates often made a vague statement, such as 'if motion is detected'. Candidates needed to be more specific and have provided a higher level of response about how the motion was detected, for example, the value received was greater than the value stored.

Question 1a

Example Candidate Response – high	Examiner Comments
1 Input and output devices are often connected to a personal computer. (a) Identify **three** input devices that can be connected to a personal computer. 1 keyboard 2 mouse 3 microphone 1 [3]	1 Three standard input devices are given. **Total mark awarded = 3 out of 3**

How the candidate could have improved their answer

This candidate gave a model answer and could not have improved it any further.

Example Candidate Response – middle	Examiner Comments
1 Input and output devices are often connected to a personal computer. (a) Identify **three** input devices that can be connected to a personal computer. 1 Monitor 1 2 Mouse 3 Keyboard [3]	1 This is an output device, rather than an input device. **Total mark awarded = 2 out of 3**

How the candidate could have improved their answer

For their first device, the candidate gave an output device rather than an input device. The candidate may have wanted to refer to an input device that also had a display screen, such as a touch screen.

Example Candidate Response – low	Examiner Comments
1 Input and output devices are often connected to a personal computer. (a) Identify **three** input devices that can be connected to a personal computer. 1 DVD player (1) 2 built in speakers (2) 3 Camera, microphone. (4) (3) [3]	(1) This is an ambiguous answer as it is a whole system, rather than an input device. (2) This is an output device, rather than an input device. (3) This is a correct input device. It would be beneficial for candidates to state that it is a digital camera. (4) Candidates should avoid putting two answers on a line. Only the first answer is considered. **Total mark awarded = 1 out of 3**

How the candidate could have improved their answer

- The candidate has misunderstood the concept of an input device. The candidate may have thought a DVD player was an input device as a disk was inserted into the device. However, a DVD player was a whole system that involved the input, process and output of data. It would have been beneficial if candidates only provided devices that were strictly input devices.
- The candidate gave speakers as the second device, but these were output devices, rather than input devices.
- The candidate gave the camera as their third device. This was a correct device. It was assumed that it was a digital camera, but it would have been beneficial for the candidate to have clearly stated this. The candidate wrote a second answer on the same line. Candidates should have avoided doing this as only the first answer on a line could be considered.

Common mistakes candidates made in this question

- There were some devices, about which, candidates were often confused. Candidates often gave speakers as an input device. This could possibly have been because they thought the sound had to go into the speaker to be played.
- Candidates often gave two or more devices per line, but it would have been beneficial for them to have understood that only the first answer on a line could have been considered. Candidates sometimes gave further devices under the three lines given. It would also have been beneficial for candidates to have understood that only the first three answers given could be considered.
- Sometimes candidates gave a whole system, rather than a single device. For example, some candidates gave photocopier. However, a photocopier was a combination of devices, including a scanner and a printer.

Output Devices

An **output device** is any piece of computer hardware equipment used to communicate the results of data processing carried out by an information processing system (such as a computer) which converts the electronically generated information into human-readable form.

Soft Copy: The output displayed on screen or stored in storage devices is soft copy.

Hard Copy: The output printed on paper is hardcopy output.

Inkjet Printer

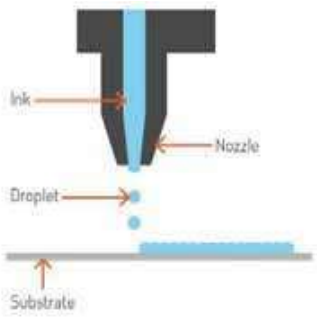
How inkjet printers work:

S No	Step
1	Printer driver translates data into a suitable format for the printer
2	Printer receives data from the computer and stores the data in the printer's buffer
3	Paper feed stepper motor activated; sheet of paper fed from paper tray
4	The print head moves across page; ink is sprayed each time the print head pauses for a fraction of a second
5	The ink droplets are produced currently 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.
6	Paper feed stepper motor advances paper a fraction of a cm after each complete head pass

Why inkjet printers are helping to reduce the cost of manufacturing OLED screens?

Current OLED manufacturing methods rely on evaporation processes, in which the organic materials are deposited onto a glass sheet through a thin metal stencil. But in this method a significant amount of the material is wasted because it disperses all over the mask.

Inkjet OLED printing has the desirable ability to allow precision deposits without the use of a mask. This could be done, for example, by placing OLED pixels on glass or plastic using a portable platform and nozzles in regular atmospheric conditions. Such methods have the potential to increase yields and lower prices.

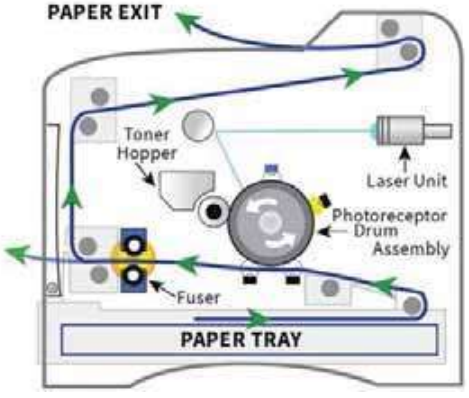


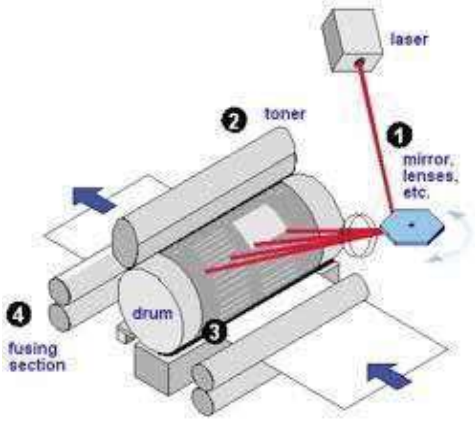
Laser Printer

Laser printers produce very high-quality hard copy output. The print rate per page is very quick if a large number of pages are being printed. They rely on large buffer memories, where the data for the whole document is stored before the pages can be printed out.

How it works

S No	Step
1	The printer driver ensures that the data is in a format that the laser printer can understand
2	Data is then sent to the laser printer and stored temporarily in the printer buffer
3	The printing drum is given a positive charge
4	As the printing drum rotates, a laser scans across it; this removes the positive charge in certain areas
5	Negatively-charged areas are then produced on the printing drum; these match exactly with the text and images to be printed
6	The printing drum is coated in positively-charged toner; this then sticks to the negatively-charged parts of the printing drum
7	A negatively-charged sheet of paper is then rolled over the printing drum
8	The toner on the printing drum is now transferred to the paper to reproduce the required text and images
9	The paper goes through a fuser which melts the toner so it fixes permanently to the paper





Uses

- Laser printers are used where noise levels need to be kept low (e.g. in an office).
- They are the best option for fast high quality high volume printing.

Advantages

- Printing is fast for high volumes. If only a few pages are to be printed they are little faster than inkjet printers.
- They can handle very large print jobs.
- The quality is consistently high.
- Toner cartridges last for a long time, so laser printers can be a cost effective option, particularly if colour outputs are not required.

Disadvantages

- Laser printers are expensive to buy.
- They are only really fast if several copies are being made.
- Colour laser printers tend to be expensive to run, since four cartridges (three colours plus black) are needed as well as diffuser kits, etc.
- 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.

Q (a) (i) The following sequence of steps (1 to 7) describe how a single page is printed on a laser printer.

The statements A, B, C and D are used to complete the sequence.

A	The paper passes through a fuser, which heats up the paper. The toner melts and forms a permanent image on the paper.
B	The electrical charge is removed from the drum and the excess toner is collected.
C	The image is converted on the drum into an electrostatic charge.
D	The oppositely-charged paper picks up the toner particles from the drum. After picking up the toner, the paper is discharged to stop it clinging to the drum.

Complete the sequence by writing one of the letters **A**, **B**, **C** or **D** on the appropriate row.

1.A laser beam and a rotating mirror are used to draw an image of the page on the photosensitive drum.

2. .....

3. Electrostatic charge attracts toner.

4. The charged paper is rolled against the drum.

5. .....

6. .....

7. ..... [3]

(ii) A computer user has a laser printer to print letters and documents. The user also prints digital p hotographs taken using a digital camera.

State the most suitable type of printer for printing the photographs.

.....[1]

Q) The first column of the following table gives features of different types of printer.
Put a tick (3) in the cells to show which features describe a laser and an inkjet printer. [2]

	Type of printer	
	Laser	**Inkjet**
Impact printer		
Non-impact printer		
Line printer		
Page printer		

Plotter

Plotters are capable of producing highly accurate, very large drawings and posters.Instead of building up text and images from tiny dots,

plotters **draw** on the paper using a **pen**.

How plotter works

The pens are held in an arm which can lift the pen up or down, and which can move across the paper. The arm and pen create a drawing just like a human could, but much more **accurately** and more **quickly**. Different **coloured pens** can be used to produce coloured line drawings.

Applications

Plotters are used to produce large drawings (e.g. blueprints of buildings, factories, etc.) and are often used with CAD applications.

They are used to produce large pictures for use on billboards or giant posters. They can also print on plastic-coated paper.

If the pens are replaced with cutting tools, it is also possible to make large signs.

Advantages

They can produce huge printouts.

The print quality is extremely high.

Disadvantages

They are slow in operation.

They are expensive, both to buy and to maintain.

3D Printer

3D printing is any of various processes in which material is joined or solidified under computer control to create a three-dimensional object, with material being added together. 3D printing is used in both rapid prototyping and additive manufacturing.

The following describes some of the features of 3D printing:

Various types of 3D printers exist; they range from the size of a microwave oven up to the size of a small car.

3D printers use **ADDITIVE** manufacturing (i.e. the object is built up layer by layer);

Direct 3D printing uses inkjet technology; a print head can move left to right as in a normal printer. However, the print head can also move up and down to build up the layers of an object.

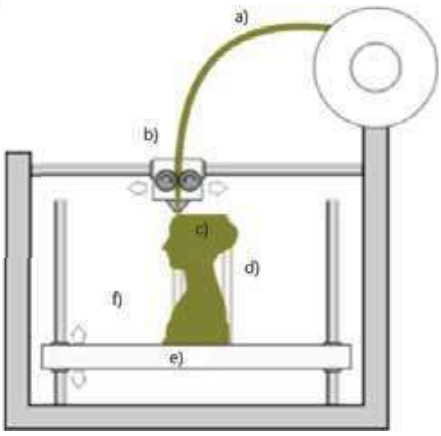
Binder 3D printing is similar to direct 3D printing. However, this method uses

two passes for each of the layers; the first pass sprays dry powder and then on the second pass a binder (a type of glue) is sprayed to form a solid layer.

Newer technologies are using lasers and UV light to harden liquid polymers; this further increases the diversity of products which can be made.

How 3D Printer Works

The steps 1 to 9 describe the basic internal operation of a 3D printer.
The following five statements are used to complete the sequence of steps.



1. The object is designed using Computer Aided Design (CAD) software
2. The software splits the object into slices.
3. The data about the slices is sent to the printer
4. The solid plastic is melted and transferred to the nozzle
5. A stepper motor moves the nozzle into position
6. The nozzle extrudes the molten plastic
7. The steps 5 to 6 are repeated until the layer is complete
8. A fan cools the layer
9. The steps 4 to 8 are repeated for each subsequent layer

Uses

- 3D printers are used to produce prototypes which actually work from CAD packages, photograph images, stored drawings, etc.
- Scale models are produced in colour before the real thing is manufactured.
- The ultimate objective is to produce organic objects (such as replacement human organs) using this layering technology.

Advantages

- 3D printers save a lot of money, since making prototypes by other methods is very time consuming and expensive.
- Physical scale models are produced with working parts, which gives a better idea of how the end product will look.
- The powders used can often be ground up and re-used.

Disadvantages

- 3D printers are expensive to buy.
- They are slow at producing their output.
- The end product can sometimes be a little rough and often needs further work to be done on it.

2D & 3D Cutter

A 2d and ***3d cutter*** is a high powered laser that cuts material such as thin metals or woods, used mostly for industrial purposes.

2D cuts a sheet and 3D cutters cuts an object using high power laser beam.

Application:

3D laser cutters can cut the following materials:

• glass
• crystal
• metal
• polymer
• wood.

Benefits:

They make precise and clean cuts, it is also is very fast which makes it efficient.

Drawback:

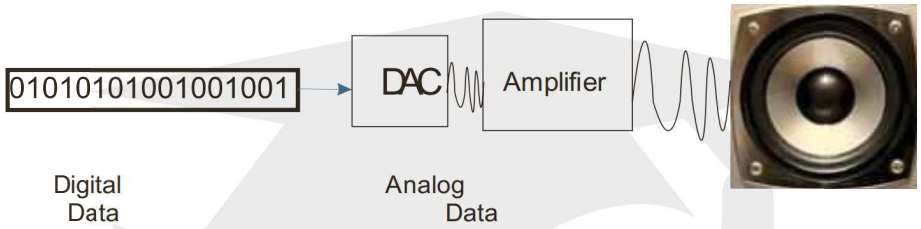
The main disadvantage of laser cutting is the high power consumption.

Loudspeakers & Headphone

Loudspeakers and headphones are output devices which are used to output sound from computer. Speakers and headphones consist of DAC (Digital to Analogue Converter), Amplifier and diaphragm.

How they work

Microprocessor sends sound signals in digital form, which are converted into analogue using DAC. Then these signals are passed the through an AMPLIFIER **to speaker, whose diaphragm vibrates and produces sound.**



The rate at which the DAC can translate the digital output into analogue voltages is known as the **SAMPLING RATE**. If the DAC is a 16-bit device, then it can accept numbers between +32 767 (2^{16} – 1) and –32 768 (2^{16}); the digital value containing all zeros is ignored. The speed at which these values can be converted is the sampling rate.

The standard sampling rate is 44 100 samples per second. This basically means that the **DAC can convert 44 100** values in the range +32 767 to –32 768 every second.

Suppose a CD is being produced to contain a number of music tracks. Each piece of music is sampled 44 100 times a second. Each sample is 16 bits. Since the music is in stereo this also needs to be taken into consideration.

The above information means that **44 100 × 2 × 16 = 1 411 200 bits per second sampling** (the number '2' is used in the calculation to account for the sound being in stereo).

Since 1 byte = 8 bits, this equates to 1 411 200/8 bytes per second.

This works out at 176 400 bytes per second.

Application:

Speakers are used to output sound from multimedia presentations.

They are used in home entertainment centres.

They can help blind people (together with speech generation software) through audio output of text on the screen.

They are used to play downloaded sound files.

LCD Monitors

LCD (LIQUID CRYSTAL DISPLAY/DIODE) monitors' front layer is made up liquid crystal diodes; these tiny diodes are grouped together in threes or fours which are known as pixels (picture elements). The three colours which are grouped together use red, green and blue diodes. Those systems that use groups of four include a yellow diode – this is said to make the colours more vivid.

Because LCD doesn't emit any light, some form of back-lit technology needs to be used. They use a cold cathode fluorescent lamp (CCFL) as the back lighting method. Essentially, CCFL uses two fluorescent tubes behind the LCD screen which supplies the light source.

LED Monitors

Modern LCD monitors are back lit using **LIGHT EMITTING DIODE (LED)** technology. This gives the image better contrast and brightness. A matrix of tiny LEDs is used behind the LCD screen.

Advantages of LED over LCD

- LEDs reach their maximum brightness almost immediately (there is no need to 'warm up' before reaching full efficiency)
- LEDs give a whiter light which sharpens the image and make the colours appear more vivid; CCFL had a slightly yellowish tint
- LEDs produce a brighter light which improves the colour definition
- monitors using LED technology are much thinner than monitors using CCFL technology
- LEDs last almost indefinitely; this makes the technology more reliable and means a more consistent product
- LEDs consume very little power which means they produce less heat as well as using less energy.

OLED Monitors

OLED ORGANIC LIGHT EMITTING DIODES use organic materials (made up of carbon compounds) to create semi-conductors which are very flexible. Organic films are sandwiched between two charged electrodes (one is a metallic **CATHODE** and the other a glass **ANODE**). When an electric field is applied to the electrodes they give off light. This means that no form of backlighting is required. This allows for very thin screens.

It also means that there is no longer a need to use LCD technology, since OLED is a self-contained system.

Light Projectors:

Uses

- Multimedia projectors are used for training presentations (to allow the whole audience to see the images from a computer).
- They are also used for advertising presentations (large images showing product features of, for example, a new car, can be shown at exhibitions, shopping malls, etc.).
- Home cinema systems (projecting the images from a DVD or television) use multimedia projectors.

Advantages

- They enable many people to see a presentation rather than all of them crowding round a small computer screen.
- They avoid the need for several networked computers. For example, when looking at a video clip on an internet site, everybody can see the video on the large screen rather than logging on to a number of computers.

Disadvantages

- Images can sometimes be fuzzy.
- Multimedia projectors are expensive to buy.
- Setting up projectors can be a little difficult.

(a) (i) Choose between:

laser printer / inkjet printer *(circle your choice)*

Describe **one** feature and **one** drawback of your chosen type of printer.

Feature .....

.....

Drawback .....

.....[2]

(ii) Choose between:

3D printer / graph plotter *(circle your choice)*

Describe **one** feature and **one** drawback of your chosen device.

Feature .....

.....

Drawback .....

.....[2]

Fill in missing statements

Questions are most commonly set from steps of bar code reading, sensors, operating ATM machine etc.

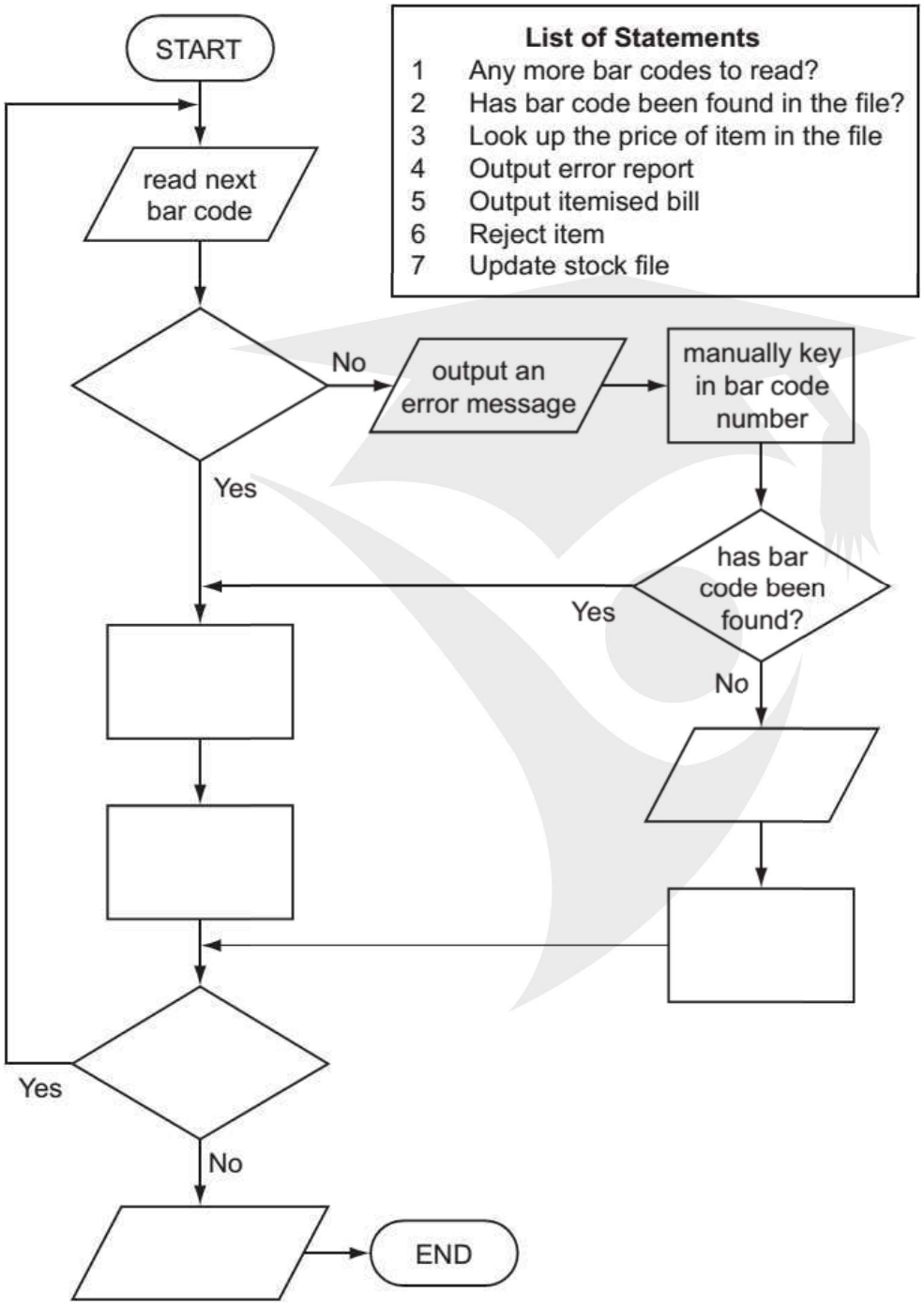
Steps of bar code reading:

When barcode has been read, then what happens?

