Cambridge Pseudocode Handout

English edition

Contents

1 Style and layout

1.1 Keywords and case

Pseudocode 伪代码 is the language Cambridge writes algorithms 算法 in. It is not a real programming language — no computer runs it — but the exam marks it as if it were, so the form matters.

Every keyword 关键字 is written in **upper case**: `IF`, `REPEAT`, `PROCEDURE`, `OUTPUT`.

```
DECLARE Count : INTEGER
Count ← 3
IF Count > 0
  THEN
    OUTPUT "Ready"
ENDIF
```

- Write `IF`, never `if` or `If`.
- A keyword can never be used as a name of your own: you may not call a variable `FOR`.

Common mistakes

- Lower-case keywords. The mark scheme expects upper case.
- Inventing keywords. Only the words in this handout are in the syllabus.

1.2 Identifiers

An **identifier** 标识符 is the name you give a variable 变量, a constant 常量, a procedure 过程 or a function 函数.

```
DECLARE NumberOfPlayers : INTEGER
NumberOfPlayers ← 4
OUTPUT NumberOfPlayers
```

Four rules, all from the syllabus:

- It must **start with a capital letter**: `Count`, not `count`.
- It may hold only letters and digits — no spaces, no punctuation.
- It is **not case-sensitive** 不区分大小写, so `Count` and `COUNT` are the same name. Pick one spelling and keep it.
- Make it mean something. `NumberOfPlayers` earns the reader's time; `N` does not.

Common mistakes

- `count ← 0` — a lower-case start. 0478 requires the capital.
- `Number of players` — spaces are not allowed inside a name.

1.3 Comments and indentation

A **comment** 注释 starts with `//` and runs to the end of the line. It is for the human reader; the algorithm ignores it.

```
// Swap the values of X and Y
DECLARE X, Y, Temp : INTEGER
X ← 1
Y ← 2
Temp ← X   // temporarily store X
X ← Y
Y ← Temp
OUTPUT X, " ", Y
```

Indentation 缩进 shows which statements are **inside** a structure. The syllabus asks for four spaces per level, with one exception you must know:

```
DECLARE X, Y : INTEGER
X ← 7
Y ← 3
IF X > Y
  THEN
    OUTPUT "X is bigger"
  ELSE
    OUTPUT "Y is bigger or equal"
ENDIF
```

- `THEN` and `ELSE` are indented **two** spaces from their `IF`.
- The statements under them are indented **four**.
- `ENDIF` lines up with its own `IF`.

Common mistakes

- Putting `THEN` on the `IF` line. That is the A-Level 9618 layout — see topic 11.
- No indentation at all. A marker has to see the structure to award the structure marks.

2 Variables, constants and types

2.1 The five data types

0478 pseudocode has exactly **five** data types 数据类型. Learn the list — naming a type that is not on it loses the mark.

Type	Holds	Example
`INTEGER`	a whole number 整数	`42`, `-7`
`REAL`	a number with a decimal part 小数	`3.14`, `-0.5`
`CHAR`	a single character 单个字符	`'A'`
`STRING`	a sequence of characters 字符串	`"Hello"`
`BOOLEAN`	`TRUE` or `FALSE` 布尔值	`TRUE`

```
DECLARE Age : INTEGER
DECLARE Price : REAL
DECLARE Grade : CHAR
DECLARE Name : STRING
DECLARE Passed : BOOLEAN
Age ← 17
Price ← 2.50
Grade ← 'A'
Name ← "Mei"
Passed ← TRUE
OUTPUT Name, " is ", Age, " and passed: ", Passed
```

- A `STRING` is written in **double** quotes, a `CHAR` in **single** quotes.
- `TRUE` and `FALSE` are keywords, so they are upper case and carry no quotes.

Common mistakes

- Writing `FLOAT`, `DOUBLE` or `BOOL`. Those are real languages, not this syllabus.
- `'Hello'` for a string — single quotes hold one character only.

