

1 A flower shop has a room that has an air-conditioning system. It is used to keep the room at a constant temperature for storing flowers.

The owner uses a keypad to set the temperature for the room.

(a) Tick (✓) **one** box to show whether a keypad is an example of an input, output, process or storage device.

- A

input

☐
- B

output

☐
- C

process

☐
- D

storage

☐

[1]

(b) The owner of the shop enters a denary number to set the temperature for the room.

The denary number is converted to a binary number to be processed. The binary number is stored in a register in the air conditioning system.

(i) Give the binary number that would be stored when the denary number 24 is entered.
..... [1]

(ii) Give the binary number that would be stored when the denary number 101 is entered.
..... [1]

(iii) The binary number 00010011 is stored in the register.
Give the denary number that has been entered for this binary number to be stored.
..... [1]

(iv) The binary number 00100010 is stored in the register.
Give the denary number that has been entered for this binary number to be stored.
..... [1]

Working space
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(c) If the air-conditioning system detects an error, it displays an error code. The error code is displayed as a hexadecimal number. The binary number for each error code is stored in a register.

(i) Give the binary number that is stored in the register to display the error code 51.

..... [1]

(ii) Give the binary number that is stored in the register to display the error code E3.

..... [1]

(iii) Give the hexadecimal number that is displayed when the binary number 10000010 is stored in the register.

..... [1]

(d) If the owner of the shop wants to make the room very cold, she may need to enter a negative denary number.

The negative denary number could be represented using two’s complement.

Give the two’s complement 8-bit binary integer that would be stored for the temperature –5.

Show all your working.

Working space

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Two’s complement 8-bit binary integer [2]

(e) The air-conditioning system uses a temperature sensor and a microprocessor to keep the temperature of the room at a constant level.

(i) Tick (✓) **one** box to show whether the sensor is an example of an input, output, process or storage device.

- A

input

☐
- B

output

☐
- C

process

☐
- D

storage

☐

[1]

(ii) The temperature sensor continuously sends analogue data to the microprocessor. This data is then converted to digital.

Explain how the microprocessor keeps the temperature of the room at a constant level.

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[3]

(f) The air-conditioning system is an example of an embedded system.

Explain why the air-conditioning system is an embedded system.

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[2]

6 A weather station uses automated systems to collect and analyse data about the weather.

The automated system uses sensors.

(a) Give **one** other component that would be part of the automated system.

..... [1]

(b) One sensor that is part of the automated system is a temperature sensor.

Give **one** other sensor that could be part of the automated system.

..... [1]

(c) An alert is sent to an employee in the weather office if a temperature above 40 °C is detected.

(i) Explain how a temperature above 40 °C is detected for the alert.

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..... [3]

(ii) The data for the alert is sent using serial simplex data transmission.

Explain how the data is sent using serial simplex data transmission.

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(d) Give **two** advantages to the weather station employees of using an automated weather system.

1

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2

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[2]

(e) Give **one** disadvantage to the weather station employees of using an automated weather system.

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..... [1]

(f) The automated weather system is upgraded and given machine learning capabilities.

(i) Machine learning is part of a branch of computer science.

Identify the name of this branch of computer science.

..... [1]

(ii) Explain how the machine learning capabilities can be used to predict future weather.

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- 5** A farmer has a plough that is an automated system. The plough is used to dig the ground in a field to prepare it for planting seeds.

The plough uses sensors and a microprocessor to maintain a straight line when digging the ground.

- (a)** State what is meant by an automated system.

[1]

- (b)** Describe the role of the microprocessor in this process.

..... [3]

- (c)** Give **two** benefits to the farmer of using an automated system for this purpose.

1

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2

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[2]

- (d)** The plough uses artificial intelligence (AI) to navigate its way around the field.

Explain how the plough makes use of AI for this purpose.

[illegible]

6 A self-driving tractor sows seeds and harvests crops for a farmer. The self-driving tractor moves automatically through the field, turning at each end and stopping when it has finished.

(a) One reason the self-driving tractor is a robot is because it has a mechanical structure that includes wheels, an engine, and a framework.

Give **one** other reason why the self-driving tractor is an example of a robot.

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..... [1]

(b) If a person is detected within 3 metres whilst the tractor is moving, the self-driving tractor must stop.

(i) Explain how an infra-red sensor, microprocessor and actuator can be used to stop the self-driving tractor if a person is detected within 3 metres.

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..... [5]

(ii) Identify **one** other sensor that the self-driving tractor might use and how it will use the sensor.

Sensor

Use

..... [2]

(c) Explain the drawbacks of a farmer using a self-driving tractor to sow seeds and harvest crops.

[3]

(d) The self-driving tractor has an in-built expert system that the farmer can use to solve any errors with the tractor.

Identify **three** components of an expert system.

1

2

3

[3]

(e) At the end of each day the self-driving tractor transmits the data it has collected to the farmer's computer in their house.

The transmission uses an echo check.

(i) Describe the role of the self-driving tractor and the farmer's computer in the echo check.

[3]

(ii) Another method of error checking is a parity block check.

The table shows 7 bytes that are transmitted using odd parity. The parity bit has been completed for each byte.

Complete the parity byte for the data.

	parity bit	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1
byte 1	1	1	0	0	1	1	1	0
byte 2	1	0	0	0	0	1	1	0
byte 3	0	1	0	0	0	0	0	0
byte 4	0	1	0	0	1	1	1	1
byte 5	1	0	0	0	0	0	0	0
byte 6	0	1	1	1	1	1	1	1
byte 7	1	1	0	0	1	1	0	1
parity byte								

[3]

11 A manufacturing company uses an automated system in its manufacturing process.

(a) The automated system uses a flow sensor.

Identify what a flow sensor measures.

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..... [1]

(b) Explain **one** advantage to employees of using an automated system in manufacturing.

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..... [2]

(c) Explain **one** disadvantage to the company owner of using an automated system in manufacturing.

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..... [2]

5 A farm has an automated drinking system for its animals. The drinking system has a water bowl that contains the water. When the water bowl is empty, it is automatically refilled.

The system uses a sensor and a microprocessor.

(a) Identify the most appropriate sensor for this system.

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(b) Describe how the sensor and the microprocessor are used to automatically refill the water bowl.

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