- The barcode number is looked up in the stock database (the barcode is known as the **KEY FIELD** in the stock item record); this key field uniquely identifies each stock item.
- When the barcode number is found, the stock item record is looked up.
- The price and other stock item details are sent back to the checkout (or **POINT OFSALE TERMINAL (POS)**).
- The number of stock items in the record is reduced by one each time the barcode is read.
- This new value for number of stock items is written back to the stock item record.
- The number of stock items is compared to the re-order level; if it is less than or equal to this value, more stock items are *automatically* ordered.
- Once an order for more stock items is generated, a flag is added to the record to stop re-ordering every time the stock item barcode is read.
- When new stock items arrive, the stock levels are updated in the database.

Q1: Winter 2006

The following flowchart shows how the bar code written on an item is used to find the price, do stock control and produce an itemised bill. Select statements from the list below to complete the flowchart.



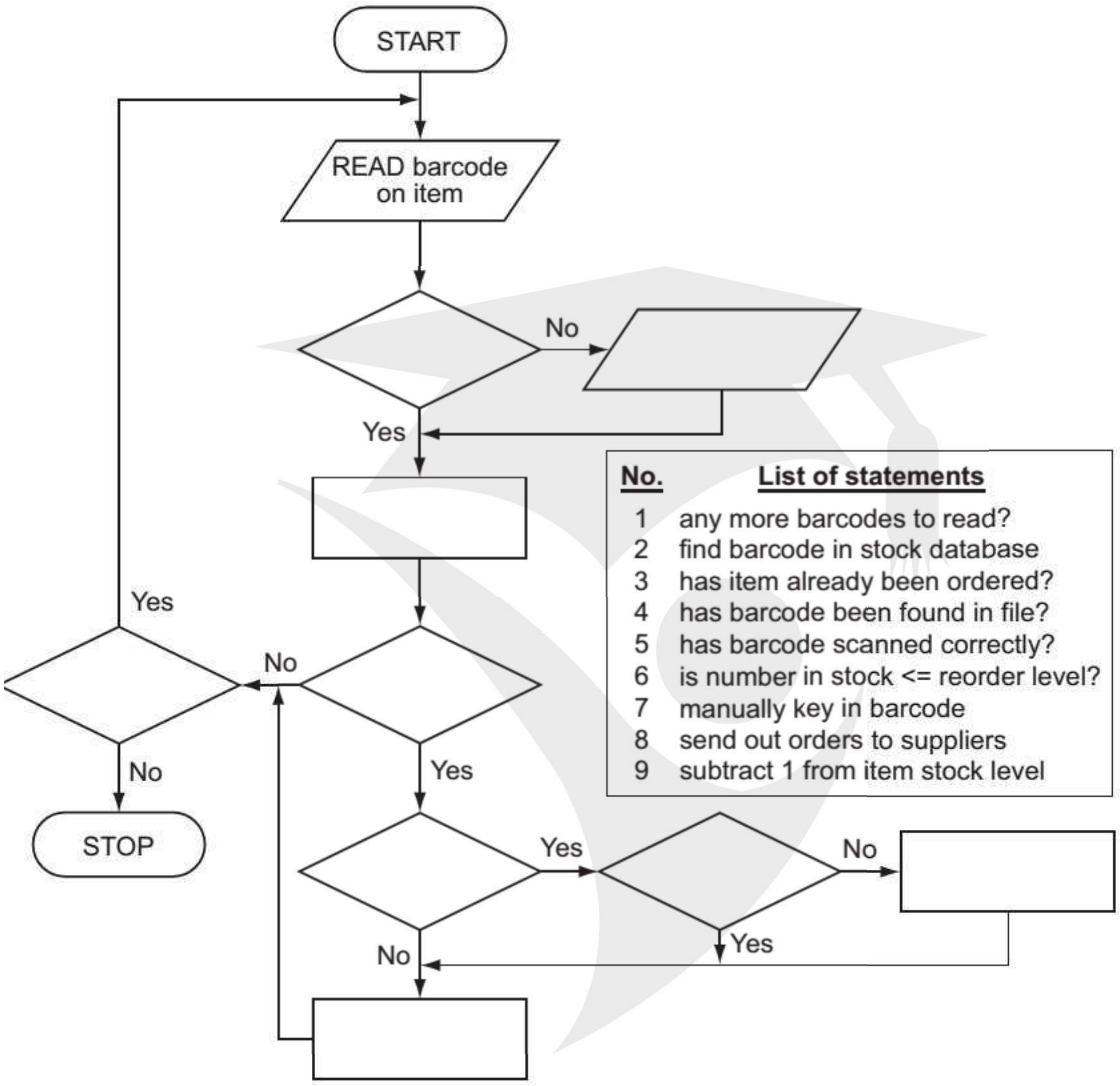
List of Statements

1. Any more bar codes to read?
2. Has bar code been found in the file?
3. Look up the price of item in the file
4. Output error report
5. Output itemised bill
6. Reject item
7. Update stock file

Q2: Winter2011 P11

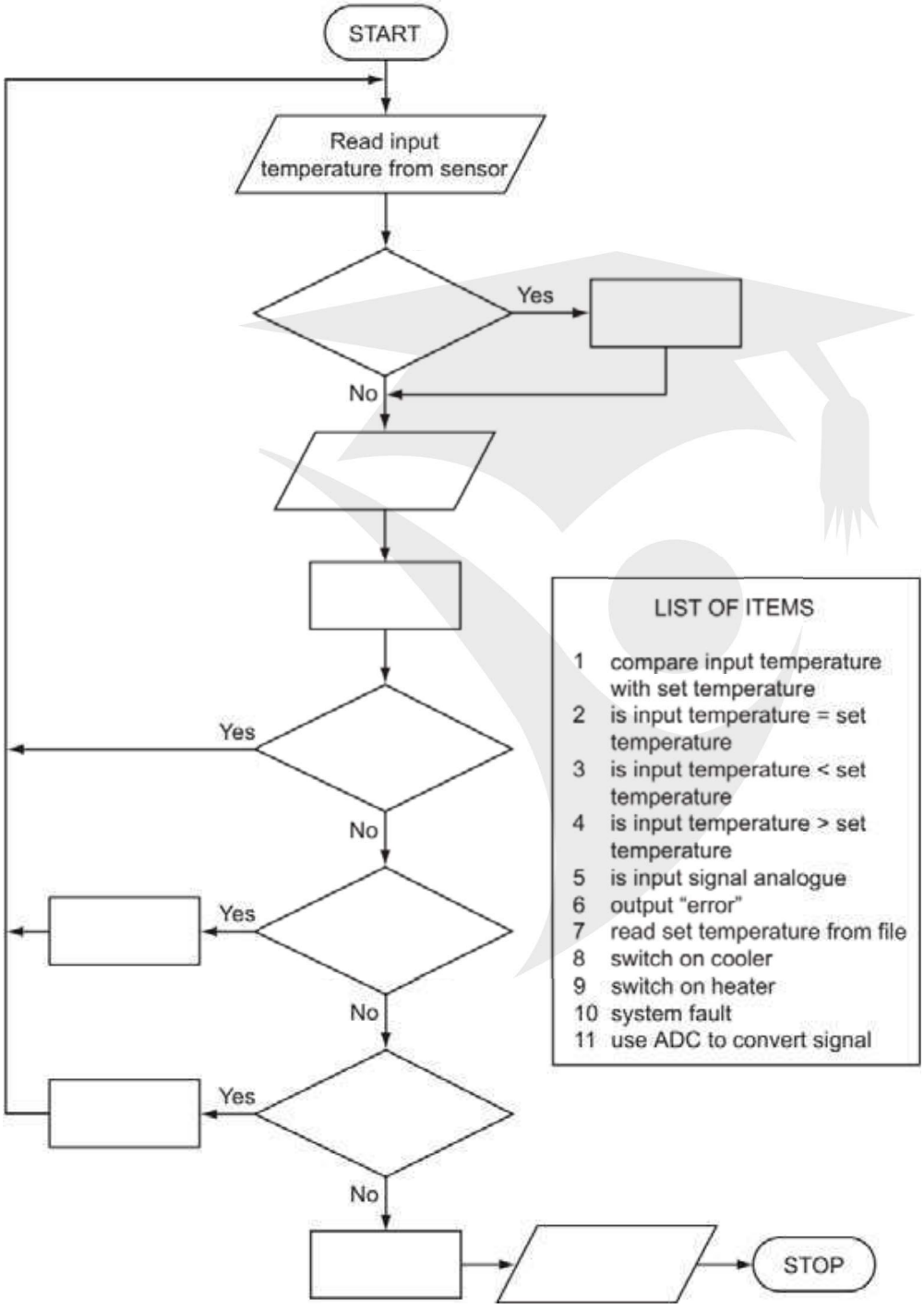
The following flowchart shows how barcodes are used at the point of sale in an automatic stock control system.

Select statements from the list below, using numbers only, to complete the flowchart.



Q3: Winter 2008

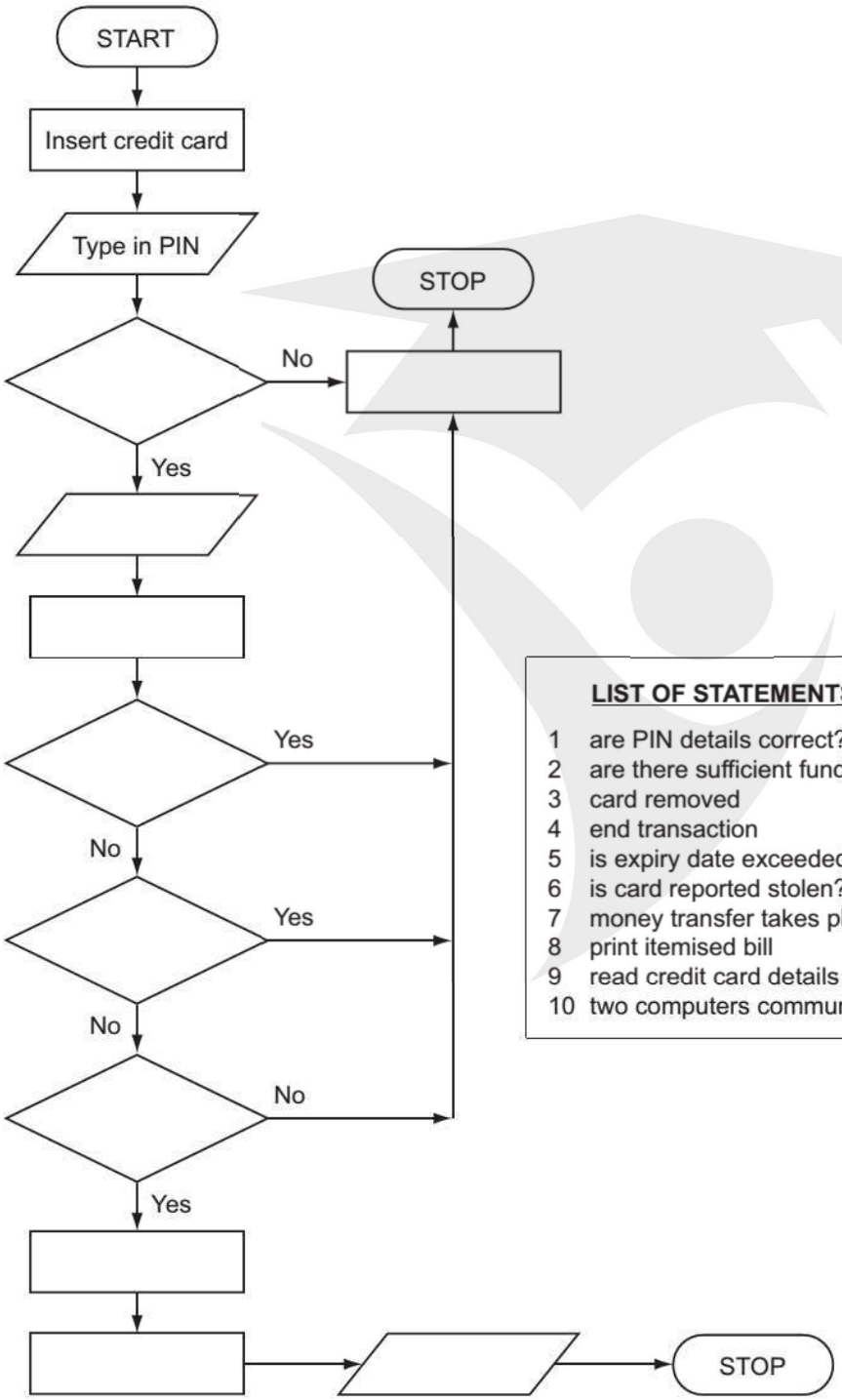
The following flowchart shows how sensors (which can be analogue or digital) and a computer are used to control the temperature of a greenhouse for plants. Complete the flowchart using the items from the list below.



Q 4Summer 2009

The following flowchart shows what happens when a customer uses a credit card to pay for goods at a supermarket. Ten of the boxes are blank.

Using the items from the list, insert the ten missing statements using the appropriate number only. Each statement may be used once only.



LIST OF STATEMENTS

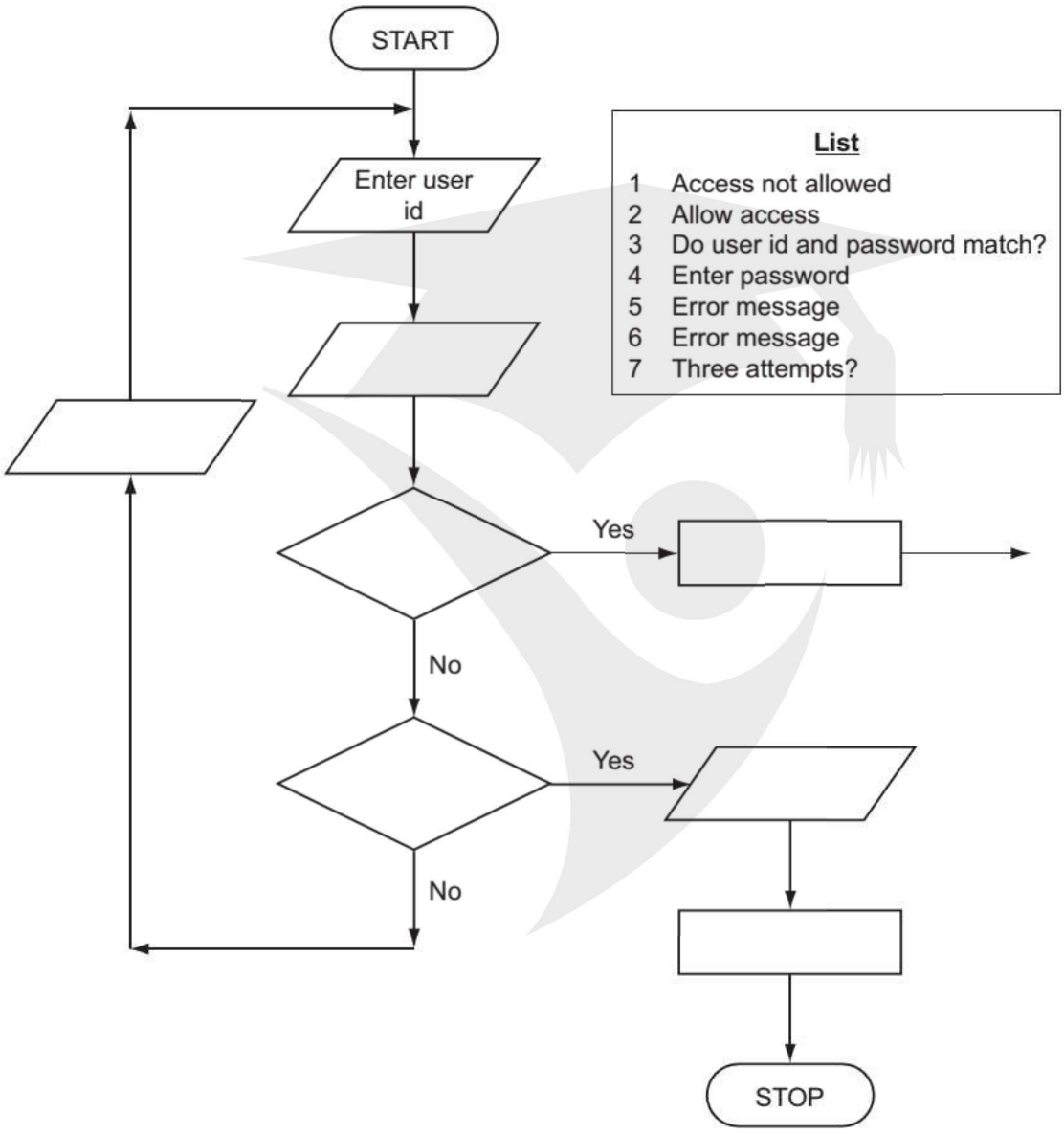
1 are PIN details correct?
2 are there sufficient funds?
3 card removed
4 end transaction
5 is expiry date exceeded?
6 is card reported stolen?
7 money transfer takes place
8 print itemised bill
9 read credit card details
10 two computers communicate

Q5: Winter 2010. P11

(a) To log on to a computer, a user needs to type in a user id followed by a password; these should match up. Only three attempts are allowed.

The flowchart below shows the log on procedure. Several boxes have been left blank.

Complete the flowchart using items from the list.

