CAMBRIDGE IGCSE (0478)

Module J: Hardware and emerging tech

Workbooklet · 7 parts · 148 marks

Contents

Part	Topic	Marks
J1	Input and output devices	21
J3	Sensors and what they measure	22
J4	Automated systems: sensors, microprocessors and actuators	22
J5	Robotics	20
J6	What artificial intelligence is	20
J7	Expert systems	21
J8	Machine learning	22
	Total	**148**

MODULE J HARDWARE AND EMERGING TECH · J1

Input and output devices

Original practice questions · 21 marks · ~25 minutes · Cambridge 0478 syllabus 3.2.1, 3.2.2

Name _____ Date _____

Instructions. Answer all questions in the spaces provided. The marks for each part are shown in brackets [ ]. The total for this worksheet is **21 marks**.

1

Total: 4 marks

(a) Explain what is meant by an **input** device and why a computer system requires one. **[2]**

(b) Explain what is meant by an **output** device and why a computer system requires one. **[2]**

2

Total: 5 marks

(a) Tick (✓) **one** box in each row to show whether each device is an input device or an output device. **[5]**

Device	Input device	Output device
Three-dimensional (3D) scanner		
Actuator		
QR code scanner		
Digital light processing (DLP) projector		
Microphone		

3 **Total: 5 marks**

A visitor centre at a mountain nature reserve has an outdoor information point with a touch screen. Visitors touch the screen to see maps and walking routes.

(a) Complete the table by writing the type of touch screen (**resistive**, **capacitive** or **infra-red**) that each description matches. **[3]**

Description	Type of touch screen
Invisible beams of light cross the screen; a touch is found where the beams are broken	
Pressing the screen pushes the top layer onto the layer below, so the two layers touch	
A finger touching the screen changes the electrical charge at that point	

(b) In winter, many visitors use the information point while wearing thick gloves. **[2]**
Identify the type of touch screen from part (a) that would **not** be suitable for these visitors.
Explain your answer.

Type of touch screen

Explanation

4 **Total: 3 marks**

A small bicycle repair workshop needs to print three different things.

(a) Complete the table by identifying the most suitable type of printer for each task. Choose from: **inkjet printer**, **laser printer**, **3D printer**. Each type is used once. **[3]**

Task	Most suitable printer
Printing 400 copies of a text-only price leaflet, quickly, every week	
Printing one high-quality colour photograph of a restored bicycle for the shop window	
Making a small plastic clip to replace a broken part that is no longer sold	

5 **Total: 4 marks**

A garden centre is setting up a self-service plant help point. Every plant label has a QR code. A customer uses the help point to get the care instructions for the plant they are holding.

(a) Identify **one** input device and **one** output device that the help point could use. For each device, explain why it is required in this system. **[4]**

Input device

Why it is required

Output device

Why it is required

Total for this worksheet: 21 marks

MODULE J HARDWARE AND EMERGING TECH · J3

Sensors and what they measure

Original practice questions · 22 marks · ~25 minutes · Cambridge 0478 syllabus 3.2.3

Name _____ Date _____

Instructions. Answer all questions in the spaces provided. The marks for each part are shown in brackets [ ]. When you name a sensor, give its type (for example, temperature sensor). Do not give brand names. The total for this worksheet is **22 marks**.

1

Total: 4 marks

(a) State what is meant by a sensor. **[2]**

(b) Give **two** purposes of sensors. **[2]**

1

2

2

Total: 4 marks

Draw **one** line from each sensor to the data it captures. Not all of the data descriptions will be used. **[4]**

pH	The height of a liquid in a container
proximity	The level of sound
flow	How acidic or alkaline a substance is
acoustic	The rate at which a liquid or gas moves through a pipe
	How near an object is to the sensor

3 **Total: 4 marks**

A public aquarium uses sensors to monitor its fish tanks and its visitor areas.

Complete the table by identifying the **most suitable** sensor for each task. Use a different sensor for each task. **[4]**

Task	Most suitable sensor
Check whether the water in a tank has dropped below a marked height, so staff know when to top it up	
Check that the water in a tank for tropical fish stays warm enough	
Measure how bright the lamps above a coral tank are	
Measure the amount of carbon dioxide in the air of a busy visitor hall	

4 **Total: 3 marks**

A company that sends fragile glassware to its customers puts a small data logger inside each box. The data logger uses a sensor to record whether the box is dropped, shaken or tipped over during the journey.