2.2 DECLARE

`DECLARE` names a variable 变量 and fixes its type before you use it.

```
DECLARE <identifier> : <data type>
```

```
DECLARE Counter : INTEGER
DECLARE TotalToPay : REAL
Counter ← 1
TotalToPay ← 19.99
OUTPUT "Item ", Counter, " costs ", TotalToPay
```

Several names of one type go on a single line, separated by commas:

```
DECLARE Length, Width, Area : INTEGER
Length ← 6
Width ← 4
Area ← Length * Width
OUTPUT "Area = ", Area
```

- Declare a variable **before** its first use, near the top of the algorithm.
- A variable keeps its type for the whole algorithm — an `INTEGER` never holds `"Mei"`.

Common mistakes

- Leaving out the colon: `DECLARE Counter INTEGER`.
- Using a variable that was never declared. The exam expects the declaration.

2.3 CONSTANT

A **constant** 常量 is a value that is fixed for the whole algorithm — a tax rate, π, the size of a class. Naming it once means a change is made in one place.

```
CONSTANT <identifier> ← <value>
```

```
CONSTANT TaxRate ← 0.20
DECLARE Price, Tax : REAL
Price ← 50.00
Tax ← Price * TaxRate
OUTPUT "Tax to pay: ", Tax
```

- In **0478 the arrow is used**, exactly as for an assignment.
- The value must be a **literal** 字面量 — a number, a string, `TRUE` — never a calculation and never another variable.
- A constant can never be given a new value later. That is the whole point of it.

Common mistakes

- `CONSTANT TaxRate = 0.20`. The `=` form is the A-Level 9618 spelling — see topic 11.

- Assigning to a constant further down the algorithm.

3 Assignment, input and output

3.1 The assignment arrow

The **assignment** 赋值 operator is ←, a left-pointing arrow. It means *take the value on the right and put it in the box on the left.*

```
<identifier> ← <value>
```

```
DECLARE Counter : INTEGER
Counter ← 0
Counter ← Counter + 1
Counter ← Counter + 1
OUTPUT Counter
```

`Counter ← Counter + 1` looks impossible as mathematics and is ordinary as an instruction: work out the right-hand side with the value the box holds now, then store the result back.

- If you cannot type ←, write `<-`. Both are accepted, here and in the exam.
- The left side must be a **single identifier** or one array element. Never a calculation.

Common mistakes

- `Counter = 0`. In pseudocode `=` is a **comparison**, not an assignment — and confusing the two is the single commonest syntax error in this paper.
- `Counter + 1 ← Counter`. The arrow points at the thing being changed.

3.2 INPUT and OUTPUT

`INPUT` reads a value from the user into a variable. `OUTPUT` displays one or more values.

```
DECLARE Name : STRING
DECLARE Age : INTEGER
INPUT Name
INPUT Age
OUTPUT "Hello ", Name
OUTPUT "Next year you will be ", Age + 1
```

- `INPUT` takes exactly **one** variable, and that variable must already be declared.
- `OUTPUT` takes any number of items separated by **commas**; they are printed one after another with nothing between them.
- A literal 字面量 string in an `OUTPUT` goes in double quotes; a variable does not.

3.2.1 Prompting the user

An `INPUT` on its own shows nothing on screen, so a well-written algorithm prints a prompt 提示 first:

```
DECLARE Radius : REAL
OUTPUT "Enter the radius: "
INPUT Radius
OUTPUT "The diameter is ", Radius * 2
```

Common mistakes

- `INPUT "Enter a number", X` — the prompt is a separate `OUTPUT` statement.
- `OUTPUT "Total: " + Total`. 0478 joins output items with a comma; `+` is arithmetic and `&` belongs to A-Level 9618 (topic 11).
- Forgetting the quotes: `OUTPUT Hello` looks for a *variable* called `Hello`.

4 Arithmetic and logic

4.1 Arithmetic operators

Five arithmetic 算术 operators, in the order a calculator uses them.

Operator	Meaning	`A` is 7, `B` is 2
`+`	add 加	`A + B` is 9
`-`	subtract 减	`A - B` is 5
`*`	multiply 乘	`A * B` is 14
`/`	divide 除	`A / B` is 3.5
`^`	raise to a power 幂	`A ^ B` is 49

```
DECLARE A, B : INTEGER
A ← 7
B ← 2
OUTPUT "Sum: ", A + B
OUTPUT "Product: ", A * B
OUTPUT "Quotient: ", A / B
OUTPUT "Power: ", A ^ B
```

Brackets come first, then `^`, then `*` and `/`, then `+` and `-` — the usual precedence 优先级. Use brackets whenever the reader would have to stop and think.

```
DECLARE Total : REAL
Total ← (12 + 18) / 2
OUTPUT "Mean: ", Total
```

Common mistakes

- Expecting `/` to give a whole number. `7 / 2` is `3.5`, not `3`; for a whole number use `DIV`.
- Writing `A x B` or `A ÷ B`. Use `*` and `/`.