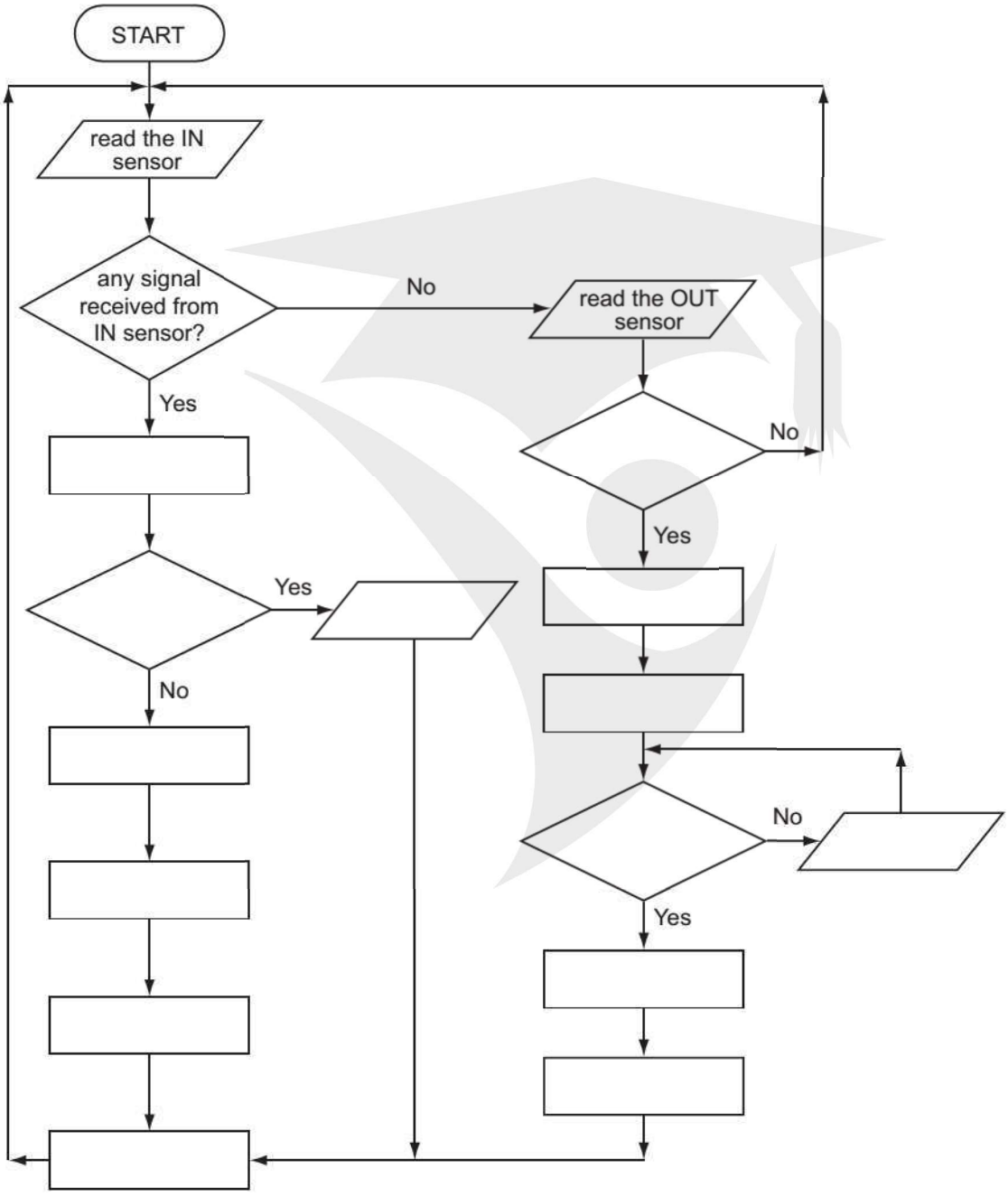


Q 6: Summer 2012. P11

A car park uses sensors and a microprocessor to monitor cars leaving and entering. The car park is open 24 hours every day. The park fee is $10 per day.

The following flowchart shows how the IN and OUT barriers are controlled. Some of the statements are missing.

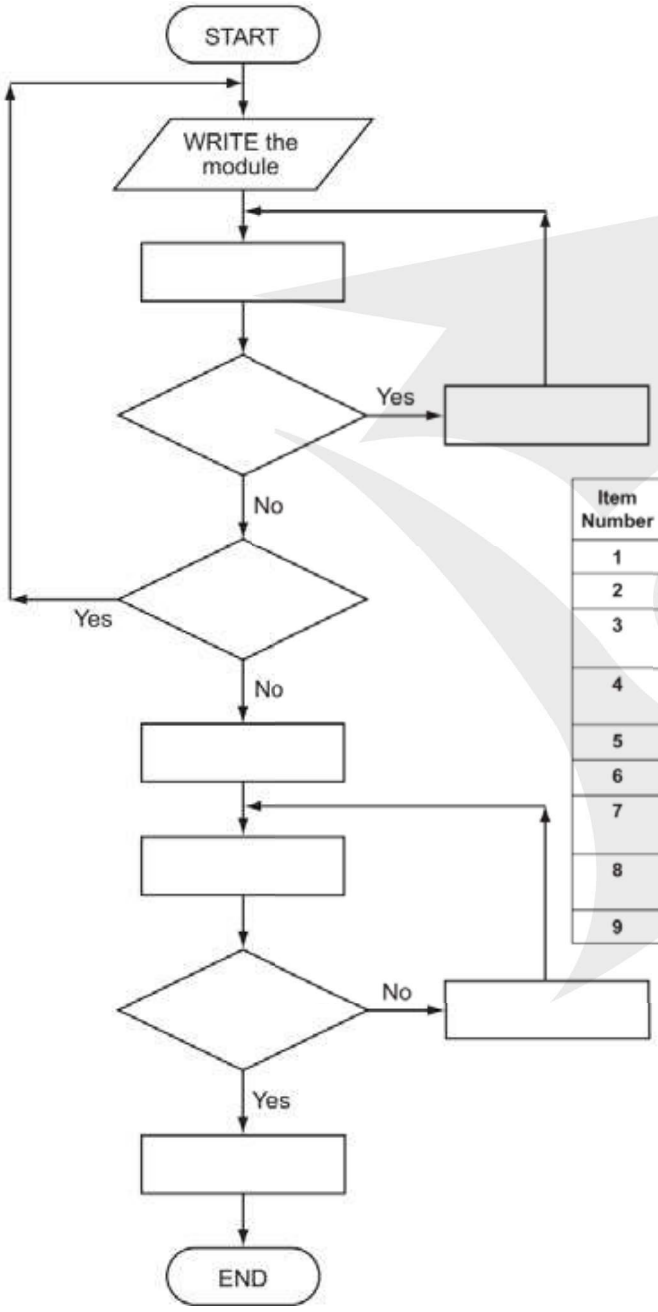
Using item numbers only, insert the correct item number into the flow chart from the item list.



Q9: Summer 2013. P12

A large word processor is being developed by first writing a series of modules. These are then put together to form the final word processor. Testing is done on each module and on the final word processor. The following flowchart shows how this word processor is developed. Several of the stages have been omitted.

Complete the flowchart, using item number only, from the list of items given.



ITEM LIST

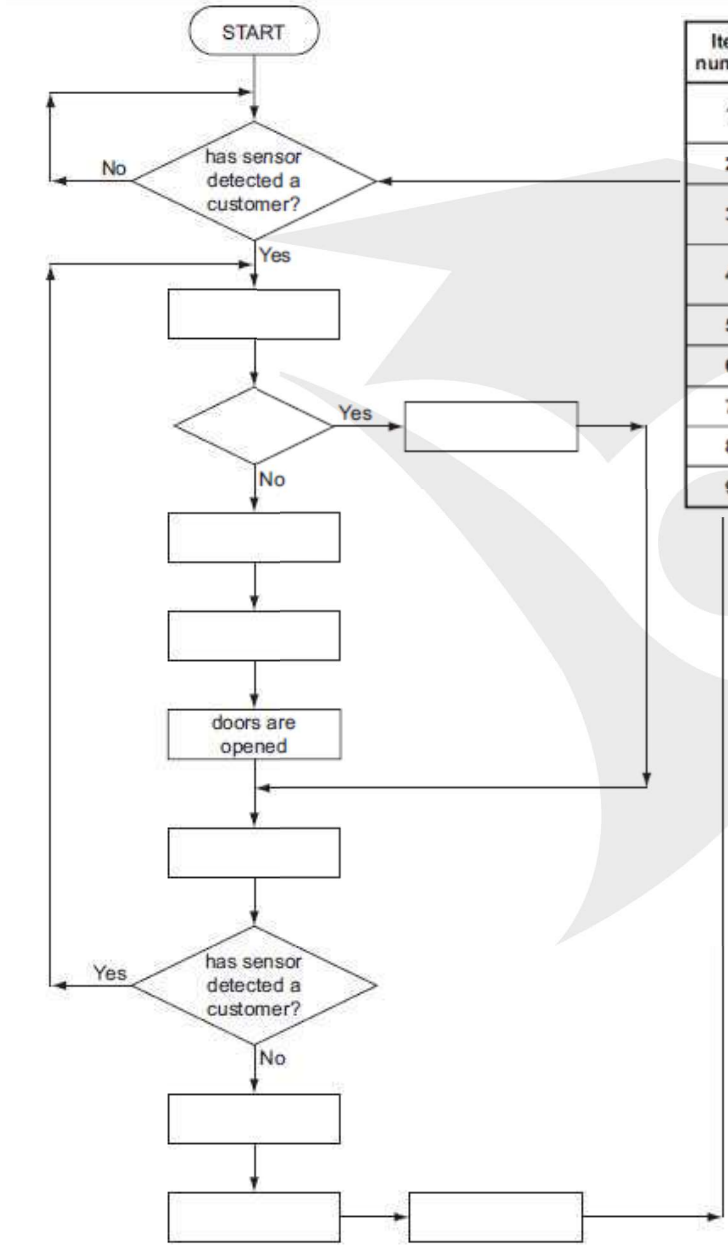
Item Number	Item Description
1	any errors in the module?
2	any more modules to write and test?
3	combine all modules to form final word processor
4	does final word processor give expected results?
5	modify final word processor
6	modify the module
7	test module using data with known outcomes
8	test final word processor using data with known outcomes
9	write user documentation

Q10: Winter 2013. P13

A microprocessor controls the opening and closing of automatic doors to a supermarket. Customers are detected using pressure sensors.

The flowchart on the next page shows how the sensors and microprocessor interact to control the opening and closing of the doors. However, several of the stages in the process have been missed out.

Using item number only, complete the flowchart using items from the following list:



Item number	Item description
1	ADC changes analogue signal into digital signal
2	are the doors already open?
3	DAC changes digital signal into analogue signal
4	DAC changes digital signal into analogue signal
5	doors are closed
6	microprocessor sends signal
7	microprocessor sends signal
8	no action is required
9	wait for 10 seconds

[5]

Question 1b

Example Candidate Response – high	Examiner Comments
(b) Identify **three** output devices that can be connected to a personal computer. 1 printer 1 2 Speaker 3 projector 2 [3]	1 The candidate could improve their answer by being more specific. For example, 2D printer, laser printer, 3D printer. 2 The candidate could improve their answer by being more specific. For example, DLP projector. **Total mark awarded = 3 out of 3**

How the candidate could have improved their answer

The candidate was awarded all three marks, but they could have improved their answer by being more specific with the names of their output device.

Example Candidate Response – middle	Examiner Comments
(b) Identify **three** output devices that can be connected to a personal computer. 1 printer 1 2 3D printer 2 3 ~~3D printer~~ microphone 3 [3]	1 The candidate could improve their answer by being more specific, for example, laser printer. 2 The candidate is given the benefit of the doubt with this answer. It assumes that they are referring to a 2D printer as device 1, so they are awarded 3D printer as device 2. It is beneficial for the candidate to provide a different type of output device. 3 The candidate provides an input device rather than an output device. **Total mark awarded = 2 out of 3**

How the candidate could have improved their answer

The candidate could have improved their answer by being more specific with their first output device. It was a common misconception that a microphone was an output device. Candidates may have thought this because a person spoke into a microphone and sound was heard. However, the candidates needed to recognise that the sound was produced by a speaker and not the microphone.

Example Candidate Response – low	Examiner Comments
(b) Identify **three** output devices that can be connected to a personal computer. 1 Keyboard 2 mouse (1) 3 Speakers (2) [3]	(1) The candidate gives two input devices, rather than output devices. (2) This is a correct output device. **Total mark awarded = 1 out of 3**

How the candidate could have improved their answer

The candidate provided two input devices, rather than output devices. They may have misunderstood and seen them as output devices because when they clicked a key, or a button, an action could be seen on screen. However, the candidates should have understood that it was the screen that was the output device.

Common mistakes candidates made in this question

Candidates sometimes misunderstood the difference between some input and output devices. A common misconception was that a microphone was an output device.

Question 4bii

Example Candidate Response – high	Examiner Comments
(ii) Marley prints the images for his project using an inkjet printer. Describe how the inkjet printer prints an image. Inkjet printer can use two of the technologies - piezoelectric and thermal bubble. Inkjet printer uses liquid ink and print statement by statement line by line. The paper enters the printer. The print head (contains nozzles) moves across the page with the help of stepper motor and belt. Ink is sprayed onto the paper to create the required colours. After printing one line, the paper is advanced allowing the next line to be printed. The colours used are (4 black, yellow, green, magenta). Different colour are sprayed in different proportions to obtain the final colour. [4]	1 The candidate is awarded the first two marks for naming the two technologies that are used for inkjet printers. 2 The candidate is awarded the third mark for stating the print has a print head that moves across the page. 3 If the candidate had stated the ink is sprayed through nozzles, the fourth mark would have been awarded here. 4 The candidate is awarded the fourth mark for stating that colours are mixed to get a final colour. **Total mark awarded = 4 out of 4**

How the candidate could have improved their answer

The candidate was awarded full marks for their answer, with the fourth mark gained in the last sentence. The candidate could have gained the fourth mark at an earlier point if they had referred to the ink being sprayed through nozzles onto the paper.

Example Candidate Response – middle	Examiner Comments
(II) Marley prints the images for his project using an inkjet printer. Describe how the inkjet printer prints an image. An inkjet (printer) uses liquid ink it uses piezoelectric technology. It also uses a thermo bubble (1) Inkjet printers are used to print small quantities of image at a high quality (2) [4]	(1) The candidate is awarded two marks for naming the technologies that are used. (2) This is a use of inkjet printers, rather than the function of how one works. **Total mark awarded = 2 out of 4**

How the candidate could have improved their answer

The candidate named the two technologies that could be used in inkjet printers. The remainder of their answer was about the use of inkjet printers and not the function of how one printed an image.

Example Candidate Response – low	Examiner Comments
(ii) Marley prints the images for his project using an inkjet printer. Describe how the inkjet printer prints an image. Inkjet printer prints an image by throwing (1) ink droplets to the Page to create an image. Thousand of ink droplets are thrown on a page in one second. It is very fast and efficient procss. It produces a good quality image (2) It didn't uses a powdu ink, it uses a liquid ink to create an image. [4]	(1) The candidate is missing the reference to nozzles being used to spray the ink. (2) These points are related to the uses and benefits of inkjet printers, rather than how it operates. **Total mark awarded = 0 out of 4**

How the candidate could have improved their answer

- The candidate missed some key technical language from the first part of their answer. If they had stated that the ink was sprayed through nozzles onto the page, this would have demonstrated the level of technical language required.
- The remainder of the candidate's answer was about the use of inkjet printers and not the function of how one printed an image.

Common mistakes candidates made in this question

Many candidates gave uses and benefits of inkjet printers, rather than describing how they printed an image. The question required them to have described how they operated.

Question 10

Example Candidate Response – high	Examiner Comments
10 Remy has a mobile device that has a capacitive touch screen. Describe how the capacitive touch screen registers Remy's touch. There are many layers of glass. There is an electric field on the layers. (1) When the top layer is touched, there is a change in the electric field. (2) The sensors detect the change. Microprocessors calculate where the change (3) occured and calculate which part of the screen has been touched. (4) [4]	(1) The first mark is awarded for the reference to the electric field. (2) The second mark is awarded for the reference to the change in the electric field. This is acceptable for an effect of the charge being transferred to the user. (3) The third mark is awarded for the sensors use in detecting the change, implying that they read the electric field. (4) The fourth mark is awarded for the calculation of the location of the user's touch. **Total mark awarded = 4 out of 4**

How the candidate could have improved their answer

The candidate could have explained why the electric field changed, stating this was due to the charge being transferred to the user's finger.

Example Candidate Response – middle	Examiner Comments
10 Remy has a mobile device that has a capacitive touch screen. Describe how the capacitive touch screen registers Remy's touch. - has many sayers made up of glass (1) - electric #field / current flows from all 4 sides of the screen. - when the screen is touched the electric field / current changes (2) - location of touch is calculated by an on-board microprocessor. (3) [4]	(1) The first mark is awarded for stating the electric current flows from the corners of the screen. (2) The second mark is awarded for stating the electric field changes as a result of the user's touch. (3) The third mark is given for the calculation of the location of the user's touch. **Total mark awarded = 3 out of 4**

How the candidate could have improved their answer

If the candidate had added how the electric field was read, for example, using sensors, then this would have gained them a further mark.

Example Candidate Response – low	Examiner Comments
10 Remy has a mobile device that has a capacitive touch screen. Describe how the capacitive touch screen registers Remy's touch. In a capacitive touch screen layers of ~~conduction~~ glass are use which conduct electricity.[1] When the screen is touched, an electro-static current is produced[2] That corrent is dected by a sensor[3] which then calculates the location of the touch.[4] [4]	[1] This isn't accurate; an electric field is present on the screen, but the layers don't strictly conduct electricity. [2] This isn't correct; the electric field is present at all times, it isn't just produced when the screen is touched. [3] The candidate is given the benefit of the doubt and is awarded a mark for the use of a sensor reading the current. [4] The candidate refers to the sensor calculating the location of the touch, which is incorrect. The sensor cannot do this. **Total mark awarded = 1 out of 4**

How the candidate could have improved their answer

The candidate lacked accuracy in their response. In this type of touch screen, an electric field was present on the screen, but the layers did not strictly conduct electricity. The electric field was always present and was not created when a user touched the screen, which was what the candidate had stated. If the candidate had said the current changed, rather than was produced, this would have gained them an additional mark.

Common mistakes candidates made in this question

Candidates often lacked accuracy when they were asked to describe technical processes. Candidates should have made sure that they used the correct terminology and were accurate in their description.

Topical Past Papers

Q 1) Summer 2015 P11

8 (d) The LCD (liquid crystal display) on the clock face is back-lit using blue LEDs (light emitting diodes). The brightness of the clock face is determined by the level of light in the room. The amount of light given out by the LEDs is controlled by a control circuit.

Describe how the sensor, microprocessor and LEDs are used to maintain the correct brightness of the clock face.

.....
.....
.....
.....
.....
.....
.....
.....[3]

(e) Modern LCD monitors and televisions use LED back-lit technology.

Give **two** advantages of using this new technology compared to the older cold cathode fluorescent lamp (CCFL) method.

1 .....
.....
.....

2 .....
.....
..... [2]

Examiner's Comments on Question 8 (a), (b), (c), (d) and (e)

Many candidates answered both part (a) and part (b) very well. Candidates demonstrated a good knowledge of converting between binary and denary.

Most candidates only gained one or two marks for part (c). Many candidates did not refer to the time being stored in the registers in their answer, which often made their answer imprecise.

Many candidates provided a good response to part (d) that gained two or three marks. The most common error in this questions was candidates that incorrectly referring to the microprocessor sending 'information' rather than 'data' or a 'signal'.

In part (e) many candidates gave a good response. The most common answers gained marks for providing a higher resolution, being thinner/lighter and being more energy efficient. Some candidates referred to health and safety issues as a benefit that did not gain marks. Some candidates were imprecise in their answer such as 'better picture' or 'smaller size', these could not be awarded marks.

Q 2) Summer 2015 P12

2 The majority of mobile phones use touch screens. Three common technologies are used by different mobile phone manufacturers.

Choose one of the following mobile phone technologies:

• resistive • capacitive • infrared

Chosen technology .....

(i) Describe how your chosen technology works to allow a user to make selections by touching the screen.

.....

.....

.....

.....

.....[2]

(ii) Give **one** benefit and **one** drawback of your chosen technology when used on mobile phone touch screens.

Benefit

.....

.....