(a) Identify the **most suitable** sensor for the data logger. **[1]**

(b) Explain why this sensor is suitable for this purpose. **[2]**

5 **Total: 3 marks**

The car park of an office building has a display at the entrance that shows how many parking spaces are free. A sensor is fixed into the ground in the middle of each parking space. The wheels of a parked car do not touch the sensor. Each sensor is used to detect whether a car is parked over it.

Suggest a suitable sensor for each parking space **and** explain why it is suitable. **[3]**

Sensor

Explanation

6 **Total: 4 marks**

A plant nursery is setting up an automatic watering system for its outdoor flower beds. The system must water a bed only when the soil in that bed is dry. A technician suggests using a humidity sensor in each bed.

Explain why a moisture sensor would be more suitable than a humidity sensor for this system. **[4]**

Total for this worksheet: 22 marks

MODULE J HARDWARE AND EMERGING TECH · J4

Automated systems: sensors, microprocessors and actuators

Original practice questions · 22 marks · ~25 minutes · Cambridge 0478 syllabus 6.1.1, 6.1.2

Name _____ Date _____

Instructions. Answer all questions in the spaces provided. The marks for each part are shown in brackets [ ]. The total for this worksheet is **22 marks**.

1

Total: 4 marks

Automated systems use sensors, a microprocessor and actuators working together.

Tick (✓) **one** box in each row to show which component each description is about. **[4]**

Description	Sensor	Microprocessor	Actuator
Measures the amount of water in the soil of a field			
Compares a reading with a stored value and decides whether action is needed			
Opens a valve so that water flows into a tank, when it receives a signal			
Takes readings of the air pressure and sends them to be processed			

2

Total: 2 marks

A sports centre uses an automated system to switch on the floodlights for its outdoor courts when it gets dark. The system uses a light sensor, a microprocessor and an actuator.
A manager says: "The light sensor switches the floodlights on when it gets dark."

Explain why the manager's description is **not** correct. **[2]**

3 **Total: 4 marks**

A railway station has automatic sliding doors at its main entrance. An automated system opens the doors when a person walks up to them.

Complete the description of how the automated system works. Use words from the list. Each word may be used once or not at all. **[4]**

actuator · compares · continuously · deletes · microprocessor · once · router · sensor

An infra-red sensor above the doors takes readings _____ and sends the data to the _____. The microprocessor _____ each reading with stored values. If a person is detected near the doors, the microprocessor sends a signal to an _____ (a motor), which slides the doors open.

4 **Total: 6 marks**

A road tunnel has an automated ventilation system. Gas sensors in the tunnel measure the level of harmful exhaust gases in the air. When the level is too high, the system switches on large fans that blow fresh air into the tunnel.
Before the system was installed, employees walked through the tunnel with hand-held gas meters and switched the fans on from a control panel.

(a) Explain **two** advantages of using the automated ventilation system instead of employees. **[4]**

Advantage 1

Advantage 2

(b) Explain **one** disadvantage of using the automated ventilation system. **[2]**

5 **Total: 6 marks**

A science laboratory keeps cell samples in an incubator. An automated system keeps the temperature inside the incubator between 36.5 °C and 37.5 °C. The incubator has a temperature sensor, a microprocessor, a heater and a cooling fan. Actuators switch the heater and the cooling fan on and off.

Describe how the temperature sensor, the microprocessor and the actuators are used to keep the temperature inside the incubator between 36.5 °C and 37.5 °C. **[6]**

Total for this worksheet: 22 marks

MODULE J HARDWARE AND EMERGING TECH · J5

Robotics

Original practice questions · 20 marks · ~25 minutes · Cambridge 0478 syllabus 6.2.1, 6.2.2, 6.2.3

Name _____ Date _____

Instructions. Answer all questions in the spaces provided. The marks for each part are shown in brackets [ ]. The total for this worksheet is **20 marks**.

1

Total: 4 marks

Tick (✓) **one** box in each row to show whether each statement is true or false. **[4]**

Statement	True	False
Robotics is a branch of computer science that includes the design, construction and operation of robots		
A machine can only be a robot if it is shaped like a human		
A robot follows a stored program, which can be changed so that the robot carries out a different task		
In a robot, the actuators take readings from the surroundings and send them to the microprocessor		

2 **Total: 4 marks**

A bakery uses a robot to decorate cakes. The robot has a jointed arm that holds a nozzle, and it pipes icing patterns onto cakes as they pass along a conveyor belt.

