Exercise walk-through

Algorithms ▪ 9.2

eXercise

You must be able to

- complete an **identifier table** 标识符表 for the data a problem uses
- write **pseudocode** 伪代码 using **sequence** 顺序, **selection** 选择 and **iteration** 迭代 (a **loop** 循环), and **declare** 声明 your variables
- write pseudocode that processes an **array** 数组 with a loop
- write pseudocode **from** a **structured English** 结构化英语 description, and **complete** a given flowchart or pseudocode
- use **stepwise refinement** 逐步求精 to break a task into steps
- **describe** an algorithm in words, with no pseudocode

Method — A — Identifier table (the exam format)

Before writing code, name every piece of data. The exam gives you an **example value** and an **explanation**, and you fill in a sensible **variable** 变量 name and **data type** 数据类型:

Example value	Explanation	Variable name	Data type
`"Fruit"`	a category of stock	`Category`	`STRING`
`20/02/2025`	the date an item was sold	`SaleDate`	`DATE`
`12.67`	the cost of one item	`ItemCost`	`REAL`
`TRUE`	whether the item is in stock	`InStock`	`BOOLEAN`

Method — A — Identifier table (the exam format)

Pick a **descriptive** name (`ItemCost`, not `x`). Choose the type from the example: whole number → `INTEGER`, number with a decimal → `REAL`, text → `STRING`, one true/false → `BOOLEAN`, a date → `DATE`.

Method — B — The three constructs (quick reference)

```
INPUT Price                          // sequence: steps in order
Total ← Price * Quantity

IF Mark >= 50 THEN                    // selection: choose a path
    OUTPUT "Pass"
ELSE
    OUTPUT "Fail"
ENDIF
FOR Count ← 1 TO 5                    // iteration: a counted loop
    OUTPUT Count
NEXT Count
```

A **WHILE** loop tests **before** each pass (may run 0 times); a **REPEAT … UNTIL** loop tests **after** (runs at least once). Use ← to assign, = <> < > <= >= to compare.

Method — C — Write pseudocode from a structured English description

This is the most common exam task. **Method:**

1. List the data in an identifier table.
2. Take the steps **in order**; turn each into pseudocode.
3. "Repeat …" → a loop; "if …" → an `IF`.

Worked example. *Input 100 numbers one at a time; add up only the positive ones; output the total.*

```
DECLARE Count   : INTEGER
DECLARE Number  : INTEGER
DECLARE Total   : INTEGER
Total ← 0
FOR Count ← 1 TO 100
    INPUT Number
    IF Number > 0 THEN
        Total ← Total + Number
    ENDIF
NEXT Count
OUTPUT Total
```

Method — C — Write pseudocode from a structured English description

`Total ← 0` **before** the loop, then add inside it — this running-total pattern appears again and again.

Method — D — Loop over an array

An array 数组 holds many values under one name. `Data` below has 30 elements; `Data[Index]` is element number `Index`. A `FOR` loop visits each one.

Worked example. *Output every non-blank element of the array `Data`, then output how many you found.*

```
DECLARE Index : INTEGER
DECLARE Found : INTEGER
Found ← 0
FOR Index ← 1 TO 30
    IF Data[Index] <> "" THEN
        OUTPUT Data[Index]
        Found ← Found + 1
    ENDIF
NEXT Index
OUTPUT Found
```

Method — D — Loop over an array

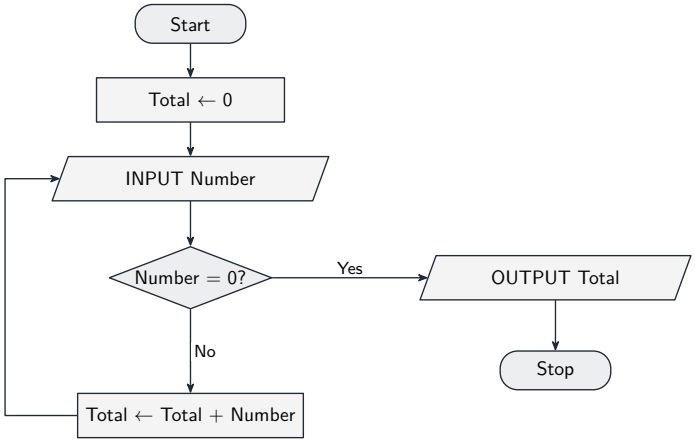
(Arrays are covered fully in topic 10 — here you only need `Data[Index]` and a counted loop.)