Drawback

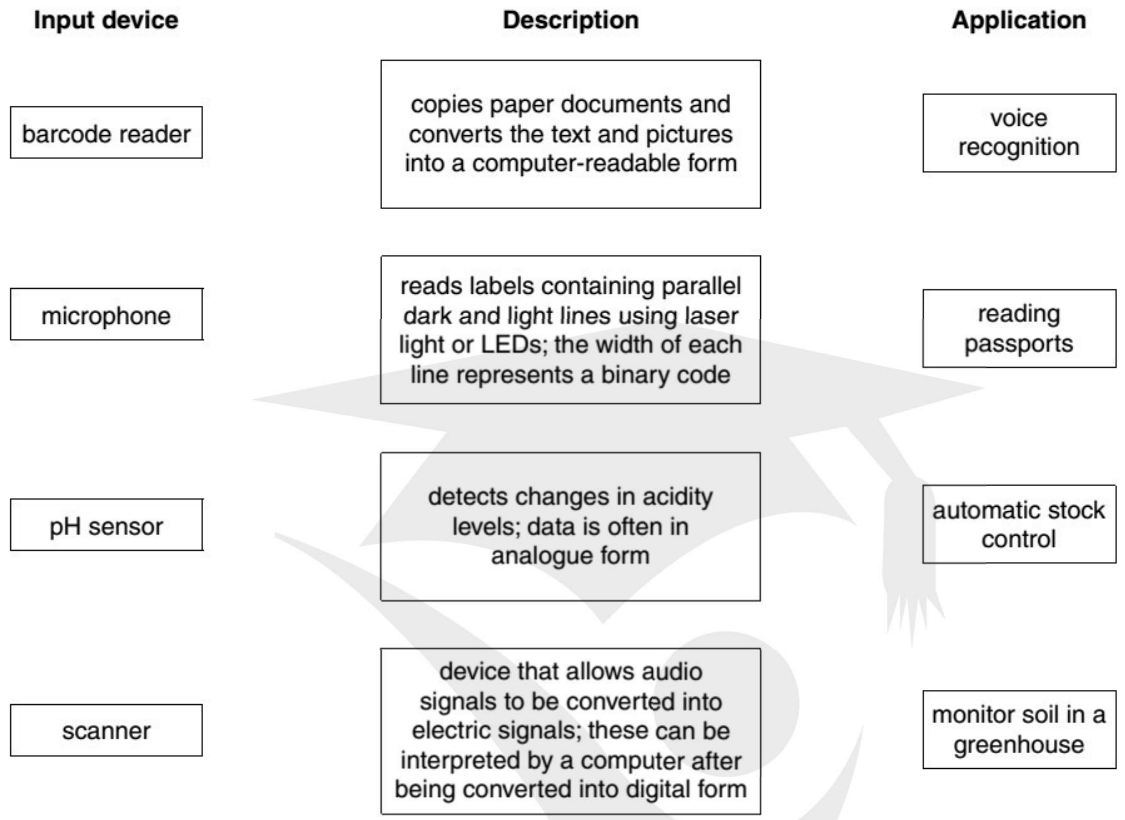
.....

..... [2]

Examiner's comments on Questions 2(i) and (ii)

Very few candidates displayed knowledge of touch screen technology. Very few candidates gained marks for this question and generally repeated phrases from the question, rather that describing how touch screen technology works. Candidate's answers were mostly too vague, with a simplistic level of knowledge displayed. The most common answer given was infrared technology. In terms of infrared touch screen technology candidates gave a vague description of a heat based method, but most infrared touch screen technology works with a grid of infrared beams that are interrupted to register a 'touch' on the screen.

3 Four input devices, four descriptions and four applications are shown below.
Draw a line to connect each input device to its correct description. Then connect each description to its correct application. [6]



Examiner's comments on Question 3

Many candidates displayed an excellent level of knowledge input devices and their uses, gaining five or six marks for the answer. The most common error was candidates confusing stock control and reading passports.

7 (a) Street lighting is controlled automatically. A light sensor and a microprocessor are used to decide when to switch each street light on or off.
Describe how the sensor, microprocessor and light interact to switch the street light on or off.
Include in your answer how the microprocessor stops the street lights being frequently switched on and off due to brief changes in the light intensity.

.....
.....
.....
.....
.....
.....
.....
.....
.....
.....[5]

(b) Name **three** different sensors (other than light and pH) and describe an application for each of these sensors.
A different application is needed for each sensor.
Sensor 1 .....
Application .....
.....
Sensor 2 .....
Application .....
.....
Sensor 3 .....
Application .....
..... [6]

Examiner's comments on Questions 7(a) and 7(b)

The full range of marks were awarded in part (a), but not many responses gained full marks. Most candidates gave a good description of a sensor sending data/signal to a microprocessor and the value being compared to a stored value. Some candidates included the use of an analogue to digital converter. Very few candidates acknowledged the issue of preventing the lights frequently turning on and off. A most common error in this questions was candidates that incorrectly referring to the microprocessor sending 'information' rather than 'data' or a 'signal'.
Most candidates gained some marks in part (b) with the full range being awarded. Some candidates were too vague in their naming of the sensor, for example a heat sensor, and some candidates repeated the application they gave for different parts of the question.

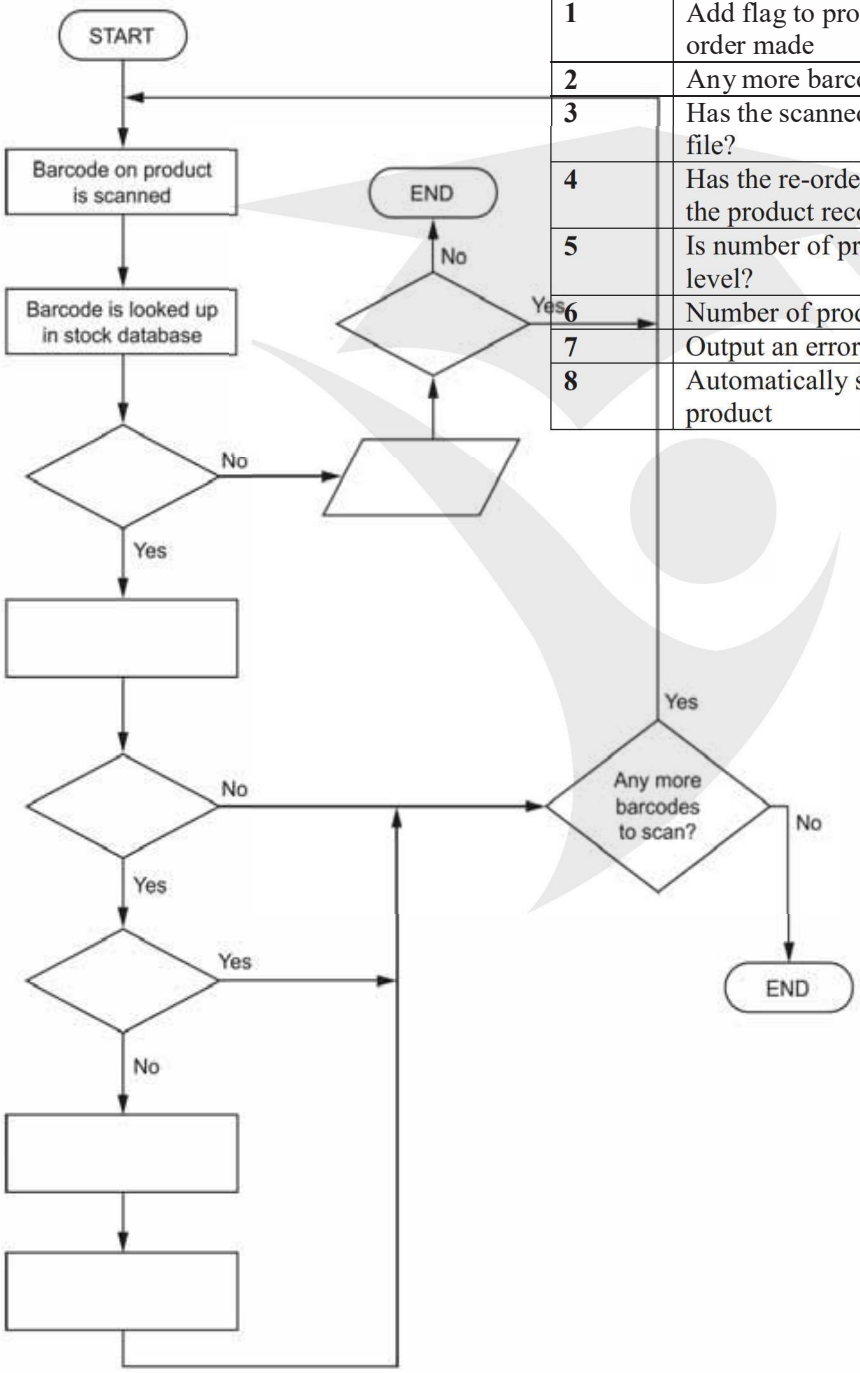
Q 3) Winter 2015 P12

3 The flowchart on the opposite page shows what happens when the barcode on a product is scanned at the checkout in a supermarket. The barcodes are used in an automatic stock control system.

Several of the statements in the flowchart are missing.

Using **item number only** from the list below, complete the flowchart. [4]

Item number	Statement
1	Add flag to product record to indicate re-order made
2	Any more barcodes to scan?
3	Has the scanned barcode been found in the file?
4	Has the re-order flag already been added to the product record?
5	Is number of product in stock <= re-order level?
6	Number of product in stock is reduced by 1
7	Output an error message
8	Automatically send out order for new product



Examiners' Comments Question 3

Many candidates were able to accurately order the process. Candidates had clearly read the question carefully and were able to construct an accurate flowchart as a result.

8 The steps to print a document using a laser printer are shown in the table below.
Put each step in the correct order. The first step has been done for you. [8]

Step	Order
As the printing drum rotates, a laser scans across it; this removes the positive charge in certain areas	
The printing drum is coated in positively-charged toner; this then sticks to the negatively-charged parts of the printing drum	
The paper goes through a fuser which melts the toner so it fixes permanently to the paper	
The printer driver ensures that the data is in a format that the laser printer can understand	**1**
A negatively-charged sheet of paper is then rolled over the printing drum	
Data is then sent to the laser printer and stored temporarily in the printer buffer	
The toner on the printing drum is now transferred to the paper to reproduce the required text and images	
The printing drum is given a positive charge	
Negatively-charged areas are then produced on the printing drum; these match exactly with the text and images to be printed	

Examiners' Comments Question 8

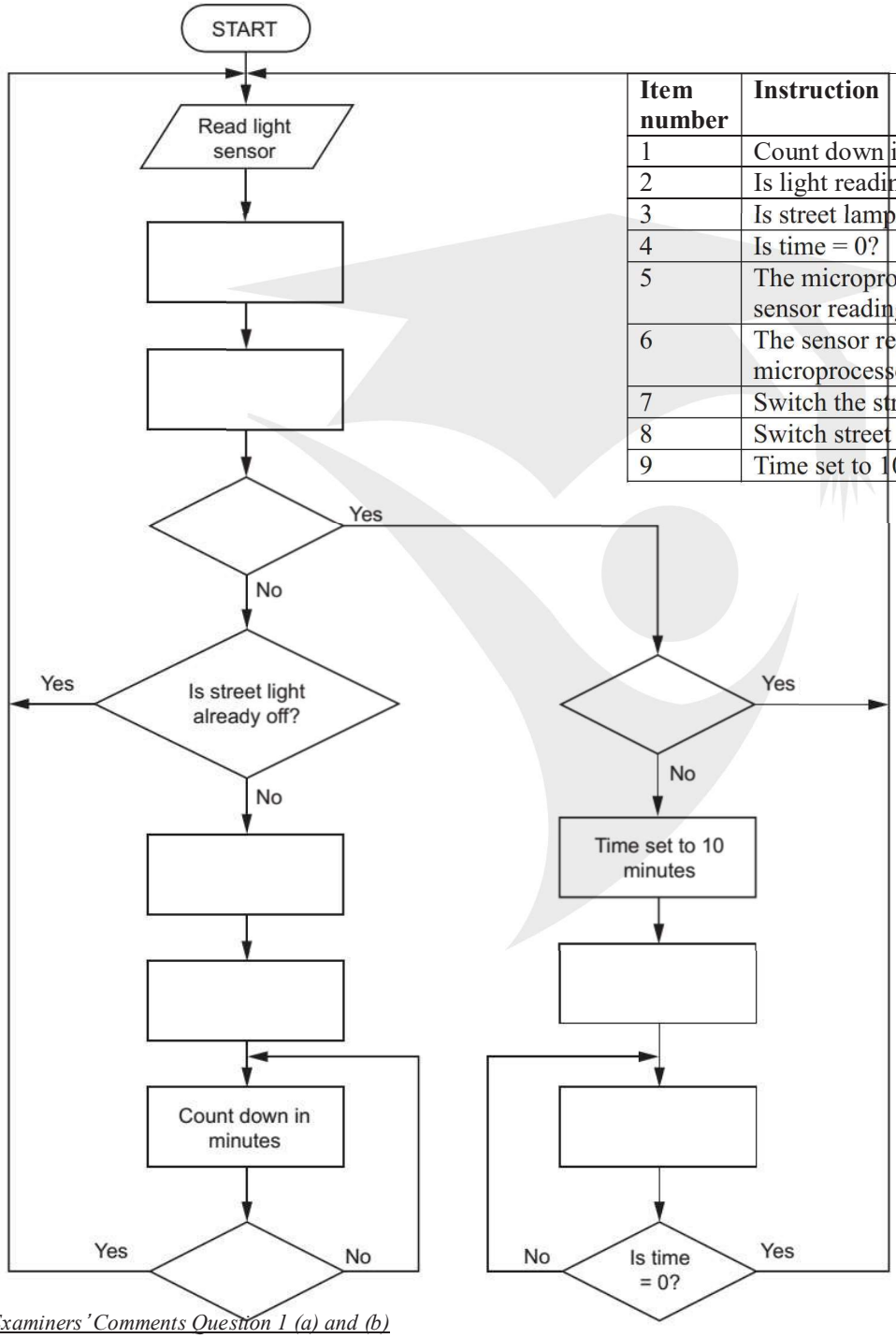
This question proved very challenging to candidates and tested the depth of their knowledge in this area. Many were able to start off with a correct sequence, and many were able to end with a correct sequence, but most became a little lost with their sequence in the middle stages. Candidates need to make sure they are fully reading each stage and carefully considering what will come before that and appear after that.

Q 4) Winter 2015 P13

1 (a) Name an application which makes use of the following sensors. A different application should be used in each case.

Temperature .....
.....
Magnetic field .....
.....
Motion .....
..... [3]

(b) The flowchart on the opposite page shows how a light sensor and microprocessor are used to switch a street lamp on or off. When the sensor reading is <= 50 light units, the lamp is turned on automatically.
Several of the instructions have been omitted from the flowchart.
Using **item numbers only** from the list below, complete the flowchart:[5]



Item number	Instruction
1	Count down in minutes
2	Is light reading <= 50?
3	Is street lamp already on?
4	Is time = 0?
5	The microprocessor compares the sensor reading with stored values
6	The sensor reading is sent to the microprocessor
7	Switch the street lamp off
8	Switch street lamp on
9	Time set to 10 minutes

Examiners' Comments Question 1 (a) and (b)

In part (a) many candidates were able to provide a suitable application for each sensor. Some candidates did not understand what is meant by an application and some candidates gave a vague description of a possible use. Candidates need to name a specific

and clear application.
In part (b) most candidates were able to provide a correct order to complete the flow chart. Candidates need only write the number of the instruction in the flowchart box and not the instruction text itself.

6 Passengers fly into an airport from other countries. The airport has a security system that uses:
• computers
• scanners
• digital cameras
To gain entry to the country, each passenger must have a passport or identification (ID) card. This must contain a recent photograph and other personal data. The passenger must:
• place their passport or ID card on a scanner that reads machine-readable characters and scans the photograph
• look towards a camera that takes an image of the passenger's face
Describe how a computer checks whether the image just taken by the camera matches the scanned photograph.

.....
.....
.....
.....[2]

Examiners' Comments Question 6

Many candidates were vague in their answer and were not able to provide specific detail about the comparison operation. When candidates answer questions about the operation of devices they need to provide specific and clear detail.

7 Name a suitable output device for each of the following applications. A different device should be used for each application.

Application	**Suitable output device**
Production of one-off photographs of very good quality	
High volume colour printing of advertising flyers	
Production of an object, which is built up layer by layer; used in CAD applications	
Converting electrical signals into sound	
Showing enlarged computer output on a wall or large screen	

Examiners' Comments Question 7

Many candidates were able to provide a suitable output device. Some candidates were not specific enough in identifying a device, for example providing an answer of printer, but not stating which type of printer. This level of detail was important to the question.

8 Four input devices are shown in the table below.
Give an application which makes use of each device and state a reason why the device is appropriate for that application. Your application must be different in each case.

Input device	Application and reason
Light sensor	Application ..... Reason ....
Keyboard	Application ..... Reason ....
Barcode reader	Application ..... Reason ....
Touch screen	Application ..... Reason ....

Examiners' Comments Question 8

Most candidates were able to get some marks for this question. Many were not specific enough in their application, for example stating supermarket, rather than at a supermarket checkout. Candidates need to make sure they are providing a full and clear application..

Q 5) Winter 2015 P11

1 (a) Four hardware items are shown in the table below.
For each hardware item:
• name a suitable application
• state how it is used in the application
Give a different application in each case. [8]

Hardware item	Application	How the hardware item is used
Microphone	....	....
Barcode reader	....	....
Touch screen	....	....
Infrared sensor	....	....

Examiners' Comments Question 1(a) (b) and (c)

In part (a) some candidates confused the two sections that needed to be completed. Candidates must understand what an application is of hardware. Many described the operations of the hardware and not how the hardware item is used to carry out tasks.
In part (b) many candidates answered this question well, giving two suitable differences.

5 (a) Inkjet printers and laser printers are two common types of printer.
Describe the features and principles of operation of each type of printer.

(i) Inkjet printer

.....
.....
.....
.....
..... [4]

(ii) Laser printer

.....
.....
.....
.....
..... [4]

(b) Another type of printer is the 3D printer.
Describe 3D printing.

.....
.....
.....
.....
..... [3]

Examiners' Comments Question 5(a)(i)(ii) and (b)

In all parts of this question candidates demonstrated limited knowledge of the operations of different types of printers. They were able to describe at a basic level that an inkjet printer spray ink onto paper and a laser printer uses toner and charges. Beyond this very limited knowledge was shown.

11 A passenger logs onto an airline website and types in the reference number for their flight. Once the passenger accesses their account they can choose their seat and also print out a boarding pass which contains a unique barcode. This barcode is scanned at the airport check-in desk.
Name **one** input and **one** output device found at the check-in desk and give a reason for your choice.

Input device: .....
Reason: .....
.....
Output device: .....
Reason: .....
.....[4]

Examiners' Comments Question 11

Most candidates were able to provide suitable input and output devices. Some candidates were not specific to the question in their reasons for the device, for example saying 'to enter text', and not giving a specific text entry to the question. Candidates must make sure that when they are provided with a scenario in a question, they use that scenario as part of the detail in their response, where appropriate.

Q 6) Summer 2016 P11 & P13

3 (a) Five sensors and five applications are shown below.
Draw a line to link each sensor to its most appropriate application. [4]

Sensor	Application
Light sensor	Monitor the pollution levels in a river
Moisture sensor	Control the switching off and on of street lights
Gas sensor	Detect intruders breaking into a building
pH sensor	Monitor the amount of water left in clothes in a dryer
Pressure	Monitor acidity levels in the soil in a green house

(b) Automatic doors in a building are controlled by the use of infrared sensors and a microprocessor.
Describe how the sensors and the microprocessor are used to automatically open a door as a person approaches.

.....
.....
.....
.....
.....
.....
.....[4]

Examiner Report Question 3(a) and (b)
In part (a) most candidates were able to correctly identify a correct sensor for the corresponding application.
In part (b) candidates need to make sure that they are writing a description of the system that if referred to in the question. Many candidates provided a generic description of a system that uses a sensor and a microprocessor, and did not relate their description to the system given in the question. Candidates must make sure when answering questions about systems involving sensors and microprocessors, that they think about processes involved in the specific system given in the question. They need to select suitable sensors (if not provided in the question) and describe how the microprocessor will operate to run that specific system.

4 (a) Nikita wishes to print out some documents and connects her printer to the computer using one of the USB ports.

(i) Identify what type of data transmission is being used.

.....[1]

(ii) Give three reasons for using a USB port.

1 .....

.....

2 .....

.....

3 .....

..... [3]

(iii) The printer runs out of paper while it is printing the documents. A signal is sent to the processor to request that the problem is dealt with.

Name this type of signal.

.....[1]

(b) State one suitable application for each printer below. A different application must be given for each printer.

Inkjet printer .....

.....

3D printer .....

..... [2]

(c) Name another type of printer and describe one way in which it is different from the printers named in part (b).

Give an application for this printer.

Type of printer .....

Description .....

.....

.....

Application .....