4.2 DIV and MOD

Integer division 整数除法 answers two different questions, and 0478 writes each of them as a **function** 函数, with the two values in brackets.

- `DIV(a, b)` — how many whole times `b` goes into `a`, the **quotient** 商.
- `MOD(a, b)` — what is left over, the **remainder** 余数.

```
OUTPUT DIV(10, 3)
OUTPUT MOD(10, 3)
OUTPUT DIV(17, 5)
OUTPUT MOD(17, 5)
```

Both take integers, and both return an integer.

4.2.1 What they are for

`MOD` is the standard test for *divides exactly*, which makes it the way to ask whether a number is even 偶数:

```
DECLARE Number : INTEGER
Number ← 12
IF MOD(Number, 2) = 0
  THEN
    OUTPUT Number, " is even"
  ELSE
    OUTPUT Number, " is odd"
ENDIF
```

`DIV` converts a total into whole units — seconds into minutes, pence into pounds:

```
DECLARE Seconds : INTEGER
Seconds ← 200
OUTPUT DIV(Seconds, 60), " minutes and ", MOD(Seconds, 60), " seconds"
```

Common mistakes

- `10 MOD 3`. That is the A-Level 9618 form; **0478 uses the function form** `MOD(10, 3)`.
- Mixing the two up. `DIV` gives the whole part; `MOD` gives what does not fit.

4.3 Relational and logic operators

A **relational operator** 关系运算符 compares two values and produces `TRUE` or `FALSE`.

Operator	Means
`=`	is equal to 等于
`<>`	is not equal to 不等于
`>`	is greater than 大于
`<`	is less than 小于
`>=`	is greater than or equal to 大于等于
`<=`	is less than or equal to 小于等于

```
DECLARE Mark : INTEGER
Mark ← 55
OUTPUT "Pass: ", Mark >= 50
OUTPUT "Perfect: ", Mark = 100
OUTPUT "Not zero: ", Mark <> 0
```

The three **logic operators** 逻辑运算符 join conditions:

- `AND` — both sides must be `TRUE`.
- `OR` — at least one side must be `TRUE`.
- `NOT` — turns `TRUE` into `FALSE` and back.

```
DECLARE Age : INTEGER
DECLARE HasTicket : BOOLEAN
Age ← 16
HasTicket ← TRUE
IF Age >= 15 AND HasTicket = TRUE
  THEN
    OUTPUT "Admitted"
ENDIF
IF NOT (Age > 18)
  THEN
    OUTPUT "Still a student rate"
ENDIF
```

Common mistakes

- `<>` is the *not equal* sign here — not `!=`, which belongs to other languages.
- `IF Age >= 15 AND <= 18`. Each side of `AND` needs its own complete comparison: `Age >= 15 AND Age <= 18`.
- Calling these *comparison operators* in an answer. The syllabus term is **relational**.

5 String operations

5.1 LENGTH, UCASE and LCASE

0478 publishes four string 字符串 routines and no others. Three of them are here.

`LENGTH(<identifier>)` returns how many characters 字符 a string holds — spaces included.

```
OUTPUT LENGTH("Happy Days")
OUTPUT LENGTH("")
```

`UCASE(<identifier>)` returns the string in upper case 大写, `LCASE(<identifier>)` in lower case 小写. Neither changes the original 原值 — each hands back a new value.

```
DECLARE Name : STRING
Name ← "Happy"
OUTPUT UCASE(Name)
OUTPUT LCASE(Name)
OUTPUT Name
```

That last line still prints `Happy`: to keep the change you must assign it back.

```
DECLARE Name : STRING
Name ← "Happy"
Name ← UCASE(Name)
OUTPUT Name
```

5.1.1 Comparing without worrying about case

`UCASE` on both sides is the standard way to accept an answer however it was typed:

```
DECLARE Answer : STRING
Answer ← "yes"
IF UCASE(Answer) = "YES"
  THEN
    OUTPUT "Accepted"
ENDIF
```

Common mistakes

- Expecting `UCASE(Name)` to change `Name`. Assign the result back.
- `LENGTH` counts characters, not words. `LENGTH("Happy Days")` is 10.