Method — E — Flowcharts: shapes, and a loop

Shape	**Meaning**
Rounded box	Start / Stop
Parallelogram	Input / Output
Rectangle	Process
Diamond	Decision

A loop is a **decision with an arrow that goes back up**. This flowchart adds input numbers to a total and stops at a **sentinel 哨兵值** of 0:

Method — E — Flowcharts: shapes, and a loop



Method — F — Stepwise refinement

Stepwise refinement 逐步求精 means: start with a few high-level steps, then refine each until it is small enough to code. You write the **steps in words** (no pseudocode).

Worked example. *Average the numbers stored in a file.*

```
Step 1 - open the file; set Total to 0 and Count to 0
Step 2 - read the next number; add it to Total and add 1 to Count
Step 3 - repeat step 2 until the end of the file
Step 4 - set Average to Total / Count
Step 5 - output Average and close the file
```

Practice 2.1 ▪ 4 marks

Complete the **identifier table** for a program that stores one student's record.

Example value	Explanation	Variable name	Data type
`"Ahmed"`	the student's name		
`16`	the student's age in years		
`72.5`	the student's average mark		
`TRUE`	whether the student passed		

Solution 2.1

Method: A — Identifier table (the exam format)

Worked steps

`Ahmed` → `Name STRING`; `16` → `Age INTEGER`; `72.5` → `Average REAL`; `TRUE` → `Passed BOOLEAN` **B1** *each pair name+type; sensible names accepted.*

Practice 2.2 ▪ 2 marks

Describe what is meant by **stepwise refinement**.

Solution 2.2

Method: F — Stepwise refinement

Worked steps

Start with a few **high-level steps**, then **break each step down** (refine it) into smaller steps, until every step is simple enough to write as code B1 B1 *break into steps, refine until codeable.*

Practice 2.3 ▪ 5 marks

Write **pseudocode** from this description: *input 20 numbers one at a time; count how many are greater than 100; output the count.* Declare your variables.

Solution 2.3

Method: C — Write pseudocode from a structured English description

Worked steps

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```
DECLARE Index  : INTEGER
DECLARE Number : INTEGER
DECLARE Big    : INTEGER
Big ← 0
FOR Index ← 1 TO 20
    INPUT Number
    IF Number > 100 THEN
        Big ← Big + 1
    ENDIF
NEXT Index
OUTPUT Big
```

Solution 2.3

B1 M1 M1 A1 *declare variables, loop 1 to 20 with INPUT inside, IF Number $>$ 100, add 1 + OUTPUT after the loop*

Practice 2.4 ▪ 2 marks

The algorithm in 2.3 uses **sequence**. Name **one** other basic construct it uses and describe how it is used.

Solution 2.4

Worked steps

Iteration — the `FOR` loop repeats the input-and-test 20 times; **or** selection — the `IF` decides whether to add 1 B1 B1 *construct named, correct description.*

Practice 2.5 ▪ 3 marks

Complete the pseudocode so it averages 10 input values. Write what goes in each blank.