..... [3]

Examiner Report Question 4(a)(i), (ii), (iii), (b) and (c)

In part (a)(i) many candidates correctly identified the type of transmission.

In part (a)(ii) most candidates were able to refer to a USB becoming industry standard and universal to most devices. Some candidates could identify that a USB port can only have a USB device plugged in one way. Very few candidates identified further features of a USB port. Some candidates mistakenly gave features of a USB storage device or serial transmission, rather than the USB port itself.

In part (a)(iii) many candidates were able to correctly identify the type of signal.

In part (b) most candidates were able to identify a suitable example of use for each printer.

In part (c) many candidates were able to identify a further type of printer. Some candidates were able to expand on their answer and provide a suitable description of the operations of the printer and a suitable use. Many candidates identified Laser as their answer, some also identified answer outside the syllabus, such as Dot Matrix. Some candidates mistakenly gave LaserJet as the name for the type of printer. This is a HP brand name for printers and brand names are not creditable in answers.

12 (a) Name the following type of barcode:

.....[1]

(b) The barcode in **part (a)** contains the denary value 2 6 4 0
Convert this value to hexadecimal.

.....

.....

Write the value as a 12-bit binary number. [4]

(c) An airport uses the type of barcode shown in **part (a)** to advertise local places of interest.
Describe how a visitor landing at the airport could use these barcodes to help plan their visit.

.....

.....

.....

.....

.....

.....[3]

Examiner Report Question 12(a), (b) and (c)

In part (a) many candidates were able to identify the type of barcode.
In part (b) some candidates were able to carry out the correct calculation and conversions. This calculation did prove challenging to many candidates.
In part (c) many candidates were able to describe the process of a person scanning the QR code with their mobile device, this linking to a website that would provide details about local tourist information. Some candidates were too vague in their description, stating the barcode would be scanned, or scanning the phone with an app., but not explaining this would be done with a mobile device.

Q 7) Summer 2016 P12

2 Motion sensors are used in a security system to detect intruders.
Name **three** other sensors that could be used in the following applications.
Give a different type of sensor for each application. [3]

Application	Sensor
controlling street lights	
monitoring a river for pollution	
controlling traffic lights	

Examiner Report Question 2

Many candidates were able to provide suitable sensors for the given applications. Most candidates were able to list a light sensor for the first application. Many candidates were able to list gas or pH sensor for the second application. Some candidates were able to list pressure sensor for the third application. The most common error made was candidates not using the correct name for a type of sensor and rather listing and example of the type of sensor, such as O2 sensor or CO2 sensor for gas sensor, and acidity sensor for pH sensor. A number of candidates also incorrectly listed motion sensor for the third application.

5 Six descriptions and **six** devices are shown below.
Draw a line to link each description to the correct device.

Description	Device
Allows a user to write on a surface using a pen; text and drawings are then captured electronically and stored for later use.	Digital Light Projector
Converts sound into an electrical signal/voltage.	Inkjet printer
Uses thermal bubble and piezoelectric technology to produce a hard copy.	Interactive whiteboard
Uses a bright white light source and micro mirrors (on a chip) to produce an image to be shone onto a wall or screen.	Laser printer
Converts a hard copy document into an electronic form to be stored as a file on a computer.	Microphone
Uses negatively charged images on a rotating drum and positively charged toner to output a hard copy.	Scanner (2D)

Examiner Report Question 5
Most candidates were able to match the correct descriptions to the correct devices. The most common error was the confusion of Laser and Inkjet printers.

Q 8) Winter 2016 P12

11 A security system is installed in a house. A hexadecimal number is entered to activate or deactivate the alarm.
(a) The alarm code is set to hexadecimal number **2 A F**
Show how this number would be stored in a 12-bit binary register.[3]

(b) Identify **two** sensors that the security system could use to detect intruders.
Describe how each sensor could be used in the security system.
Sensor 1 .....
Description .....
.....
.....
.....
Sensor 2 .....
Description .....
.....
.....
.....[6]
Examiner Report

In part **(a)** many candidates could convert the hexadecimal to 12-bit binary.
In part **(b)** some candidates could correctly identify at least one sensor and describe how it could be used.
The most common error was candidates identifying the same type of sensor, for example giving a motion sensor and an infrared sensor as their answer.

Q 9) Winter 2016 P11& 13

4 The Henslows Diner is a local restaurant.
(a) Staff currently use a keyboard to input a customer food order into a computer. The food order is then sent to the kitchen.
State **two** disadvantages of using a keyboard to input a customer food order.
1 .....
.....
2 .....
.....[2]

b) A concept keyboard has a flat surface that is overlaid with images of food items available from the restaurant menu. Staff can click on an image to add the food item to a customer food order.
The Henslows Diner wants to change to a concept keyboard to input customer food orders.
Explain **two** benefits of making this change.
1 .....
.....
.....
.....
2 .....
.....
.....
..... [4]

Examiner Report
In part **(a)** many candidates answered this question well, providing two reasonable disadvantages of using a keyboard.
In part **(b)** some candidates could provide two reasonable benefits. Most candidates tried to turn the disadvantages into a benefit, which provided some good answers. Candidates need to make sure that they provide benefits relating to the context they are given. Some candidates provided a benefit that was not relevant to the context they had been given.

7 Modern Liquid Crystal Display (LCD) monitors use Light-Emitting Diode (LED) backlit technology.
Give **four** benefits of using LED technology.
1 .....
.....
.....
2 .....
.....
.....
3 .....
.....
.....
4 .....
.....
.....[4]

Examiner Report
Some candidates provided good, clear benefits, demonstrating their understanding of LED technology. Some candidates provided very vague answers, for example, it is a better technology.

9 A security light is controlled by sensors and a microprocessor.
Describe how the sensors and microprocessor interact to switch on the security light when an intruder is detected.

.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....[6]

Examiner Report
Some candidates gained 5 or 6 marks for this question on sensors and a microprocessor controlling a security light, providing very good, detailed answers. Many candidates could give a suitable sensor, but provided a vague response as to how they would be used in the system, in conjunction with the microprocessor. Candidates are reminded to consider the context they are given when answering questions and not provide a generic response.

Q 10) March 2017 India

1 Name **three** different sensors.

Sensor 1 .....

Sensor 2 .....

Sensor 3 ..... [3]

Examiner Report
Most candidates correctly named at least two sensors.

10 Describe the differences between a barcode and a Quick Response (QR) code.

.....
.....
.....
.....
.....
.....[3]

Examiner Report
Most candidates could correctly describe at least one difference between a barcode and a QR code. Some excellent answers for this question were seen.

Q 11) Summer 2017 P11

9 A supermarket has a system that allows customers to check out their own shopping.
Identify and describe the purpose of **two** input devices and **one** output device used in this system.

Input device 1 .....
Purpose .....
.....
.....
Input device 2 .....
Purpose .....
.....
.....
Output device 1 .....
Purpose .....
.....
..... [6]

Examiner Comment on Q 9
Most candidates provided suitable input and output devices. Candidates need to remember to read thecontext of the question and apply it to their answer. Some candidates did not do this and provided input andoutput devices that were not applicable. Some candidates gave a very generic description of the use of thedevice e.g. barcode scanner, to scan barcodes. Candidates are reminded to refer to the context of thequestion when providing a use for input and output devices.

12 The processes in a chemical factory are monitored by sensors connected to a microprocessor.
(a) Identify **two** different sensors used in this application. Give an example of how each sensor could be used in the chemical factory.

Sensor 1 .....
Use .....
.....

Sensor 2 .....
Use .....
..... [4]

(b) Describe how the sensors and a microprocessor are used to monitor a process.

.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
..... [5]

Examiner Comment on Q 12(a)
Many candidates provided two suitable sensors and described how they could be used in the chemicalfactory. Candidates had a large range of sensors they could choose and it was pleasing to see that the fullrange of suitable sensors were seen in candidate's answers.
Examiner Comment on Q 12(b)
Many candidates gave a detailed answer about how the sensors and the microprocessor would be used.Some candidates lacked detail in their answer, forgetting detail such as comparing the input value to thestored value. It would be beneficial for candidates to understand the context of the question and use it whendescribing the actions that may be taken, and not just provide a generic response. It would also be beneficialfor candidates to understand that the process in continuous.

Q 12) Summer 2017 P12

3 The diagram shows **five** output devices and **five** descriptions.
Draw a line between each output device and its description. [4]

Output Device	Description
Inkjet printer	Flat panel display that uses the light modulating properties of liquid crystals.
LCD screen	Flat panel display that uses an array of light-emitting diodes as pixels.
2D cutter	Droplets of ink are propelled onto paper.
LED screen	Electrically charged powdered ink is transferred onto paper.
Laser printer	High powered laser that uses the x-y plane.

Examiner Comment on Q 3
Most candidates correctly match the five terms to the correct descriptions.

6 Airline boarding passes can be read from a smart phone instead of a printout.

Identify what type of barcode **A** is an example of. Explain how the data stored in this type of barcode is read.

.....
.....
.....
.....
.....
.....
.....
..... [4]

Examiner Comment on Q 6

Many candidates identified the barcode to be a QR code, and some candidates gave a description of howthe QR code would be read. Many candidates provided an explanation of what a QR is and how much data itcan store. Candidates are reminded to read the question and provide the detail required.

9 A cold store is kept at a constant low temperature using a sensor, a microprocessor and a cooling unit.

Explain how the sensor and microprocessor will maintain a constant low temperature.

.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....[6]

Examiner Comment on Q 9

Many candidates gave a detailed answer about how the sensors and the microprocessor would be used.Some candidates lacked detail in their ans wer, forgetting detail such as comparing the input value to thestored value. It would be beneficial for candidates to understand the context of the que stion and use it whendescribing the actions that may be taken, and not just provide a generic response. It would also be beneficialfor candidates to understand that the process in continuous.

Q 13) Winter 2017 P12

9 Anna has a farm that grows fruit.

She has a system that monitors the conditions for growing the fruit.

Sensors are used in this system.

(a) Explain what is meant by the term **sensor**.

.....
.....
.....
.....[2]

(b) State **two** sensors that could be used in this system and describe how they could be used.

Sensor 1 .....

Use .....

.....

.....

.....

.....

Sensor 2 .....

Use .....

.....

.....

.....

..... [6]

Q 14) Winter 2017 P13

1 A washing machine has a small display screen built into it.

One use of the display screen is to show an error code when a problem has occurred with a washing cycle.

(a) State whether the display screen is an input, output or storage device.

..... [1]

(b) The display screen shows a hexadecimal error code:

E04

This error code means that the water will not empty out of the washing machine.

Convert this error code to binary.

[3]

(c) State why hexadecimal is used to display the error code.

.....

.....

.....

.....[1]

(d) Identify three sensors that could be used in the washing machine.

State what each sensor could be used for.

Sensor 1.....

Use .....

.....

Sensor 2 .....

Use .....

.....

Sensor 3 .....

Use .....

..... [6]

Q 15) March 2018 P12 (India)

4 An air conditioning system is used to control the temperature in a hospital.
The air conditioning system uses temperature sensors and a microprocessor.
The temperature must remain between 21°C and 24°C.
Describe how the sensors and the microprocessor are used to control the temperature of the hospital.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....[6]

Comments on Question 4

Some candidates answered this question well, but some provided a very generalised response. It would be helpful if candidates used the context and values provided in a question of this nature in their response. This will show a greater understanding about how that particular system will operate

12 A hospital stores the results of medical tests on a computer system. Each patient is given a wristband containing a unique barcode. The barcode is used every time the patient has a medical test.

(a) Explain **two** benefits of using barcodes in this situation.

Benefit 1 .....

.....

.....

Benefit 2 .....

.....

.....[4]

(b) Describe how the barcode is read.

.....

.....

.....

.....

.....

.....

.....

.....[4]

Comments on Question 12

(a) This question appeared challenging for candidates. Many candidates described that the process was made easier linked regarding the fact that the data will be stored in an electronic database and it will be easier to see all the details and update them. This process would be just the same if the patients name was typed in, rather than the barcode scanned. Candidates did not consider this fact. It would be helpful for candidates to focus on the process indicated in the question of using the barcode to access the records, making it quicker to scan and less likely to have an input error. The process beyond this would be the same as typing in the patient name.

(b) Many candidates answered this question well. It was pleasing to see the level of understanding provided about how a barcode scanner operates. Some candidates gave information about how barcode scanners are used, rather than describing how they operate.

Q 16) Summer 2018 P11

1 Jane answers an examination question about computers and data correctly.

Six different words or numbers have been removed from her answer.

Complete the sentences in Jane's answer, using the list given. Not all items in the list need to be used.

• 2	• 10	• 16	• analogue
• binary	• denary	• digital	• hexadecimal

As humans, we process …… data, but a computer cannot process this type of data. For a computer to be able to process data it needs to be converted to …… data.

As humans, we mostly use a …… number system; this is a base …… number system.

Computers use a …… number system; this is a base …… number system. [6]

8 A supermarket uses a barcode scanner to read the barcodes on its products.

(a) Describe how the barcode scanner reads the barcode.

……

……

……

……

……

…… [4]

(b) Explain how the barcode system could help the supermarket manage its stock.

……

……

……

……

……

…… [3]

(c) An infrared touch screen is used to view and navigate the supermarket stock system.

Explain how the infrared touch screen detects a user's touch.

.....

.....

.....

.....

.....

..... [4]

Q 17) Summer 2018 P12

2 (a) Nancy has captured images of her holiday with her camera. The captured images are stored as digital photo files on her camera.

Explain how the captured images are converted to digital photo files.

.....

.....

.....

.....

.....

.....[4]

9 An advertisement in a magazine displays this barcode:

(a) Identify this type of barcode.

..... [1]

(b) Explain how the data stored in this barcode is read.

.....

.....

.....

.....

.....

.....

.....

..... [4]

10 Alexandra has a new mobile device.

It has a touch screen that uses capacitive technology.

(a) Describe how a capacitive touch screen registers Alexandra's touch.

.....

.....

.....

.....

.....

.....

.....

..... [4]

(b) Alexandra is wearing gloves because it is cold.

She presses an icon on her touch screen but her action is not registered.

(i) Explain why the touch screen will not register her touch.

.....

.....

.....

..... [2]

(ii) Alexandra does not want to remove her gloves.

Explain how Alexandra could use her mobile device whilst still wearing gloves.

.....

.....

.....

..... [2]

11 A factory uses a security system to control a security light. The system uses a sensor and a microprocessor.

Explain how the security system makes use of the sensor and the microprocessor to control the security light.

Q 18) Winter 2018 P12

5 (a) Karina is taking her Computer Science examination. She has three questions to answer about output devices.

(i) For the first question she writes the answer:

"It is a high powered laser that cuts materials such as thin metals or wood."

Identify the output device that Karina is describing.

.....[1]

(ii) For the second question she writes the answer:

"The screen is made up of blocks of red, green and blue pixels. The screen uses layers of different types of liquid." Identify the output device that Karina is describing.

.....[1]

(iii) For the third question she writes the answer:

"It is responsible for powering and moving a motor in machinery, such as a robot arm in a factory."

Identify the output device that Karina is describing.

.....[1]

(b) Karina correctly answers another examination question about some more output devices.

Five different terms have been removed from her answer.

Complete the sentences in Karina's answer, using the list given. Not all terms in the list need to be used.

• 3D	• digital light projector	• inkjet
• interactive whiteboard	• laser	• rotating
• scanning	• sliding	• speaker
• thermal bubble		

An ..... allows a user to write on a surface using a pen, the text and drawings can then be captured and stored for later use.

An ..... printer produces a hard copy of a document using ..... and piezoelectric technology. A ..... printer uses a ..... drum, and positive and negative charges, to produce a hard copy of a document. [5]

10 A system uses pH sensors and a microprocessor to help monitor pollution in a river.

The pH of the water should be between 6 and 8. The system outputs an alert if the pH of the water is not in this range.

Explain how the system uses the pH sensors and the microprocessor to help monitor the pollution.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....[5]

Q 19) Winter 2018 P13

1 There are six output devices and six descriptions shown. Draw a line to connect each output device to the most appropriate description. [5]

Description	Device
Laser Printer	Uses a high-intensity beam of light shone through three layers of changing pixels
LCD Projector	Uses millions of micro mirrors to reflect light through a lens
Digital Light Projector (DLP)	Uses plastic, resin or powdered metal to generate a physical output
Inkjet Printer	Uses a static electric charge on a rotating drum to generate a physical output
3D Printer	Uses liquid ink to generate a physical output
2D Cutter	Uses a high-power laser to generate a physical output

3 An elevator (lift) has a maximum weight limit of 2400 kg. The weight carried is monitored by a sensor and a microprocessor. Describe how the sensor and the microprocessor are used to make sure the maximum weight limit is not exceeded. .....

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [6]

Q 20) March 2019 P12

2 Many computer systems have an input device and an output device.

(a) (i) State what is meant by an input device.

.....

..... [1]

(ii) Give an example of an input device.

..... [1]

(b) (i) State what is meant by an output device.

.....

..... [1]

(ii) Give an example of an output device.

..... [1]

3 (b) Sensors are used at the finish line to identify the number of competitors who finish the race.

(i) Identify **two** different sensors that could be used to identify the number of competitors.

Sensor 1.....

Sensor 2..... [2]

(ii) The sensors are used with a microprocessor to count how many competitors finish the race.

Explain how the sensor and the microprocessor are used.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [6]

6 Nadia purchases a printer to print out her homework.

She connects the printer to her computer using USB.

(a) Explain what is meant by USB.

.....

.....

.....

.....

.....

..... [3]

(b) Nadia's printer uses powdered toner rather than liquid ink.

(i) State the type of printer Nadia has purchased.

..... [1]

(ii) Give **two** benefits of using this type of printer.

Benefit 1 .....

.....

Benefit 2 .....

..... [2]

(iii) Give **one** drawback of using this type of printer.

Drawback 1 .....

..... [1]

Q 21) Summer 2019 P11

3 Five descriptions of different input or output devices are given in the table.

Complete the table by stating the **name** of each input or output device. [5]

Description	Name of device
This is an input device that works by shining a light onto the surface of a document. The light source is automatically moved across the document and the reflected light is captured by mirrors and lenses.	.....
This is an input device where a laser or a light source is moved across an object. The width, height and depth of the object are measured to allow a model to be created.	.....
This is a large input device that is usually fixed to a wall. A user can calibrate the device to make sure the sensors align with a projected image. The user can use either their finger or a special pen to make selections.	.....
This is an output device that uses many small mirrors to reflect light towards a lens. This will display an image.	.....
This is an output device that creates an object by building layer upon layer of material.	.....

Q 22) Summer 2019 P12

1 Input and output devices are often connected to a personal computer.

(a) Identify **three** input devices that can be connected to a personal computer.

1 .....

2 .....

3 ..... [3]

(b) Identify **three** output devices that can be connected to a personal computer.

1 .....

2 .....

3 ..... [3]

4 (ii) Marley prints the images for his project using an inkjet printer.

Describe how the inkjet printer prints an image.

.....

.....

.....

.....

.....

.....

.....

..... [4]

7 (a) An office has an automated lighting system. When movement is detected in the office the lights are switched on. If movement is not detected for a period of 2 minutes the lights are switched off. The system uses a sensor and a microprocessor.

Describe how the automated lighting system uses a sensor and a microprocessor.

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [6]

10 Remy has a mobile device that has a capacitive touch screen.

Describe how the capacitive touch screen registers Remy's touch.

.....

.....

.....

.....

.....

.....

..... [4]

Q 23) Winter 2019 P13

1 A library has a system that allows customers to check out the books that they want to borrow.

Each book has a barcode that can be used to identify the book.

(a) (i) Identify **two** input devices that may be used in the library's system.

Input device 1 .....

Input device 2 .....[2]

(ii) Identify **two** storage devices that may be used in the library's system.

Storage device 1 .....

Storage device 2 .....[2]

(iii) Identify **two** output devices that may be used in the library's system.

Output device 1 .....

Output device 2 .....[2]

(d) The library often holds events that introduce new authors.

At the events, the library has a Liquid Crystal Display (LCD) screen that displays data, including an image and information about the author.