5.2 SUBSTRING

`SUBSTRING(<identifier>, <start>, <length>)` pulls a piece out of a string — starting at position `start`, taking `length` characters.

```
OUTPUT SUBSTRING("Happy Days", 1, 5)
OUTPUT SUBSTRING("Happy Days", 7, 4)
```

△ **Counting starts at 1**, not 0. The first character of `"Happy Days"` is at position 1.

5.2.1 Taking one character, and the rest

```
DECLARE Word : STRING
Word ← "Computer"
OUTPUT "First letter: ", SUBSTRING(Word, 1, 1)
OUTPUT "Last letter: ", SUBSTRING(Word, LENGTH(Word), 1)
OUTPUT "Without the first: ", SUBSTRING(Word, 2, LENGTH(Word) - 1)
```

`LENGTH` inside `SUBSTRING` is what makes the last two lines work for a word of any size — hard-coding `8` would break the moment the word changed.

5.2.2 Reading a string one character at a time

```
DECLARE Word : STRING
DECLARE Index : INTEGER
Word ← "Cat"
FOR Index ← 1 TO LENGTH(Word)
    OUTPUT SUBSTRING(Word, Index, 1)
NEXT Index
```

Common mistakes

- Starting at 0. Position 1 is the first character.
- Reading the third argument as an *end position*. It is a **count** — `SUBSTRING(W, 2, 3)` takes three characters beginning at the second.
- Asking for more characters than the string has.

6 Selection

6.1 IF, THEN, ELSE, ENDIF

Selection 选择 runs one group of statements or another, depending on a condition 条件.

```
IF <condition>
  THEN
    <statements>
ENDIF
```

```
DECLARE Mark : INTEGER
Mark ← 72
IF Mark >= 50
  THEN
    OUTPUT "Pass"
ENDIF
```

Add `ELSE` for the other case. Exactly one of the two branches 分支 runs — never both, never neither.

```
DECLARE Mark : INTEGER
Mark ← 41
IF Mark >= 50
  THEN
    OUTPUT "Pass"
  ELSE
    OUTPUT "Fail"
ENDIF
```

The layout is the one part students lose marks on, so learn it as a shape:

- `IF` and its condition on one line, **nothing after the condition**.
- `THEN` and `ELSE` on their own lines, indented **two** spaces.
- The statements indented **four**.
- `ENDIF` back at the column of its `IF`.

6.1.1 Nesting 嵌套

An `IF` inside an `IF` handles more than two outcomes. Each one needs its own `ENDIF`.

```
DECLARE Mark : INTEGER
Mark ← 85
IF Mark >= 80
  THEN
    OUTPUT "Distinction"
  ELSE
    IF Mark >= 50
      THEN
        OUTPUT "Pass"
      ELSE
        OUTPUT "Fail"
    ENDIF
ENDIF
```

Common mistakes

- Forgetting `ENDIF`. Every `IF` closes, and a missing one is a syntax error 语法错误 the marker will see at a glance.
- `IF Mark >= 50 THEN OUTPUT "Pass"` on one line. **No such form exists** in either syllabus; write the three lines.
- `IF Mark = 50 THEN` written as `IF Mark ← 50`. The arrow assigns; `=` compares.

6.2 CASE OF

When one variable is tested against several **single values**, `CASE OF` says it far more clearly than a stack of nested `IF`s.

```
CASE OF <identifier>
    <value 1> : <statement>
    <value 2> : <statement>
    OTHERWISE <statement>
ENDCASE
```

```
DECLARE Choice : INTEGER
Choice ← 2
CASE OF Choice
    1 : OUTPUT "You chose north"
    2 : OUTPUT "You chose south"
    3 : OUTPUT "You chose east"
    4 : OUTPUT "You chose west"
    OTHERWISE OUTPUT "That is not a direction"
ENDCASE
```

- Each branch is a **value**, a colon, then what to do.
- `OTHERWISE` catches everything the listed values missed. It is optional, and writing one is good practice — it is what happens when the user types something unexpected.
- The first matching branch runs, and the rest are skipped.