(a) Complete the table by describing how the cake-decorating robot shows each characteristic of a robot. **[2]**

Characteristic of a robot	How the cake-decorating robot shows this characteristic
A mechanical structure or framework	
Electrical components	

(b) The bakery changes the icing pattern on its cakes every month. The robot is programmable. Explain how this helps the bakery when it changes the pattern. **[2]**

3 **Total: 4 marks**

The cake-decorating robot must only start piping icing when a cake is directly under its nozzle. The robot uses a proximity sensor, a microprocessor and actuators to do this.

Explain how the robot uses the proximity sensor, the microprocessor and the actuators so that it only starts piping when a cake is in position. **[4]**

4 Total: 4 marks

Robots perform roles in many different areas.

Write the area that each robot is used in. Choose each area from this list. Each area may be used once or not at all. **[4]**

agriculture · domestic settings · entertainment · industry · medicine · transport

Robot	Area
A robot that picks ripe strawberries in a greenhouse	
A model dinosaur in a theme park that moves its head and roars when visitors walk past	
A driverless shuttle that carries passengers between the terminals of an airport	
A robot that cuts the grass in the garden of a house	

5 Total: 4 marks

An energy company checks the blades of its wind turbines for damage. At present, a technician climbs each turbine to check the blades. The company plans to use a drone fitted with a camera to check the blades instead.

(a) Explain **one** advantage of using the drone instead of the technician to check the blades. **[2]**

(b) Explain **one** disadvantage of using the drone instead of the technician to check the blades. **[2]**

Total for this worksheet: 20 marks

MODULE J HARDWARE AND EMERGING TECH · J6

What artificial intelligence is

Original practice questions · 20 marks · ~25 minutes · Cambridge 0478 syllabus 6.3.1, 6.3.2

Name _____ Date _____

Instructions. Answer all questions in the spaces provided. The marks for each part are shown in brackets [ ]. Do not give brand names of software or hardware. The total for this worksheet is **20 marks**.

1

Total: 4 marks

Tick (✓) **one** box in each row to show whether each statement about artificial intelligence (AI) is true or false. **[4]**

Statement	True (✓)	False (✓)
AI is a branch of computer science.		
AI deals with the simulation of intelligent behaviours by computers.		
A computer system must have a mechanical structure before it can use AI.		
An AI system needs a collection of data, but it does not need any rules for using that data.		

2

Total: 2 marks

Give **two** examples of intelligent behaviours that a computer could simulate using AI. **[2]**

1

2

3

Total: 2 marks

Identify the type of AI system described by each statement. **[2]**

Statement	Type of AI system
A program that has the ability to automatically adapt its own processes and/or data	
A system made up of a knowledge base, a rule base, an inference engine and an interface	

4 **Total: 4 marks**

A parcel delivery company uses an AI system to plan which van carries each parcel each day.

Identify the characteristic of AI shown by each action of the system. A characteristic may be used more than once. **[4]**

Action of the AI system	Characteristic of AI
It stores the weight and delivery address of every parcel, and the rule "a parcel over 20 kg must go on a van with a lift".	
It applies its rules to today's parcels to decide which van each parcel is loaded on.	
It records that deliveries to one town are often late, then changes its own rule so that this town is given an earlier van.	
It uses traffic data and its rules to reach the conclusion that one route will be quicker than another.	

5 **Total: 5 marks**

A board-game program lets an adult play a strategy game against the computer. The computer player uses AI to choose its moves.

(a) Explain how the computer player uses the ability to reason when it chooses its next move. **[2]**

(b) The computer player also has the ability to learn and adapt. **[3]**
Explain how this ability could help the computer player to win more games over time.

6 **Total: 3 marks**

A hotel has an AI system that answers guests' typed questions about its restaurant, such as opening times and which dishes are vegetarian. Staff wrote all of its rules. The system never changes its rules or its data by itself. The hotel manager says: "This system cannot be AI, because it does not learn."

Explain why the manager is **not** correct. **[3]**

Total for this worksheet: 20 marks

MODULE J HARDWARE AND EMERGING TECH · J7

Expert systems

Original practice questions · 21 marks · ~25 minutes · Cambridge 0478 syllabus 6.3.2, 6.3.3

Name _____ Date _____

Instructions. Answer all questions in the spaces provided. The marks for each part are shown in brackets [ ]. Use the full name of each component of an expert system. Do not give brand names. The total for this worksheet is **21 marks**.