Describe how an LCD screen operates to display this data.

.....

.....

.....

.....

.....

.....

.....

.....

..... [5]

4 (c) A sensor and a microprocessor are used to monitor the pH of the cleaning products. The sys tem records each reading that is taken. If the reading is greater than 7 a warning message is displ ayed on a monitor. Explain how the sensor and microprocessor are used in the system.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [6]

Q 24) Winter 2019 P12

6 Touch screen technologies can be described as resistive or capacitive.

Six statements are given about resistive and capacitive technology.

Tick (✓) to show if the statement applies to **Resistive** or **Capacitive** technology. [6]

Statement	Resistive (✓)	Capacitive (✓)
This touch screen has multi-touch capabilities		
This touch screen cannot be used whilst wearing gloves		
This touch screen is made up of two layers with a small space in between		
This touch screen uses the electrical properties of the human body		
This touch screen is normally cheaper to manufacture		
This touch screen has a quicker response time		

Q 25) March 20 P12

7 A room has an automatic lighting system. Electric lights are automatically turned on when a person enters the room and the natural light level in the room is 10 or less.

Explain how sensors and a microprocessor are used to control the electric lights in the room.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [7]

Q 26) Summer 20 P12

6 Six statements are given about touch screen technology.

Tick (✓) to show if the statement applies to **Capacitive** or **Resistive** touch screen technology. [6]

Statement	**Capacitive (✓)**	**Resistive (✓)**
Needs pressure to be applied to create a circuit		
May not register a touch if the user is wearing gloves		
More commonly used in smartphones		
More responsive to a touch		
Needs an electrical field to be changed to register a touch		
Cheaper to manufacture		

8 Leonard has a new laser printer to print letters for his business.

Leonard connects his printer to his computer using the USB port.

(a) Give **three** benefits of using the USB port to connect the printer to the computer.

Benefit 1 .....

.....

Benefit 2 .....

.....

Benefit 3 .....

..... [3]

(b) State **two** benefits and **one** drawback of Leonard using a laser printer, instead of an inkjet printer, to print the letters.

Benefit 1 .....

.....

Benefit 2 .....

.....

Drawback .....

..... [3]

(c) An interrupt signal is sent from the printer to the computer.

(i) Give **two** examples of when a printer would generate an interrupt signal.

Example 1 .....

Example 2 ..... [2]

(ii) Many devices send interrupt signals.

Identify the software in the computer that will receive and manage all interrupt signals.

..... [1]

Q 27) 15a Summer 20 P11

1 An image of a smartphone is shown.

(a) Identify **one** input device that is part of the smartphone.

..... [1]

(b) Identify **two** output devices that are part of the smartphone.

1 .....

2 ..... [2]

6 Four scenarios are given.

Identify the most suitable sensor for each scenario.

A **different** sensor must be used for each scenario. [4]

Sensor	Scenario
	Detecting when a person is approaching an automatic door system
	Monitoring the pollution level in a river
	Checking if a tropical aquarium is 25 degrees Celsius
	Counting the number of cars that cross a bridge

8 Benny is a photographer and prints his photos using an inkjet printer.

(a) Benny is printing some photos and the paper gets jammed in the printer.

A signal is sent to alert the computer about the paper jam.

State the name of this type of signal.

..... [1]

(b) Identify **one** benefit and **two** drawbacks of Benny using an inkjet printer, instead of a laser printer, to print his photos.

Benefit .....

.....

Drawback 1 .....

.....

Drawback 2 .....

..... [3]

(c) Four statements are given about printers.

Tick (✓) to show whether the statement applies to an **Inkjet** printer or a **Laser** printer. [4]

Statement	Inkjet (✓)	Laser (✓)
Uses a rotating drum to transfer the image to the paper		
Uses powdered toner		
Uses nozzles to spray droplets on to the paper		
Uses a print head mechanism that moves side to side		

Q 28) Winter 20 P12

1 (c) Tina uses a microphone to record a welcome message for her website.

(i) State whether the microphone is an **input** or **output** device.

..... [1]

5 Tammy is buying a new computer that has an LED display.

(a) Five statements about LED displays are given.

Tick (✓) to show if each statement is **True** or **False**. [5]

Statement	**True (✓)**	**False (✓)**
It is a flat panel display		
It creates images using red, green and blue diodes		
It is not very energy efficient and gives off heat		
It can be used in mobile devices such as smartphones and tablets		
It is a front-lit display		

Q 29) Winter 20 P13

1 Five hardware devices are given.

Tick (✓) to show if each device is an **Input**, **Output** or **Storage** device. [5]

Device	**Input (✓)**	**Output (✓)**	**Storage (✓)**
Solid state drive (SSD)			
Headphones			
2D cutter			
LCD projector			
Microphone			

8 Edith is buying a new computer monitor that displays images using LCD technology.

(a) Explain what is meant by LCD technology.

.....
.....
.....
.....
.....
..... [3]

(b) State **three** benefits of LCD technology.

Benefit 1 .....
.....

Benefit 2 .....
.....

Benefit 3 .....
..... [3]

11 A theme park has a game where a player tries to run from the start to the finish without getting wet. The system for the game uses sensors and a microprocessor to spray water at a player as they run past each sensor.
Describe how the sensors and the microprocessor are used in this system.

.....
.....
.....
.....
.....
.....
.....
.....
.....
..... [6]

Q 30) March 21 P12

3 The given table shows the name or description of four devices. The table is incomplete.
Complete the missing device names and descriptions. [4]

Device name	Description
.....	Uses either thermal bubble or piezoelectric technology
Actuator	.....
.....	Uses thousands of tiny mirrors that can move very quickly to create an image
Mouse	.....

4 A supermarket sells many products. Each product has a barcode.
(a) Explain how the barcode is read at the supermarket checkout and how the price of the product is found.

.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
..... [6]

Marking Scheme

Q 1) Summer 2015 P11

5 **1** mark per device, **1** mark per category

Description of storage device	Name of storage device	Category of storage		
		Primary	Secondary	Off-line
optical media which uses one spiral track; red lasers are used to read and write data on the media surface; makes use of dual-layering technology to increase the storage capacity	**DVD**			✓
non-volatile memory chip; contents of the chip cannot be *altered*; *it is often* used to store the start-up routines in a computer (e.g. the BIOS)	**ROM**	✓		
optical media which uses concentric tracks to store the data; this allows read and write operations to be carried out at the same time	**DVD-RAM**	✓		(✓)
non-volatile memory device that uses NAND flash memories (which consist of millions of transistors wired in series on single circuit boards)	**Solid State Drive/memory (SSD)**		✓	
	(SD/XD card) (USB storage device)			(✓)
optical media that uses blue laser technology to read and write data on the media surface; it uses a single 1.1 mm polycarbonate disc	**Blue-ray**			✓

Page 9	Mark Scheme	Syllabus	Paper
	Cambridge O Level – May/June 2015	2210	11

(c) Any **three** from:

- reads values in registers "C" and "D"
- and checks the values against those stored in registers "A" and "B"
  (**NOTE**: the first two statements can be interchanged, i.e. "A" and "B" read first)
- If values in corresponding registers are the same
- the microprocessor sends a signal to sound alarm/ring [3]

(d) Any **three** from:

- uses a light sensor
- sends signal/data back to microprocessor
- signal/data converted to digital (using ADC)
- value compared by microprocessor with pre-set/stored value
- if value < stored value, signal sent by microprocessor …
- … to the voltage supply (unit)
- … "value" of signal determines voltage supplied/brightness of LED [3]

(e) Any **two** from:

- no need to warm up
- whiter tint/more vivid colours/brighter image
- higher resolution
- much thinner monitors possible/lighter weight
- more reliable technology/longer lasting
- uses much less power/more efficient [2]

Q 2) Summer 2015 P12

Page 3	Mark Scheme	Syllabus	Paper
	Cambridge O Level – May/June 2015	2210	12

2 (i) Either of the three options, **resistive**, **capacitive** or **infra-red** must be chosen maximum of **two** marks from chosen technology:

resistive
- uses multiple layers of material …
- … that transmit electric currents
- when the top layer/screen is pushed/touched into the lower/bottom layer …
- … the electric current changes and location of "touch" is found

capacitive
- current sent/flows out from all 4 corners of the screen
- when finger/stylus touches screen, the current changes
- the location of "touch" is calculated

infra-red
- an "invisible" grid on the screen (pattern of infra-red LED beams)
- sensors detect where the screen has been touched through a break in an infrared beam(s)
- the position where the screen touched is calculated [2]

(ii) **1** mark for **benefit**, **1** mark for **drawback**

Resistive

benefits:
- inexpensive/cheap to manufacture
- can use stylus/finger/gloved finger/pen

drawbacks:
- poor visibility in sunlight
- vulnerable to scratching
- wears through time
- does not allow multi-touch facility

capacitive

benefits:
- good visibility in sunlight
- (very) durable surface
- allows multi-touch facility

drawbacks:
- screen (glass) will shatter/break/crack (on impact)
- cannot use when wearing (standard) gloves

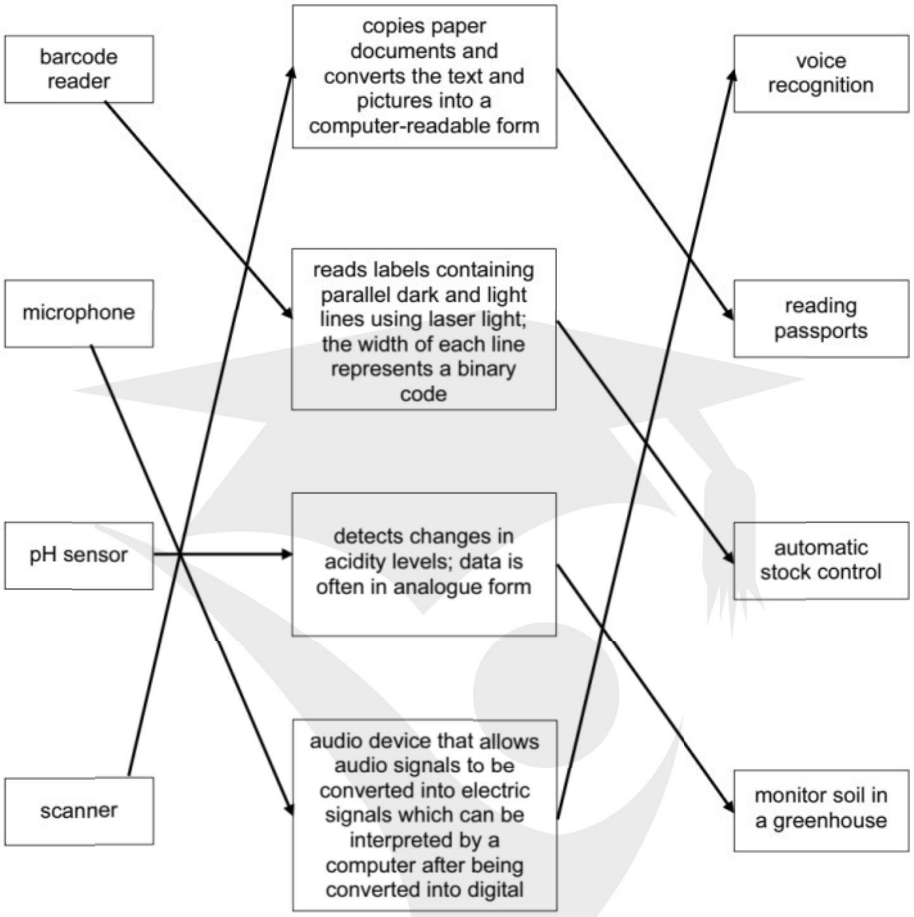
infra-red

benefits:
- good durability
- allows multi-touch facility
- can use stylus/finger/gloved finger/pen

drawbacks:
- expensive to manufacture
- screen (glass) will shatter/break/crack (on impact)
- sensitive to dust/dirt [2]

Page 4	Mark Scheme	Syllabus	Paper
	Cambridge O Level – May/June 2015	2210	12

3



7 (a) Maximum 5 marks **in total** for question part

Description of how street light is controlled: **(max 4 marks)**

- sensor sends signal/data to the microprocessor
- signal/data converted to digital/using ADC
- microprocessor compares value to a stored value
- if input value < stored value …
- … signal sent from microprocessor to actuator
- … and light is switched on/off
- whole process continues in an infinite loop

Avoiding frequent on/off switches: **(max 2 marks)**

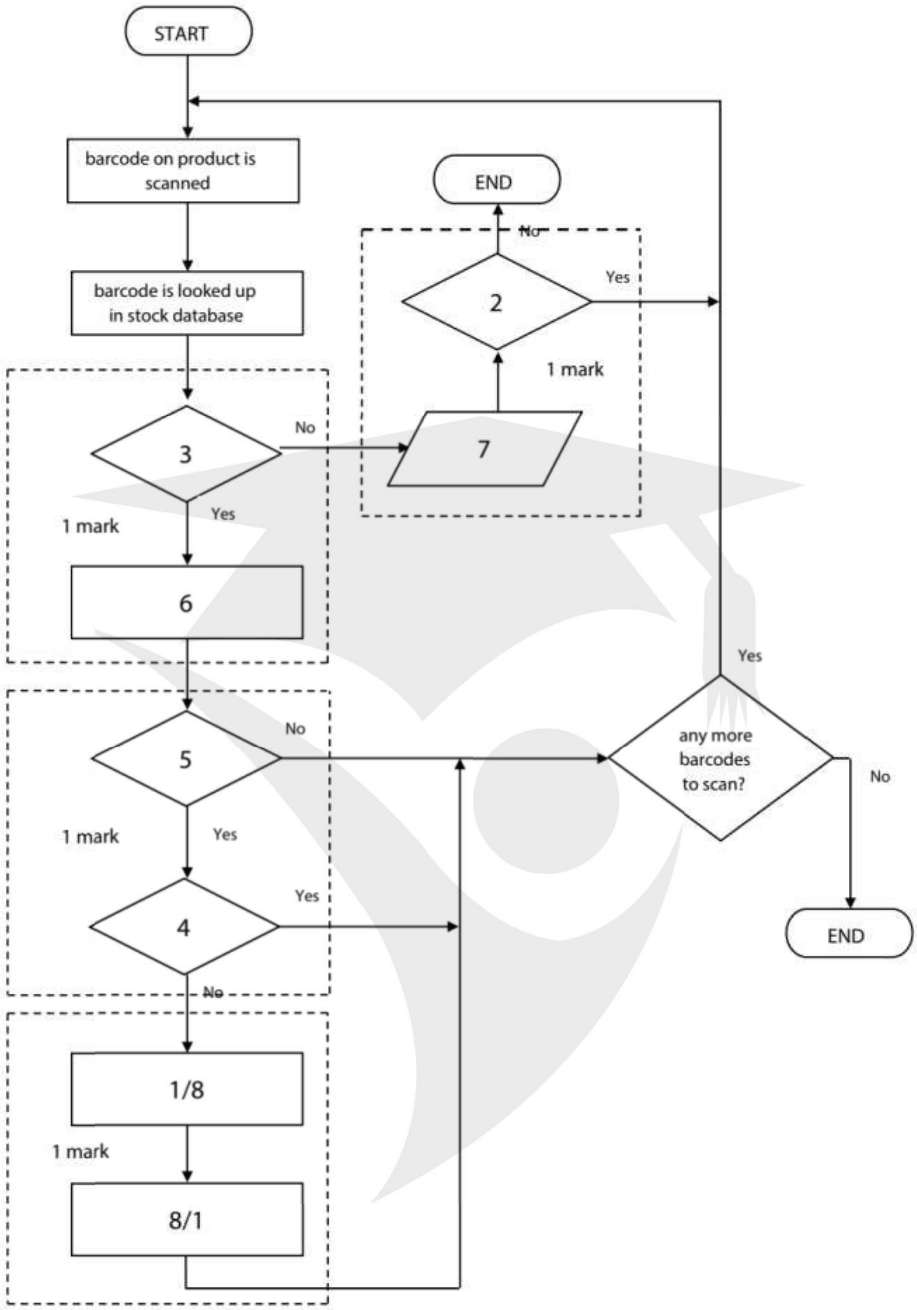
- microprocessor continues to keep light on/off for a pre-determined period
- after pre-determined period, sensor output is again sampled

(b) **1** mark for correct sensor, **1** mark for its matching application
(all THREE applications must be different)

sensor	application
infra-red/motion	automatic doors burglar alarm systems
temperature	chemical process central heating/air con system greenhouse environment oven
sound/acoustic	burglar alarm systems leak detection system disco lighting
moisture/humidity	clothes drier environmental control (greenhouse, air con)
pressure	burglar alarm system traffic light control chemical process
carbon dioxide/ oxygen/gas	pollution monitoring in a river greenhouse environment (growth control) confined area (e.g. space craft) Fish tank/Aquarium
magnetic field	mobile phone anti-lock braking CD players

Q 3) Winter 2015 P12

3



5 **(a)** Any **five** from:
- naming a suitable sensor, e.g infra-red, pressure, motion sensors, send signal/data to microprocessor
- signal/data is converted to digital (using an ADC)
- microprocessor instructs/send signals to camera to capture image/video
- captured image/video data sent to microprocessor

either
- microprocessor compares the image/video with stored images/video…
- … if person detected = stored image …
- …alert given to signal a person has been identified

or
- microprocessor compares the biometric data from an image/video with stored biometric data for images/video …
- … if biometric data matched = stored data …
- … alert given to signal a person has been identified

– Continual/repeated process [5]

(b) 1 mark for correct calculation, 1 mark for correct answer
- number of photos = **12 × 60 × 24** = 17 280
- memory requirement = 17 280/1024 = **16.9 (16.875)**
- (17 280/1000 = 17.28/17.3 is acceptable) [2]

(c) Any **two** from:
- (data transmission) is faster
- more secure/safer (because it is a dedicated line)
- (fibre optic transmission) is more reliable [2]

8 1 mark for each step in correct order. (NOTE: Marks can be awarded for a correct se

Steps in the printing process	Step order
As the printing drum rotates, a laser scans across it; this removes the positive charge in certain areas	4
The printing drum is coated in positively-charged toner; this then sticks to the negatively-charged parts of the printing drum	6
The paper goes through a fuser which melts the toner so it fixes permanently to the paper	9
The printer driver ensures that the data is in a format that the laser printer can understand	*(1)*
A negatively-charged sheet of paper is then rolled over the printing drum	7
Data is then sent to the laser printer and stored temporarily in the printer buffer	2
The toner on the printing drum is now transferred to the paper to reproduce the required text and images	8
The printing drum is given a positive charge	3
Negatively-charged areas are then produced on the printing drum; these match exactly with the text and images to be printed	5

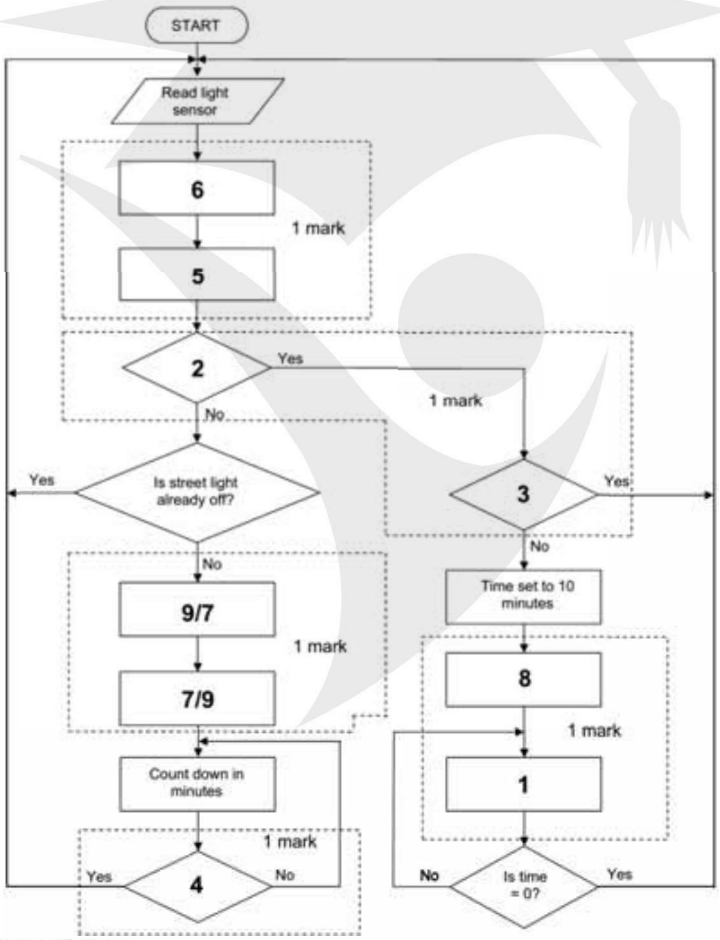
Q 4) Winter 2015 P13

1 (a) Temperature
– central heating / air con system
– greenhouse environment
– a chemical reaction / process

