

Solutions

Each answer shows the steps, then the **result**.

2.1

- a display only tells the driver → **monitoring**
- the air conditioner changes the room temperature itself → **control**
- an alarm only warns a person → **monitoring**
- the light is switched on by the system itself → **control**
- recording only → **monitoring**

2.2

- (a) a person's body heat, or a broken beam → **infra-red**
- (b) crying is a loud sound → **sound**
- (c) how cold it is → **temperature**
- (d) a force pressing on the mat → **pressure**

2.3

- a device that turns a signal from the processor into movement or another physical change
- for example a motor, a pump, a valve or a heater

2.4

- the sensor produces an **analogue** signal (a continuously changing voltage)
- the microprocessor can process only **digital** (binary) data, so the signal must be converted

2.5

- (a) **yes**
- its microprocessor is built into the oven and only runs the fixed cooking program
- (b) **no**
- it is a general-purpose computer: the user can install and run many different programs

2.6

- the device that measures → **sensor**
- the microprocessor **compares** the reading with a **preset** value
- the heater is switched by an **actuator**
- the loop never stops → **continuously**

3.1

- (a) it is a microprocessor system built into a larger device, the washing machine
- it has one dedicated task: running the wash programs

- its program is stored in ROM and the user cannot install other software

(b) any **two** of:

- it is small, so it fits inside the machine
- it is cheap to mass-produce
- it uses little power
- it is reliable, and it is ready as soon as the machine is switched on

(c) any **two** of:

- it is hard to upgrade or to add new wash programs
- it is hard to repair, so a fault often means replacing the whole unit
- it can only do this one task
- if the machine is connected to the internet and is never updated, it can be hacked

3.2

(a) **monitoring**

- the system only measures and reports the readings; it does nothing to change the temperature or the wind

(b) the sensor's reading is converted by an ADC and sent to the microprocessor

- the microprocessor compares each reading with the stored value 0 °C
- if the reading is below 0 °C, it sends a warning (a message or an alarm) to the office

3.3

(a) any **six** of:

- the temperature sensor measures the water temperature and sends the reading to the microprocessor
- an ADC converts the analogue reading to digital
- the microprocessor compares the reading with the stored values 26 °C and 28 °C
- if the reading is below 26 °C, it sends a signal to the actuator to switch the heater on
- if the reading is above 28 °C, it sends a signal to switch the heater off
- if the reading is in the range, no action is taken
- the process is repeated continuously

(b) the heater changes the water temperature, so the output of the system affects its next input

- the sensor measures the effect of each change, so the system knows whether to keep heating or to stop
- so the system corrects itself automatically and keeps the water in the range, without a person

3.4

(a) one mark for each sensor, and one for its use, for example:

- an **infra-red** sensor detects a car arriving at, or still under, the barrier, because the car breaks the beam
- a **pressure** sensor in the road detects a car waiting at the barrier or passing over it

(b) a **motor**

- it raises and lowers the barrier when the microprocessor sends it a signal

(c) the system does not only report what the sensors detect: it **acts** by moving the barrier itself

- and the position of the barrier depends on the next sensor readings (whether a car is still under it), so there is feedback

(d) any **two** of:

- it is smaller and cheaper
- it uses less power
- it is more reliable: it runs only this one program, with no other software to fail or be changed
- it starts at once after a power cut