1

Total: 4 marks

Draw **one** line from each component of an expert system to its description. Not all of the descriptions will be used. **[4]**

inference engine	Lets the user enter data and shows the user questions and results
knowledge base	Automatically changes its own processes and data as it is given more data
interface	Stores the facts about the specialist area
rule base	Applies the rules to the facts and to the user's answers to reach a conclusion
	Stores the rules that are used to reason with the facts

2 **Total: 4 marks**

A water company has pumping stations across a large region. Its engineers use an expert system to help them find the cause of a fault in a pump. When a new type of pump is installed, the company's senior engineers add new facts and rules to the expert system.

Tick (✓) **one** box in each row to show which component of the expert system each item belongs to. **[4]**

Item	Knowledge base	Rule base	Inference engine	Interface
The screen where the engineer taps Yes or No to answer "Is the pump making a grinding noise?"				
"Pump type K normally runs at a motor temperature between 40 °C and 60 °C."				
The part that uses the engineer's answers so far to decide which question to ask next				
"IF the pump is vibrating AND the motor is above 60 °C THEN the bearings may be worn."				

3 **Total: 4 marks**

The water company's expert system in Question 2 is an example of artificial intelligence (AI).

Describe **two** characteristics of AI that this expert system shows. **[4]**

Characteristic 1

Characteristic 2

4 Total: 5 marks

A mining company uses an expert system to help its geologists decide whether a site might contain copper. The expert system asks a geologist a series of questions about rock samples taken from the site. The geologist answers "Yes" to the question "Does the rock contain green-coloured minerals?".

Explain how the expert system uses this answer to decide what to output next. **[5]**

5 Total: 4 marks

A company that repairs kitchen appliances gives each of its repair technicians a tablet computer with an expert system. The expert system helps a technician work out why an appliance has stopped working.

(a) Give **two** tasks that the interface of this expert system carries out. **[2]**

1

2

(b) A technician has answered three questions, but the expert system has not yet given a result. It asks another question.

Explain why the expert system may need to ask the technician more questions before it gives a result. **[2]**

Total for this worksheet: 21 marks

MODULE J HARDWARE AND EMERGING TECH · J8

Machine learning

Original practice questions · 22 marks · ~25 minutes · Cambridge 0478 syllabus 6.3

Name _____ Date _____

Instructions. Answer all questions in the spaces provided. The marks for each part are shown in brackets [ ]. Where a question gives a scenario, link your answer to that scenario. Do not give brand names. The total for this worksheet is **22 marks**.

1

Total: 3 marks

(a) State what is meant by machine learning. **[2]**

(b) Machine learning gives an artificial intelligence (AI) system one of the main characteristics of AI. State this characteristic. **[1]**

2

Total: 4 marks

Tick (✓) **one** box in each row to show whether each statement describes a feature of an expert system or a feature of machine learning. **[4]**

Statement	Expert system (✓)	Machine learning (✓)
Its facts are gathered from human experts in one specialist area and stored in a knowledge base		
The program automatically changes its own processes as it is given more data		
An inference engine applies a rule base to the facts to reach a conclusion		
The program finds patterns in the results of its past decisions and uses them to make better decisions next time		

3 **Total: 6 marks**

A nature charity fixes cameras to trees in a large forest. Each camera takes a photo when an animal walks past. Software looks at each photo and identifies the species of the animal. Each week, an adult volunteer checks some of the photos and corrects the software when it has identified a species wrongly. The software uses machine learning.

(a) Identify **two** items of data the software could use to learn. **[2]**

1

2

(b) Explain how machine learning allows the software to identify species more accurately over time. **[4]**

4 **Total: 6 marks**

A parcel depot uses an AI system to decide which delivery van each parcel is loaded onto. The system stores data about each van and each parcel. Each evening it records which parcels were delivered late.

Complete the table by identifying **three** characteristics of AI **and** describing how this system shows each characteristic. **[6]**

Characteristic of AI	How the parcel depot system shows this characteristic
1	
2	
3	

5 **Total: 3 marks**

An office building has a heating controller that uses machine learning. The controller has a temperature sensor and records the times that staff arrive at and leave the building each day. Nobody has entered fixed heating times into the controller.

Explain how the controller could use machine learning to decide when to switch the heating on. **[3]**

Total for this worksheet: 22 marks