Magnetic field
– anti-lock brakes on a car
– detection of motor vehicles (e.g. at traffic lights)
– reading magnetic ink characters on cheques
– geophysical surveys

Motion
– automatic doors
– burglar alarm

(b)



6 Any **two** from:
– facial recognition software / biometric software used to scan face
– face image converted to digital format / data by the camera
– digital image formed from scanned photo / biometric data stored in passport
– key features of the face are checked / compared

7

Application	Suitable output device
Production of one-off photographs of very good quality	**inkjet printer**
High volume colour printing of advertising flyers	**laser printer**
Production of an object, which is built up layer by layer; used in CAD applications	**3D printer**
Converting electrical signals into sound	**speaker/headphones**
Showing enlarged computer output on a wall or large screen	**Projector**

8 1 mark for each named application + 1 mark for each matching reason for choice

Input device	Application and reason
Light sensor	Automatic doors – detects a person when light beam broken and opens doors Street lighting – detects change in light and switches on / off the street lights Greenhouse – ensures correct lighting conditions for growth of plants
Keyboard	Word processor / spreadsheet / database – need to key in data manually (e.g. report writing) Control room interface – need to manually key in data (e.g. flow speed of liquid)
Barcode reader	Supermarket checkout – read barcodes to find prices, description – allows automatic stock control Library system – can track books on loan – can link books to borrowers using barcoded cards Airport check-ins – barcodes on luggage to track whereabouts
Touch screen	Ticket / information kiosk – easy method for public to enter data – limited number of options Mobile phone / tablet – easy method to input data – use of icons for application selection Control room interface – faster / easier method to input data into system – fewer chances of error since number of choices limited

Q 5) Winter 2015 P11

1 **(a)** 1 mark for each name of application + 1 mark for description of use

Hardware item	Application and how the hardware item is used
Barcode reader	Supermarket checkout – read barcodes to find prices, description – allows automatic stock control Library system – can track books on loan – can link books to borrowers using barcoded cards Airport checkouts – barcodes on luggage to track whereabouts
Microphone	Voice recognition system – allows computer to recognise spoken words and use them as input to, e.g., a word processor Multimedia presentations – allows voice-overs on presentations Video conferencing/VoIP – allows users to speak to each other
Touch screen	Mobile telephone/tablet – allows user to select apps/icons – easy method to input data Ticket/information kiosk – limits the options available for ease of use
Infrared sensor	Burglar/intruder detection system – detects presence of a person by breaking beam/change of temperature Automatic doors – breaking i/r beam allows detection of person approaching door Counting, e.g. people/cars – every time beam is broken it can automatically send data and allow automatic counting

(b) Any **two** from:
- Blu-ray discs use blue/violet lasers rather than red lasers as used by DVDs
- storage capacity of Blu-ray discs is much higher than standard DVDs
- Blu-ray discs use one polycarbonate layer; DVDs use two layers
- Blu-ray discs have a built-in secure encryption system

[2]

(c) Any **two** from:
- DVD has one spiral track; DVD-RAM has several concentric tracks
- DVD-RAM can be written to and read from at the same time; DVD-R only allows the read operation to occur
- DVD-R only allows data to be read (can't write to it) whereas DVD-RAM allows reading and writing operation

[2]

5 (a) (i) Inkjet printer

Any **four** from:
- uses cartridges/liquid ink
- makes use of thermal bubble/piezoelectric technology
- sprays ink in droplets on the paper
- uses a moving print head
- suitable for low volume (high quality) output, e.g. a photo

(ii) Laser printer

Any **four** from:
- uses powdered ink/toner cartridges
- uses a (charged) printing drum
- makes use of static electricity charges
- uses a fuser to fix/melt ink onto the paper
- uses a discharge lamp to remove static charge from the drum
- useful for high volume (high quality) output, e.g. leaflets

(b) Any **three** from:
- produces solid, 3D objects/prototypes
- used in CAD/CAM
- makes use of tomography/slices of an object
- solid built up in thin layers
- uses resin, powdered metal, paper, plastic…

11 1 mark for each input device + 1 mark for correct MATCHING reason for each device

Input Devices

- Barcode scanner
- … to scan the barcode on boarding pass/mobile phone screen

- keyboard
- … to key in data in case barcode fails to scan

- (electronic) scales
- … weigh luggage at check-in

1 mark for each output device + 1 mark for correct MATCHING reason for each device

Output Devices

- beeper/speaker
- … confirm barcode read/indicate error if barcode not read

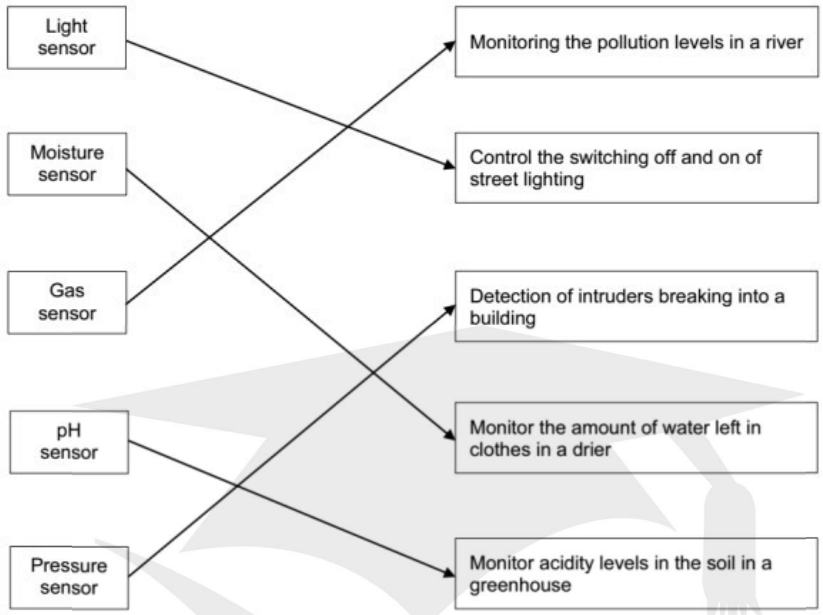
- (LCD) screen
- … select options (e.g. airline) at check-in

- printer
- … produce bag labels

Q 6) Summer 2016 P11 & P13

Page 3	Mark Scheme	Syllabus	Paper
	Cambridge O Level – May/June 2016	2210	11

3 (a)



4/5 matches – 4 marks
3 matches – 3 marks
2 matches – 2 marks
1 match – 1 mark [4]

(b) Any **four** from:

- sensor(s) sends signal/data to microprocessor
- signal/data converted to digital (using an ADC)
- microprocessor compares signal/data with pre-set/stored value
- if sensor(s) signal/data indicates the presence of a person / the door needs to be opened / a match is found / door is closed …
- … microprocessor sends a signal to an actuator …
- … to operate/drive a motor to open the door [4]

Page 4	Mark Scheme	Syllabus	Paper
	Cambridge O Level – May/June 2016	2210	11

4 (a) (i) serial [1]

(ii) Any **three** from:
- automatically detects the hardware/installs drivers
- plug only goes in one way/can't connect incorrectly
- supports different data transmission speeds/a range of data transmission speeds
- has become the industry standard/universally used
- backwards compatible (with earlier versions of USB ports) [3]

(iii) interrupt [1]

(b) **1** mark each use of printer, max 1 mark per printer.

inkjet printer	– (small quantities of) documents – photographs
3D printer	– (physical) prototype (from CAD) – (physical) model (from a blueprint) [2]

(c) **1** mark for naming printer + **1** mark for description + **1** mark for application

Laser printer

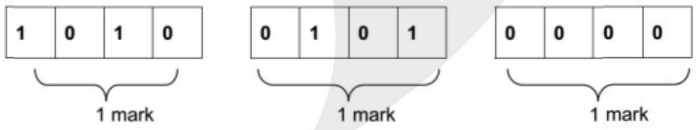
- uses toner/powder ink
- uses (positive and negative) charged drums // rotating drum
- uses static charge
- no moving head
- faster at printing
- high volume output/high speed
- producing flyers/leaflets/magazines [3]

This is an example, other types of printers can be credited.

Page 10	Mark Scheme	Syllabus	Paper
	Cambridge O Level – May/June 2016	2210	11

12 (a) QR (quick response) Code [1]

(b) – A 5 0 (1 mark)



[4]

(c) Any **three** from:
- visitor scans the QR code with (the camera on) the mobile device
- App is used to read/interpret the QR code
- links to a website/opens a document …
- … to access local tourist information
- can store the QR code to refer to again for the information [3]

Q 7) Summer 2016 P12

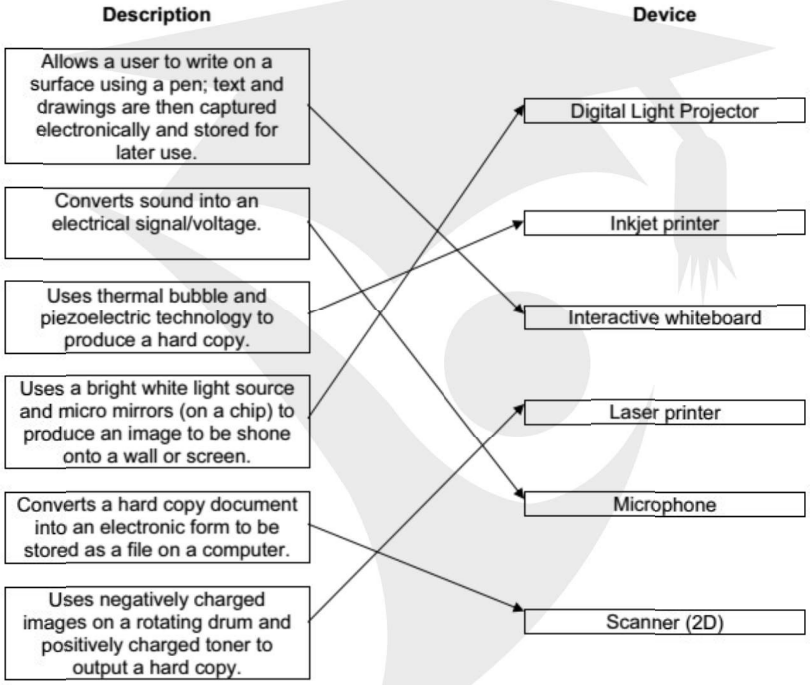
2

Application	Sensor
controlling street lights	**Light**
monitoring a river for pollution	**Gas, pH, temperature, light**
controlling traffic lights	**pressure, magnetic field,**

NOTE: The same sensor cannot be given twice [3]

Page 4	Mark Scheme	Syllabus	Paper
	Cambridge IGCSE – May/June 2016	0478	12

5



5/6 matches – 5 marks
4 matches – 4 marks
3 matches – 3 marks
2 matches – 2 marks
1 match – 1 mark

[5]

Q 8) Winter 2016 P12

11 **(a)** 1 mark per nibble

0010 1010 1111

[3]

(b) 1 mark for identification of each sensor, max 2 for each description

Infrared/motion sensor

- Receives infrared rays/heat
- Sends data to microprocessor
- Receives microwaves
- Placed in the corner of a room, across a doorway
- Used to detect the heat of an intruder // used to detect if an infrared beam has been broken by an intruder

Pressure sensor

- Receives current if circuit created // stops receiving current if circuit is broken
- Sends data to microprocessor
- Placed on a window/door, at the entrance
- Used to detect a change in pressure

[6]

Q 9) Winter 2016 P11& 13

4 **(a)** Any **two** from:

- Easy to make a mistake
- Can be slow if not trained
- Dirt/food can get into keys

[2]

(b) Any **two** with identification and explanation from:

- Fewer typing errors may be made …
- … because one button is pressed to order an item
- Speed up the time to enter an order …
- … because fewer buttons are pressed to complete the order
- May require less training …
- … because it is easier to identify an order item from its image rather than typing it
- Can stop dirt/food damage …
- … normally has a protective layer // because there are no keys for dirt/food to get into

[4]

7 Any **four** from:

- reaches maximum brightness quickly
- colours are vivid
- good colour definition/contrast can be achieved
- screens can be thinner/thin
- more reliable as LED's are long lasting
- consume very little/less energy [4]

9 Any **six** from:

- infrared / motion / pressure (sensor) // sensor detects movement/pressure
- signals/data sent (continuously) to microprocessor
- converted from analogue to digital (using ADC)
- microprocessor compares value with those stored in memory
- if sensor value does not match the stored value(s) …
- … signal sent to switch on the light
- … signal sent to keep the light on
- … light remains on for a period of time (30 seconds)
- if sensor value matches the stored value(s) …
- … light will remain off
- … will turn off after period of time (30 seconds)
- works in a continues loop [6]

Q 10) March 2017 India

Question	Answer	Marks
1	Any **three** from: ∞ light ∞ temperature ∞ gas ∞ magnetic field ∞ pressure ∞ moisture ∞ humidity ∞ pH ∞ motion	3

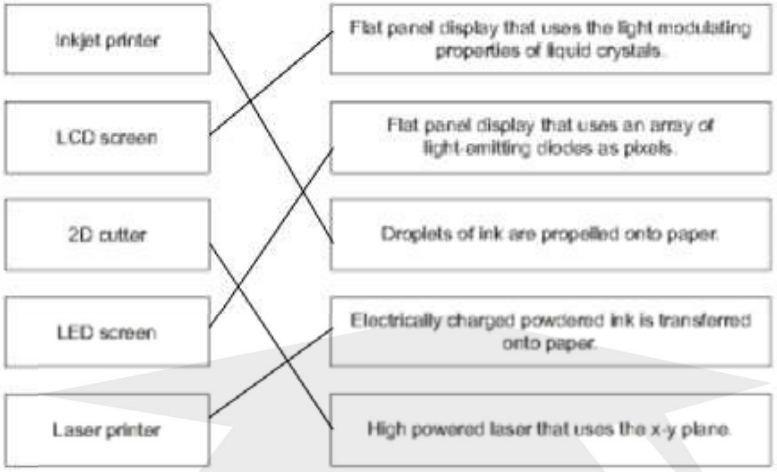
Question	Answer	Marks
10	Any **three** from: ∞ barcode 1D **and** QR code 2D ∞ barcodes contain vertical lines **and** QR codes contain 'squares' ∞ QR code can hold more data than a barcode ∞ QR code can be read from any angle, some barcode readers have to be lined up with the barcode // QR codes are more error tolerant / faster to scan than barcodes ∞ barcodes are frequently used at checkouts / libraries // QR codes are used for advertising // QR codes are frequently used by mobile phones to obtain information	3

Q 11) Summer 2017 P11

Question	Answer	Marks
9	1 mark for appropriate device name and 1 further mark for appropriate purpose. **Input devices** **Two** from: ∞ **Keypad / Keyboard** … ∞ … e.g. to allow customer to input the quantity of an item ∞ **Touchscreen** … ∞ … e.g. to allow a customer to select a payment method ∞ **Barcode scanner / Barcode reader** … ∞ … e.g. to allow a customer to scan in their shopping ∞ **Card reader // Cash deposit / intake** … ∞ … e.g. to allow a customer to pay for their shopping ∞ ***Weighing scales*** … ∞ … e.g. to allow a customer to weigh fresh produce **Output devices** **One** from: ∞ **Display / Touchscreen** … ∞ … e.g. to allow a customer to see the running total of their shopping ∞ **Speaker** … ∞ … e.g. to give audio instructions to a customer about how to use the self-checkout ∞ **Printer** … ∞ … e.g. to print a receipt for the customer	6

Question	Answer	Marks
12(a)	1 mark for appropriate sensor and 1 further mark for appropriate use. **Two** from: ∞ **Gas (sensor)** … ∞ … e.g. to measure the levels of oxygen/carbon dioxide / nitrogen in the factory to make sure they are not too high / low ∞ **Temperature (sensor)** … ∞ … e.g. to measure the temperature of the chemicals to make sure it is not too high/low ∞ **Motion / Infra-red (sensor)** … ∞ … e.g. to detect any persons in an unauthorised area of the factory ∞ **Pressure (sensor)** … ∞ … e.g. to measure the pressure of chemicals flowing through pipes to check that level are not too high / low ∞ **pH (sensor)** … ∞ … to measure the pH to make sure the acidity / alkalinity of the chemicals is correct ∞ **Light (sensor)** … ∞ … to measure the level of light to make sure it remains at a constant level for the chemical process	4
12(b)	**Five** from: ∞ Sensors send signals to microprocessor ∞ Analogue signals are converted to digital (using ADC) ∞ Microprocessor compares value to stored value … ∞ … If out of range / matches stored values … ∞ … signal sent to alert workers (e.g. sound alarm) ∞ … microprocessor send signal to cause an action to occur e.g. cool a process down, heat a process up, add a chemical ∞ … no action taken ∞ Output/record readings ∞ Monitoring is continuous	5

Q 12) Summer 2017 P12

Question	Answer	Marks
3	 1 mark for each correct line to a max of 4 marks.	4

Question	Answer	Marks
6	1 mark for correct name of code, up to a further 3 marks for appropriate explanation ∞ Quick response (QR) Code **Three** from: ∞ Barcode is captured / scanned / imaged, by a camera / scanner / barcode reader / QR code reader ∞ Read using a laser ∞ Processed by an app ∞ Light is reflected back ∞ Black squares reflect less light than white squares ∞ Modules are used for orientation / alignment ∞ Squares / data are decoded	4

Question	Answer	Marks
9	**Six** from: ∞ temperature sensor ∞ analogue data / temperature is converted to digital data (with an ADC) ∞ sensor sends signal to the microprocessor ∞ microprocessor compares input values with stored values/pre-set values … ∞ … if the temperature value input is too high/low … ∞ … a signal is sent from the microprocessor to turn on / off / up / down the cooling unit ∞ … if temperature matches the stored values … ∞ … no action is taken ∞ an actuator is used to turn the cooling unit on / off / up / down ∞ the process is a continuous loop	6

Q 13) Winter 2017 P12

9(a)	∞ It is an <u>input</u> device ∞ It measures/takes (physical) readings of the surrounding environment / environment by example / physical properties	2
9(b)	1 mark for each sensor, 2 marks for each description: Moisture (sensor) ∞ To measure the water content of the soil ∞ To alert when the soil is too dry or too wet/needs watering pH (sensor) ∞ To measure how acidic/alkaline the soil is ∞ To alert when there may be something polluting the soil Light (sensor) ∞ To measure the brightness of the environment ∞ To alert when the fruit has too little/too much light Temperature (sensor) ∞ To measure the temperature of the environment ∞ To alert when it is too hot/too cold for the fruit to grow Gas (sensor) ∞ To measure the amount of CO2/oxygen present ∞ To alert when too much CO2/oxygen present Humidity (sensor) ∞ To measure the water content in the air ∞ To alert when the air is too dry Infra-red / motion (sensor) ∞ To measure level of infra-red/microwaves deflected ∞ To alert to any intruders e.g. animals stealing the fruit	6