```
Total ← 0
FOR Index ← 1 TO 10
    INPUT Value
    Total ← ____________(1)
NEXT Index
Average ← ____________(2)
OUTPUT ____________(3)
```

Solution 2.5

Worked steps

(1) `Total + Value`
(2) `Total / 10`
(3) `"Average = ", Average` B1 *each.*

Exam-style 3.1 ▪ 8 marks

A program plays a guessing game. A function `RANDOM(X, Y)` returns a random integer between `X` and `Y` inclusive. The program generates a secret integer from 1 to 50, then **repeatedly** inputs a guess until the guess is correct. After each wrong guess it outputs `"higher"` if the guess was too low, or `"lower"` if it was too high. When the guess is correct it outputs `"correct"`.

Write **pseudocode** for this algorithm. Declare your variables.

Solution 3.1

Worked steps

```
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DECLARE Secret : INTEGER
DECLARE Guess  : INTEGER
Secret ← RANDOM(1, 50)
REPEAT
    INPUT Guess
    IF Guess < Secret THEN
        OUTPUT "higher"
    ENDIF
    IF Guess > Secret THEN
        OUTPUT "lower"
    ENDIF
UNTIL Guess = Secret
OUTPUT "correct"
```

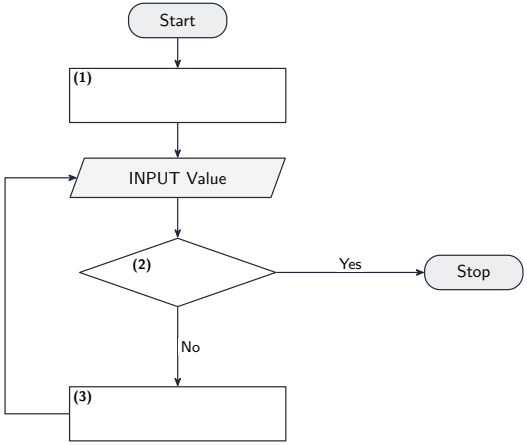
Solution 3.1

B1 M1 M1 M1 M1 M1 A1 B1 *declare + generate Secret, loop that repeats the input, INPUT inside the loop, test too-low → "higher", test too-high → "lower", loop ends when Guess = Secret, "correct" output once after the loop, fully correct logic (A WHILE loop with a first input before it is equally valid.)*

Exam-style 3.2 ▪ 5 marks

The array `Data` has 20 elements of type `INTEGER`. The algorithm below inputs values one at a time and stores them in `Data`, stopping when the value `-1` is input (the `-1` is **not** stored). You may assume at most 20 values are entered. Complete the **three** missing parts of the flowchart.

Exam-style 3.2 ▪ 5 marks



Solution 3.2

Method: E — Flowcharts: shapes, and a loop

Worked steps

(1) `Count ← 1` (set the array index to the first element)
(2) decision `Value = -1`? (the sentinel that ends the loop)
(3) `Data[Count] ← Value` then `Count ← Count + 1` (store, then move to the next element) **M1** **M1** **M1** **A1** **A1** *initialise the index, correct sentinel test, store into 'Data[Count]', increment the index, the No branch loops back to the input.*

Exam-style 3.3 ▪ 6 marks

A file `Marks.txt` stores exam marks, one per line. Using **stepwise refinement**, describe up to **six** steps for an algorithm that outputs how many marks are a pass (50 or more) and the highest mark. Do **not** use pseudocode.

Solution 3.3

Method: F — Stepwise refinement

Worked steps

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```
Step 1 - open Marks.txt; set PassCount to 0 and Highest to 0
Step 2 - read the next mark from the file
Step 3 - if the mark is 50 or more, add 1 to PassCount
Step 4 - if the mark is greater than Highest, set Highest to the mark
Step 5 - repeat from step 2 until the end of the file
Step 6 - output PassCount and Highest; close the file
```

Solution 3.3

B1 B1 B1 B1 B1 B1 *initialise counters + open, read in a loop to end of file, count passes, track highest, output, no pseudocode used / clear steps*

Exam-style 3.4 ▪ 5 marks

An array `Score` holds 40 integers. **Describe** an algorithm (no pseudocode) to find and output the **largest** score and the **position** in the array where it is stored.

Solution 3.4

Worked steps

Set the largest-so-far to `Score[1]` and its position to 1 (B1). Look at each remaining element from index 2 to 40 in turn (B1). If an element is greater than the largest-so-far, set the largest-so-far to that element and set the position to that index (B1)(B1). After checking all elements, output the largest-so-far and the position (B1).