

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

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- 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]

4 An automated teller machine (ATM) is a device where a person inserts their bank card and can request to withdraw money. The ATM also allows the person to check how much money they have in their bank account.

(a) A sensor is used to detect when a person stands within 1 metre of the ATM. When a person is detected, a welcome message is displayed on the screen.

(i) Identify an appropriate sensor for the ATM to use to detect a person.

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(ii) Describe the role of the microprocessor in detecting the person.

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(b) Describe the features of the ATM that identify it as an embedded system.

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..... [2]

(c) The ATM has a touch screen and a keypad.

The ATM may need to be used by people who are unable to see.

Identify **one** other input device and **one** other output device that can be built into the ATM to help people who are unable to see.

Input

Output

[2]

10 A garage uses an expert system to help diagnose any problems with cars that need repair.

(a) The expert system is an example of artificial intelligence (AI).

Describe what is meant by AI.

[2]

(b) A car has a problem with its braking system, so it is brought into the garage.

Explain how the expert system operates and how it is used to help diagnose the problem.

[5]

2 A car park has a payment machine that allows a customer to pay for their parking.

The cost of parking is displayed as a denary number on a screen on the payment machine.

The cost of parking is stored in two 8-bit binary registers.

For the parking cost of \$10.50:

- register 1 stores the denary value 10 as binary
- register 2 stores the denary value 50 as binary.

- (a) Give the parking cost that would be displayed on the payment machine when the registers store:
- register 1: 00010001
 - register 2: 01000110

Parking cost displayed \$

[2]

Working space

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(b) The parking cost of \$14.98 is displayed on the payment machine.

Give the 8-bit binary numbers that are stored in the registers to display the parking cost.

Register 1

Register 2 [2]

Working space

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(c) The payment machine gives the customer a ticket when they have paid their parking cost. Each ticket has a 4-digit hexadecimal ticket number that is stored as binary.

The binary number 1010000000111101 is stored for a customer’s ticket number.

Give the hexadecimal ticket number that would be displayed on this customer’s ticket.

Hexadecimal ticket number [4]

Working space

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(d) Explain why data input into the payment machine needs to be converted to binary.

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- (e) When a customer is leaving the car park they arrive at a barrier. The customer needs to insert their ticket into a system at the barrier. This system reads the ticket number then checks whether the parking cost has been paid for the car. The barrier is raised if it has been paid.

The system uses a microprocessor.

Describe the role of the microprocessor in the system and how it checks whether the parking cost has been paid.

[4]