Q 14) Winter 2017 P13

Question	Answer	Marks
1(a)	Output	1
1(b)	1 mark for each correct conversion 	3
1(c)	Any **one** from: – Hexadecimal codes can fit in a smaller display rather than a full text based message – Smaller amount of memory needed to store the hex error messages than text based	1
1(d)	1 mark for correct sensor, 1 mark for corresponding use Possible examples could include: – Temperature (sensor) – To monitor the temperature of the water – Pressure (sensor) – To monitor the level of water in the washing machine – Motion (sensor) – To monitor whether the drum is still in motion – pH (sensor) – To monitor the level of water hardness/detergent present in the water	6

Q 15) March 2018 P12 (India)

Question	Answer	Marks
4	Any **six** from: Sensor(s) send data/signals to the microprocessor Analogue signal/data from sensor is converted to digital (using ADC) Microprocessor compares data value against set boundaries / pre-set data If value between 21 and 24 … … no action taken If value > 24 °C / signal is sent from microprocessor… … to turn conditioning unit ON//Set to cold If value is < 21 °C signal is sent from microprocessor… … to turn conditioning unit ON//Set to warm Process is repeated for a continuous operation	6

Question	Answer	Marks
12(a)	Quicker to scan ... ... rather than type into a system Fewer errors ... ... no human input	4

Question	Answer	Marks
12(b)	Any **four** from: Uses a barcode reader / scanner Reader shines light / red laser at barcode White lines reflect (more) light Sensors / photoelectric cells detect light reflected back Different reflections / bars will convert to different binary values	4

Q 16) Summer 2018 P11

Question	Answer	Marks
1	1 mark for each correct answer, in the given order: – analogue – digital – denary – 10 – binary – 2	6

Question	Answer	Marks
8(a)	Any **four** from: – Shines light / (red) laser at barcode – Light is called an illuminator – Light is reflected back // White lines reflect light // Black lines reflect less light/absorbs light – Sensors / photoelectric cells detect the light – Different reflections / bars will give different binary values / digital values // pattern converted to digital values – A microprocessor interprets the data	4
8(b)	Any **three** from: – barcode identifies a (unique) product – barcode can be used to look up product (in a database) – data about stock levels can be stored on a system – stock can be automatically deducted from the system – can check stock is below a certain level // check stock level – automatic re-order // Alerts when stock is low – automatically update new stock level – to locate if an item of stock is available in another location	3

Question	Answer	Marks
8(c)	Any **four** from: – (Infrared) rays are sent across screen (from the edges) – Has sensors around edge // Sensors capture beams – (Infrared) rays form a grid across the screen – (Infrared) ray is broken (by a finger blocking a beam) – **Calculation** is made (on where beam is broken) to locate the 'touch' // Co-ordinates are used to locate the touch	4
8(d)	Secondary Storage – any **two** from: – Not directly accessed by the CPU – Non-volatile storage – Secondary is internal to the computer/device – An example of secondary storage would be HDD/SSD Off-line storage – any **two** from: – Non-volatile storage – Off-line storage is storage that is removable from a computer/device // not internal // portable – An example of off-line storage would be CD/DVD/USB stick/SD card/magnetic tape/ external HDD/SSD	4

Q 17) Summer 2018 P12

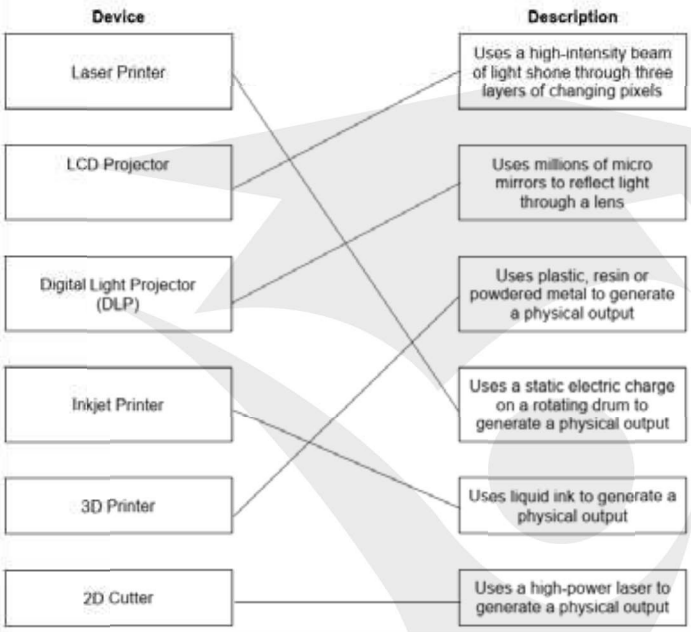
2(a)	Any **four** from: – Image is converted from analogue to digital (using ADC) – Image is turned into pixels – Each pixel is given a binary value – Pixels form a grid (to create the image) – Each pixel has a colour – Pixels are stored in sequence (in a file) – Meta data is stored (to describe the dimensions/resolution of the image) // It stores the dimensions/colour depth .etc. – An example of a suitable photo file format e.g. JPEG	4
9(a)	QR/Quick response	1
9(b)	Any **four** from: – Read/scanned using **app** (on mobile device) – It is the **camera** that is used to scan/capture the image – The three large squares are used to define the alignment // uses alignment targets/modules – Black squares reflect less light // white squares reflect more light – The app/device processes the image – Each small square/pixel is converted to a binary value	4
10(a)	Any **four** from: – Conductive layer – An electrostatic/electric field is created – **Sensor(s)** (around the screen) monitor the electrostatic field – When touched (electrostatic) charge is transferred to finger – Location of touch is **calculated** // Co-ordinates used to **calculate** touch	4
10(b)(i)	Any **two** from: – Gloves are not conductive // Gloves are an insulator – Block current/charge from finger / body / person – Stop the electrostatic field being disturbed/changed	2
10(b)(ii)	Any **two** from e.g. (1 mark for method, 1 for expansion): – She could use a (conductive) stylus… – … this will allow the charge to be charged/disturbed – She could use capacitive gloves… – … this will allow the charge to be charged/disturbed – She could use a natural language interface/voice operated interface … – … she could give vocal commands to the device	2
11	Any **six** from: – Suitable sensor (motion/infra-red) – Data converted (from analogue) to digital (using ADC) – Data sent to microprocessor – Data is compared to stored value/range … – … if data matches/out of range data security light turned on … – … waits for suitable period/until no motion detected … – … light turned off – Continuous loop/process	6

Q 18) Winter 2018 P12

Question	Answer	Marks
5(a)(i)	2D/3D cutter	1
5(a)(ii)	Liquid crystal display // LCD	1
5(a)(iii)	Actuator	1
5(b)	1 mark for each correct missing word, in the given order: ∞ interactive whiteboard ∞ inkjet ∞ thermal bubble ∞ laser ∞ rotating	5

Question	Answer	Marks
10	**Five** from: • The sensor sends data to the microprocessor • The analogue data is **converted to digital** (using ADC) • The microprocessor compares the reading to the set range/stored values/stored data (6 to 8) … – … If the reading is >8 or <6 / outside range … ○ … the **microprocessor** sends a signal to output the alert • The **process** is continuous/repeated	5

Q 19) Winter 2018 P13

Question	Answer	Marks
1	1 mark for each correct line, maximum 5 marks 	5

Question	Answer	Marks
3	**Six** from: • A pressure sensor is used • The sensor sends data/signals to the microprocessor • Data is converted to digital format • Microprocessor compares data value against set **value** • If value <= 2400 Kg/under weight limit lift is permitted to operate • If value > 2400 Kg/over weight limit **signal is sent from the microprocessor** to deliver warning message to passengers • If value > 2400 Kg **signal is sent from the microprocessor** to lift mechanism to stop lift operating • Weight continuously monitored	6

Q 20) March 2019 P12

2(a)(i)	– (A device that allows) **data** to be entered (into a computer system)	1
2(a)(ii)	**One** from e.g.: – Keyboard – Mouse – Microphone – Sensor – Touch screen	1
2(b)(i)	– (A device that allows the user to) view/hear the **data** (that has been entered into a computer system)	1
2(b)(ii)	**One** from e.g. : – Monitor – Speaker – Headphones – Printer	1
3(b)(i)	**Two** from: – Pressure sensor – Light sensor – Motion sensor – Magnetic field (can be used if competitors are wearing a compatible chip)	2
3(b)(ii)	– Sensor sends signal to microprocessor – Signal is analogue and is converted to digital (using ADC) – Data is compared to stored value // Check for signal – If data does not match / is out of range/ in range // signal detected … – … counter is incremented by 1 – Continuous process	6
6(a)	**Three** from: – Universal Serial Bus – Data transmission method – Uses serial transmission // bits of data are sent one at a time – Universal standard // common interface	3
6(b)(i)	– Laser printer	1
6(b)(ii)	**Two** from: – Cheaper **printing** cost per page – It **prints** at a faster **speed** – It prints **text** at a high quality – Colour fast	2
6(b)(iii)	**One** from: – Expensive to **purchase printer** – **Toner** is expensive – Print **images** at a lower quality – Can be quite large in size	1

Q 21) Summer 2019 P11

3	1 mark for each correct device	5

Description of input or output device	Name of device
This is an input device that works by shining a light onto the surface of a document. The light source is automatically moved across the document and the reflected light is captured by mirrors and lenses.	**2D Scanner**
This is an input device where a laser or a light source is moved across an object. The width, height and depth of the object are measured to allow a model to be created.	**3D scanner**
This is a large input device that is usually fixed to a wall. A user can calibrate the device to make sure the sensors align with a projected image. The user can use either their finger or a special pen to make selections.	**Interactive whiteboard**
This is an output device that uses many small mirrors to reflect light towards a lens. This will display an image.	**Projector**
This is an output device that creates an object by building layer upon layer of material.	**3D printer**

Q 22) Summer 2019 P12

1(a)	**Three** from e.g.: – Keyboard – Mouse – Microphone – 2D scanner – 3D scanner – Touchscreen – Webcam // digital camera – Joystick – Trackpad – Sensor – Interactive whiteboard	3
1(b)	**Three** from e.g.: – Monitor // touchscreen – Inkjet printer – Laser printer – 3D printer – Speaker – Headphones – LED Projector – DLP – 2D cutter – 3D cutter – Actuator	3
4(b)(ii)	**Four** from: – **Rollers** are used to move the paper through the printer – **Nozzles** spray/drop/jet ink onto the paper – Ink jets/print head/nozzles are moved across the paper (to distribute the ink) – Different colour inks are mixed to create required colours – Technology could be piezoelectric – Technology could be thermal bubble – **Ink** is heated – … and expands/evaporates into a bubble – Bubble is pushed through the nozzle on to the paper – … then the bubble collapses – Electrical current is applied to a crystal – … which makes it vibrate – … which forces a droplet of ink through the nozzle	4
7(a)	**Six** from: – Motion sensor is used – Sensor sends data/signal to microprocessor – Data/Signal is converted from analogue data to digital data (using ADC) – Value to compared to stored value(s) // – If value is outside range/matches … – … **microprocessor** sends signal to switch lights on – … actuator used to switch light on/off – … timer is set for 2 minutes – Every time movement is detected the timer is reset – When timer reaches **0/120/times out microprocessor** sends signal to switch lights **off** – **Process** is continuous	6
7(b)	**Three** from: – Read only memory – Non-volatile memory // Contents of memory are retained when power is turned off//permanent storage – Primary storage // directly accessed by the CPU – Holds firmware/boot-up instructions/start-up instructions/BIOS – Cannot be written to	3
10	**Four** from: – **Electrical** field/charge is spread across the screen – Sensors are located around the screen // sensors are used to read the electric field – When finger touches screen, the charge/ is transferred to the user – … as it is affected by the conductivity of another object – Coordinates of touch determined/calculated/measured	4

Q 23) Winter 2019 P13

Question	Answer	Marks
1(a)(i)	**Two** from: ∞ 2D scanner ∞ Touchscreen ∞ Keypad/keyboard ∞ Card reader ∞ Mouse ∞ Digital camera	2
1(a)(ii)	**Two** from: ∞ HDD ∞ SSD ∞ USB flash memory drive ∞ SD card ∞ Any optical	2
1(a)(iii)	**Two** from: ∞ Monitor/Touch screen ∞ Speaker ∞ Printer ∞ LED // Light	2
1(b)(i)	∞ Increase the length of the key // make key 12-bit, etc.	1
1(b)(ii)	∞ Cypher text	1
1(d)	**Five** from: ∞ The display is made up of pixels … ∞ … that are arranged together as a matrix ∞ Each pixel has three filters, red, blue and green ∞ Shades of colour are achieved by mixing red, blue and green ∞ The screen is backlit ∞ Light is shone through the liquid crystals ∞ The liquid crystals can be made to turn solid or transparent/on or off … ∞ … by changing the shape of the crystal	5
4(c)	**Six** from: ∞ Sensor sends a signal/reading/data to the microprocessor ∞ Signal/reading/data is analogue and is converted to digital using ADC ∞ Reading/data is stored in the system ∞ Microprocessor compares data/reading to the pre-set value of 7 ∞ If value is greater than 7 … ∞ … a signal/data is sent by the microprocessor to display a warning message on a monitor ∞ The process is continuous	6

Q 24) Winter 2019 P12

6 **One** mark for each correct tick — 6

Statement	Resistive (✓)	Capacitive (✓)
This touch screen has multi-touch capabilities		✓
This touch screen cannot be used whilst wearing gloves		✓
This touch screen is made up of two layers with a small space in between	✓	
This touch screen uses the electrical properties of the human body		✓
This touch screen is normally cheaper to manufacture	✓	
This touch screen has a quicker response time		✓

Q 25) March 20 P12

Question	Answer	Mark
7	Any **seven** from: • Uses light sensor **and** Infrared / Motion / Pressure sensor • Sensors send data to the microprocessor • Data is converted from analogue to digital (using ADC) • Microprocessor compares both values to stored values • If motion value is out of range/in range, light value is checked // If light value is **<= 10**, motion value is checked • If light value is **<= 10** lights are turned on // If motion value is out of range/in range lights are turned on … • … by sending a signal to actuator • Lights remain on for set period (and then turn off) // If motion is in range/out of range or light is > 10 then signal sent to turn lights off • Process repeats / is continuous	7

Q 26) Summer 20 P12

6	<table><tr><th>Statement</th><th>Capacitive (✓)</th><th>Resistive (✓)</th></tr><tr><td>Needs pressure to be applied to create a circuit</td><td></td><td>✓</td></tr><tr><td>May not register a touch if the user is wearing gloves</td><td>✓</td><td></td></tr><tr><td>More commonly used in smartphones</td><td>✓</td><td></td></tr><tr><td>More responsive to a touch</td><td>✓</td><td></td></tr><tr><td>Needs an electrical field to be changed to register a touch</td><td>✓</td><td></td></tr><tr><td>Cheaper to manufacture</td><td></td><td>✓</td></tr></table> **One** mark per correct tick	6
8(a)	Any **three** from: – It is a universal standard – It can't be inserted the wrong way around – Supports different transmission speeds – Automatically detects if correct driver installed	3
8(b)	**Two** marks for benefits, **one** mark for drawback Benefits: – Faster speed of printing – Can print duplex / on both sides – Many letters can be printed from one toner cartridge – Can print in high volumes Drawback – Toner cartridge more expensive to buy – More time to warm-up – Larger footprint	3

Question	Answer	Marks
8(c)(i)	Any **two** from: – Paper jam – Out of paper – Out of toner/ink – Buffer full – Awaiting input – Print complete – Printer ready Award any other valid example	2
8(c)(ii)	Any **one** from: – Operating system – Interrupt handler – Interrupt service routine	1

Q 27) 15a Summer 20 P11

Question	Answer	Marks
1(a)	Any **one** from: – Microphone – Touchscreen – Camera – Button	1
1(b)	Any **two** from: – Speaker – Touchscreen – Light/flash	2
6	<table><tr><th>Sensor</th><th>Scenario</th></tr><tr><td>Pressure / motion / infra-red</td><td>Detecting when a person is approaching an automatic door system</td></tr><tr><td>pH / light</td><td>Monitoring the pollution level in a river</td></tr><tr><td>Temperature</td><td>Checking if a tropical aquarium is 25 degrees Celsius</td></tr><tr><td>Magnetic field / pressure / motion / infra-red</td><td>Counting the number of cars that cross a bridge</td></tr></table> One mark per each correct sensor (each sensor **must** be different)	4
8(a)	– Interrupt	1
8(b)	**One** mark for benefit, **two** marks for drawbacks Benefit: – Printing may be higher quality – Can use larger paper sizes – Can print onto different media – No warm-up time Drawbacks: – Printing will be slower – Ink is more expensive per page – Ink can be smeared // ink is not smudge proof	3
8(c)	<table><tr><th>Statement</th><th>Inkjet (✓)</th><th>Laser (✓)</th></tr><tr><td>Uses a rotating drum to transfer the image to the paper</td><td></td><td>✓</td></tr><tr><td>Uses powdered toner</td><td></td><td>✓</td></tr><tr><td>Uses nozzles to spray droplets on to the paper</td><td>✓</td><td></td></tr><tr><td>Uses a print head mechanism that moves side to side</td><td>✓</td><td></td></tr></table> One mark per each correct row	4

Q 28) Winter 20 P12

5(a)	**One** mark for each correct row: <table><tr><th>Statement</th><th>True (✓)</th><th>False (✓)</th></tr><tr><td>It is a flat panel display</td><td>✓</td><td></td></tr><tr><td>It creates images using red, green and blue diodes</td><td>✓</td><td></td></tr><tr><td>It is not very energy efficient and gives off heat</td><td></td><td>✓</td></tr><tr><td>It is also used in mobile devices such as smartphones and tablets</td><td>✓</td><td></td></tr><tr><td>It is a front-lit display</td><td></td><td>✓</td></tr></table>	5

Q 29) Winter 20 P13

1	**One** mark for each correct row: **Device** / **Input (✓)** / **Output (✓)** / **Storage (✓)** Solid state drive (SSD) / / / ✓ Headphones / / ✓ / 2D cutter / / ✓ / LCD projector / / ✓ / Microphone / ✓ / /	5
8(a)	Any **three** from: – Liquid crystal display – The **display** is made of pixels – … arranged in a matrix – Uses a flat panel display – Backlit display – … with CCFLs/LEDs – Uses light-modulating properties of liquid crystals – Crystals can be turned between opaque and transparent (to allow light to pass) – Colours created using RGB	3
8(b)	Any **three** from: – Low power consumption – Runs at cool temperature – Do not suffer image burn – Do not suffer flicker issues – Bright image/colours – High resolution image – Cheaper to purchase than e.g. LED screen	3
11	**Six** from: – Suitable sensor used e.g. motion sensor/pressure sensor – (Analogue) data is converted to digital (using ADC) – Sensor sends data to microprocessor – Data compared to stored data … – … if value outside range/within range water is sprayed – … signal sent to actuator to spray water – … if value within range/outside range no action taken – Continuous loop	6

Q 30) March 21 P12

<table>
<tr>
<td>3</td>
<td>One mark for each device/description
<table>
<tr><th>Name of device</th><th>Description</th></tr>
<tr><td><u>Inkjet</u> Printer</td><td>Uses either thermal bubble or piezoelectric technology</td></tr>
<tr><td>Actuator</td><td>– Operated by signals to cause a physical movement Controls the movement of a machine // by example</td></tr>
<tr><td>DLP//Projector</td><td>Uses thousands of tiny mirrors that can move very quickly to create an image</td></tr>
<tr><td>Mouse</td><td>– Uses rolling ball / optical sensor / laser to detect motion // by example
– Movement echoed on screen // moves curser/pointer (on screen)
– Has scroll wheel / Buttons to allow data input // by example</td></tr>
</table></td>
<td>4</td>
</tr>
<tr>
<td>4(a)</td>
<td>Six from
Max four from:
– Scanned using a barcode reader
– Shines (red) laser/light
– Light is reflected back // white lines reflect light // black lines reflect less light
– Sensors/photoelectric cells detect the light
– Different reflections/bars give different binary/digital values // (pattern) converted to binary/digital values
– Microprocessor interprets the data
– Uses check digit error checking

Max three from:
– Database stores data/barcodes/products/prices
– Barcode/value/key transmitted to database/system // Searches for barcode/value/key in the database/system…
– … price is returned/found</td>
<td>6</td>
</tr>
</table>