6.2.1 A range, and a character

```
DECLARE Grade : CHAR
Grade ← 'B'
CASE OF Grade
    'A' : OUTPUT "Excellent"
    'B' : OUTPUT "Good"
    'C' : OUTPUT "Satisfactory"
    OTHERWISE OUTPUT "Unclassified"
ENDCASE
```

Common mistakes

- Using `CASE OF` for a **condition**. It tests one variable against values; `Mark >= 50` needs an `IF`.
- Forgetting `ENDCASE`.
- Leaving out `OTHERWISE` and then wondering why an unexpected value does nothing at all.

7 Iteration

7.1 FOR, the counted loop

Iteration 迭代 repeats statements. Use a `FOR` loop when you know **before you start** how many times — a count-controlled 计数控制 loop.

```
FOR <identifier> ← <value1> TO <value2>
    <statements>
NEXT <identifier>
```

```
DECLARE Index : INTEGER
FOR Index ← 1 TO 5
    OUTPUT "Line ", Index
NEXT Index
```

The counter 计数器 starts at the first value, and the loop runs once for every value up to and **including** the second. `1 TO 5` runs five times.

7.1.1 STEP

`STEP` changes the size of each jump. A negative step counts down.

```
DECLARE Index : INTEGER
FOR Index ← 2 TO 10 STEP 2
    OUTPUT Index
NEXT Index
FOR Index ← 3 TO 1 STEP -1
    OUTPUT "Countdown ", Index
NEXT Index
```

7.1.2 Running totals

The commonest use: a variable outside the loop that the loop adds to.

```
DECLARE Index, Total : INTEGER
Total ← 0
FOR Index ← 1 TO 10
    Total ← Total + Index
NEXT Index
OUTPUT "Sum of 1 to 10 is ", Total
```

`Total ← 0` must sit **before** the loop. Inside, it would reset on every pass.

Common mistakes

- `NEXT` naming the wrong counter. Nested loops must close in the reverse order they opened: the inner `NEXT` first.
- Assuming `1 TO 5` runs four times. Both ends are included.
- Changing the counter inside the loop. Let `FOR` own it.

7.2 WHILE, the pre-condition loop

A `WHILE` loop tests **before** each pass, so it can run **zero** times. Use it when the number of repeats depends on something that happens while the loop runs.

```
WHILE <condition> DO
    <statements>
ENDWHILE
```

```
DECLARE Total : INTEGER
Total ← 1
WHILE Total < 100 DO
    Total ← Total * 2
ENDWHILE
OUTPUT "First power of two past 100: ", Total
```

Something inside the loop must eventually make the condition false, or the loop never ends — an **infinite loop** 无限循环.

```
DECLARE Count : INTEGER
Count ← 5
WHILE Count > 0 DO
    OUTPUT Count
    Count ← Count - 1
ENDWHILE
OUTPUT "Lift off"
```

Common mistakes

- Forgetting to change the variable the condition tests, giving an infinite loop.
- Leaving out `DO` or `ENDWHILE`.
- Using `WHILE` where the count is known. A `FOR` says what you mean in one line.

7.3 REPEAT, the post-condition loop

A `REPEAT` loop tests **after** each pass, so it always runs **at least once**.

```
REPEAT
    <statements>
UNTIL <condition>
```

That "at least once" is the reason to choose it: validating 验证 input, where you must ask before you can judge the answer.

```
DECLARE Number : INTEGER
Number ← 0
REPEAT
    Number ← Number + 25
    OUTPUT "Trying ", Number
UNTIL Number >= 100
OUTPUT "Reached ", Number
```

△ `UNTIL` states the condition that **stops** the loop; `WHILE` states the one that **keeps it going**. They are opposites, and swapping them is the classic error.

	Tests	Runs at least once?	Condition means
`FOR`	a counter	no (an empty range runs zero times)	—
`WHILE`	before	no	keep going while this is true
`REPEAT`	after	**yes**	stop when this becomes true

Common mistakes

- Writing `UNTIL Number < 100` when you mean `UNTIL Number >= 100`.
- Using `REPEAT` where the body must be able to run zero times.
- Forgetting that `UNTIL` ends the structure — there is no `ENDREPEAT`.

