IGCSE COMPUTER SCIENCE • EXERCISE SHEET

6.1 Automated systems

Name: _____ Class: _____ Date: _____ **Total: 27 marks**

KEY WORDS sensor 传感器 • microprocessor 微处理器 • automated system 自动化系统 • actuator 执行器 • a rogue value 哨兵值

Objective

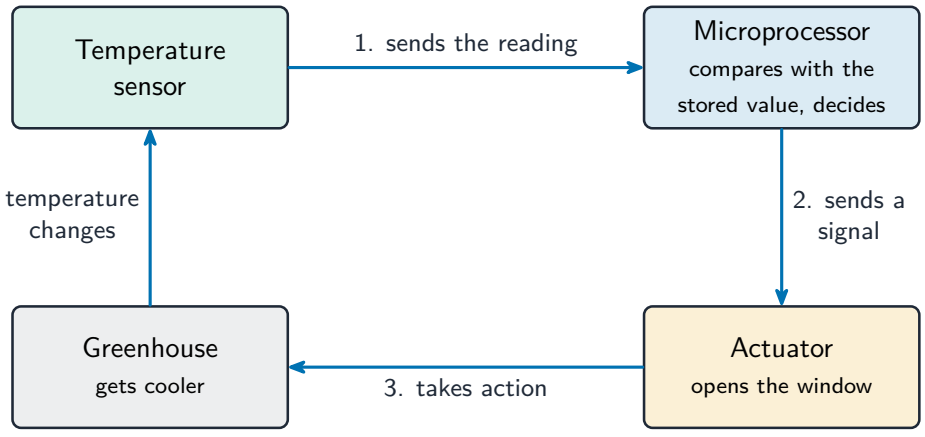
Build the skills to answer exam questions on **automated systems** 自动化系统 — the roles of **sensors** 传感器, **microprocessors** 微处理器 and **actuators** 执行器, and the pros and cons.

You must be able to:

- describe the role of the sensor, microprocessor and actuator
- describe the control loop
- give advantages and disadvantages of automated systems

1 Worked examples

The control loop



Sensor reads data → microprocessor compares with stored values → signals actuator → the loop repeats

- **sensor:** measures a quantity; **microprocessor:** decides; **actuator:** causes action.

Algorithms: what each one is for

Pseudocode or flowchart? Both describe the same algorithm. Pseudocode is quicker to write and translates straight into code; a flowchart shows the flow of control visually and is easier to follow at a glance.

The standard methods the exam expects:

- **totalling** 求和: `Total ← Total + Value` inside the loop, with `Total ← 0` before it.
- **counting** 计数: `Count ← Count + 1` each time a condition is met.
- **finding the largest**: set `Largest` to the first value (or a very small number), then replace it whenever a bigger value appears.
- **finding the smallest**: the same with the comparison reversed.
- **calculating an average**: total divided by the count, after the loop.
- **a rogue value** 哨兵值: a value outside the possible data that stops the loop, such as -1 for a mark out of 100. Test for it before adding, or the rogue value joins the total.

Worked example. Input marks until -1 is entered, then output the total and the average.

```
Total ← 0
Count ← 0
INPUT Mark
WHILE Mark <> -1 DO
    Total ← Total + Mark
    Count ← Count + 1
    INPUT Mark
ENDWHILE
IF Count > 0 THEN
    OUTPUT "Total ", Total
    OUTPUT "Average ", Total / Count
ELSE
    OUTPUT "No marks entered"
ENDIF
```

Two details earn marks: the first `INPUT` **before** the loop so the condition can be tested, and the check that `Count` is not zero before dividing.

Trace tables. Draw one column per variable and one per output, then work through the algorithm one line at a time, writing each new value on a new row. Never rub out an old value: the examiner wants to see the sequence.

2 Practice

2.1 State the role of a sensor in an automated system. [1]

2.2 State the role of an actuator. [1]

2.3 State what a rogue value is and give one example. [2]

2.4 Give the line of pseudocode that adds `Mark` to a running total. [1]

2.5 Explain why the total must be set to zero before the loop begins. [2]

3 Exam-style questions

3.1 In an automated greenhouse, the part that decides whether to open a window is the: [1]

- **A** sensor
- **B** microprocessor
- **C** actuator
- **D** window

3.2 A greenhouse is too hot.

(a) Describe the steps the system takes to cool it. [3]

(b) State one disadvantage of automated systems. [1]

3.3 A program inputs the temperatures recorded each day until the rogue value −99 is entered.

(a) State why −99 is a suitable rogue value here. [1]

(b) Write pseudocode that inputs the temperatures, and outputs the total, the average and the highest temperature. [7]

(c) Explain why the program must check the count before calculating the average. [2]

(d) Complete the trace table for the input data 12, 15, 9, −99. [4]

Mark	Total	Count	Highest	OUTPUT

(e) Give one advantage of writing this algorithm as a flowchart rather than as pseudocode. [1]

Solutions

2.1 it measures a physical quantity and sends the data.

2.2 it receives a signal and causes movement or action.

3.1 B. The microprocessor compares the data and decides.

3.2 (a) the temperature sensor sends the reading to the microprocessor; the microprocessor compares it with the stored value; it signals an actuator to open a window.
(b) any of: high cost; can break down; may replace jobs; cannot react to unplanned situations.

2.3 A value outside the range of the real data, used to stop a loop; for example −1 for a mark out of 100.

2.4 `Total ← Total + Mark`.

2.5 The variable would otherwise start with whatever value was left in it, so the total would be wrong from the first addition.

3.3 (a) A temperature of −99 °C never occurs in the real data, so it cannot be confused with a genuine reading.
(b) `Total ← 0`, `Count ← 0` and `Highest` set to the first value or a very low number; `INPUT Temp` before the loop; `WHILE Temp <> -99 DO … ENDWHILE`; `Total ← Total + Temp` and `Count ← Count + 1` inside; `IF Temp > Highest THEN Highest ← Temp ENDIF` inside; `INPUT Temp` as the last statement inside the loop; outputs of the total, `Total / Count` and `Highest` after the loop.
(c) If no temperatures were entered the count is zero, and dividing by zero would make the program crash.
(d) Row 1: Mark 12, Total 12, Count 1, Highest 12. Row 2: Mark 15, Total 27, Count 2, Highest 15. Row 3: Mark 9, Total 36, Count 3, Highest 15. Row 4: Mark −99, loop ends, OUTPUT 36, 12, 15.
(e) The flow of control, especially the branches and the loop, can be seen at a glance.