8 Arrays

8.1 One-dimensional arrays

An **array** 数组 holds many values of one type under one name. Each value sits at an **index** 下标.

```
DECLARE <identifier> : ARRAY[<lower>:<upper>] OF <data type>
```

```
DECLARE Names : ARRAY[1:3] OF STRING
Names[1] ← "Mei"
Names[2] ← "Sam"
Names[3] ← "Ana"
OUTPUT Names[2]
```

- The bounds 边界 are written `lower:upper`, and **both are included** — `[1:3]` has three elements 元素.
- Cambridge arrays normally start at **1**, not 0.
- Every element has the same type, fixed by `OF`.

8.1.1 Filling and reading with a FOR loop

An array and a counted loop belong together: the counter is the index.

```
DECLARE Scores : ARRAY[1:5] OF INTEGER
DECLARE Index, Total : INTEGER
FOR Index ← 1 TO 5
    Scores[Index] ← Index * 10
NEXT Index
Total ← 0
FOR Index ← 1 TO 5
    Total ← Total + Scores[Index]
NEXT Index
OUTPUT "Total: ", Total
OUTPUT "Mean: ", Total / 5
```

8.1.2 Finding the largest

```
DECLARE Scores : ARRAY[1:5] OF INTEGER
DECLARE Index, Largest : INTEGER
Scores[1] ← 42
Scores[2] ← 17
Scores[3] ← 93
Scores[4] ← 8
Scores[5] ← 55
Largest ← Scores[1]
FOR Index ← 2 TO 5
    IF Scores[Index] > Largest
      THEN
        Largest ← Scores[Index]
    ENDIF
NEXT Index
OUTPUT "Largest: ", Largest
```

Start `Largest` at the **first element**, never at 0 — with negative data, 0 would win and the answer would be wrong.

Common mistakes

- Reading `Scores[6]` from an array declared `[1:5]`. That is out of bounds 越界.
- Writing `Scores(3)`. Arrays use square brackets; round brackets call a function.
- Declaring `[1:5]` and then looping `0 TO 4`.

8.2 Two-dimensional arrays

A **2-D array** 二维数组 is a table: rows and columns, two indexes.

```
DECLARE <identifier> : ARRAY[<lower1>:<upper1>, <lower2>:<upper2>] OF
↪  <data type>
```

```
DECLARE Grid : ARRAY[1:2, 1:3] OF INTEGER
Grid[1,1] ← 1
Grid[1,2] ← 2
Grid[1,3] ← 3
Grid[2,1] ← 4
Grid[2,2] ← 5
Grid[2,3] ← 6
OUTPUT Grid[2,3]
```

The **first** index is the row 行, the **second** the column 列.

8.2.1 Nested loops walk a table

One loop per dimension 维度. The inner loop finishes a whole row before the outer moves on.

```
DECLARE Grid : ARRAY[1:2, 1:3] OF INTEGER
DECLARE Row, Col : INTEGER
FOR Row ← 1 TO 2
    FOR Col ← 1 TO 3
        Grid[Row, Col] ← Row * Col
    NEXT Col
NEXT Row
FOR Row ← 1 TO 2
    FOR Col ← 1 TO 3
        OUTPUT "Grid[", Row, ",", Col, "] = ", Grid[Row, Col]
    NEXT Col
NEXT Row
```

△ The inner `NEXT` closes the **inner** counter. `NEXT Row` before `NEXT Col` crosses the loops over and is nonsense — a marker spots it instantly.

Common mistakes

- Swapping row and column. `Grid[2,3]` is row 2, column 3.
- `Grid[Row][Col]`. Cambridge writes **one** pair of brackets with a comma inside.
- Crossing the `NEXT` lines over, as above.

9 Procedures and functions

9.1 PROCEDURE and CALL

A **procedure** 过程 is a named block of statements. Writing one once and calling it from several places is **decomposition** 分解 — the idea the whole of paper 2 rests on.

```
PROCEDURE <identifier>
    <statements>
ENDPROCEDURE
```

A procedure is **called** by name, with the keyword `CALL`:

```
PROCEDURE DefaultLine
    OUTPUT "------------------------------"
ENDPROCEDURE

CALL DefaultLine
OUTPUT "Report"
CALL DefaultLine
```

- The definition 定义 does nothing on its own. Only `CALL` runs it.
- Control returns to the line after the `CALL` when the procedure ends.
- A procedure **does not give a value back**. If you need one, you want a function.

Common mistakes

- Writing `DefaultLine` on its own to run it. 0478 requires `CALL`.
- Leaving out `ENDPROCEDURE`.
- Expecting the procedure's own variables to exist outside it.

9.2 FUNCTION and RETURN

A **function** 函数 is a procedure that hands a value back. It is written where that value is needed — inside an `OUTPUT`, on the right of an assignment, inside a condition.

```
FUNCTION <identifier>(<parameters>) RETURNS <data type>
    <statements>
    RETURN <value>
ENDFUNCTION
```

```
FUNCTION SumSquare(Number1 : INTEGER, Number2 : INTEGER) RETURNS INTEGER
    RETURN Number1 * Number1 + Number2 * Number2
ENDFUNCTION

OUTPUT "Sum of squares = ", SumSquare(10, 20)
```

- `RETURNS <data type>` on the header says what type comes back. It is not optional.
- `RETURN` ends the function **immediately** — nothing after it runs.
- A function is **never** called with `CALL`; it is used wherever its value belongs.

9.2.1 A function inside a condition

```
FUNCTION IsEven(Number : INTEGER) RETURNS BOOLEAN
    RETURN MOD(Number, 2) = 0
ENDFUNCTION

DECLARE Index : INTEGER
FOR Index ← 1 TO 6
    IF IsEven(Index)
      THEN
        OUTPUT Index, " is even"
    ENDIF
NEXT Index
```

Common mistakes

- `CALL SumSquare(10, 20)` — that throws the answer away.
- A function with no `RETURN` on some path. Every route out must return a value.
- Leaving `RETURNS INTEGER` off the header.

9.3 Parameters

A **parameter** 参数 is a value a procedure or function is given when it is called. Each one carries its own type.

```
PROCEDURE Line(Size : INTEGER)
    DECLARE Index : INTEGER
    FOR Index ← 1 TO Size
        OUTPUT "-"
    NEXT Index
ENDPROCEDURE

CALL Line(5)
CALL Line(20)
```

Several parameters are separated by commas, and the order at the call must match the order in the definition:

```
PROCEDURE Greet(Name : STRING, Times : INTEGER)
    DECLARE Index : INTEGER
    FOR Index ← 1 TO Times
        OUTPUT "Hello ", Name
    NEXT Index
ENDPROCEDURE

CALL Greet("Mei", 2)
CALL Greet("Sam", 1)
```

△ In **0478 every parameter is passed by value** 传值: the procedure works on a copy, so changing it inside changes nothing outside. To get a value back, use a `FUNCTION` and `RETURN` it. (A-Level 9618 adds `BYREF` for the other behaviour — topic 11.)

```
FUNCTION Doubled(Number : INTEGER) RETURNS INTEGER
    RETURN Number * 2
ENDFUNCTION

DECLARE Value : INTEGER
Value ← 7
Value ← Doubled(Value)
OUTPUT Value
```

Common mistakes

- `PROCEDURE Line(Size)` with no type.

- Calling with the arguments in the wrong order — `Greet(2, "Mei")` is a type error.
- Expecting a procedure to change the variable you passed in. In 0478 it cannot.

10 File handling

10.1 Writing to a file

A file 文件 keeps data after the program ends. 0478 uses four commands, and every one names the file it works on.

```
OPENFILE <file identifier> FOR WRITE
WRITEFILE <file identifier>, <data>
CLOSEFILE <file identifier>
```

```
OPENFILE "names.txt" FOR WRITE
WRITEFILE "names.txt", "Mei"
WRITEFILE "names.txt", "Sam"
CLOSEFILE "names.txt"
OUTPUT "Saved"
```

Three **file modes** 文件模式:

Mode	What it does
`WRITE`	start a new file — **anything already there is lost**
`APPEND`	add to the end of what is there 追加
`READ`	read from the start

```
OPENFILE "log.txt" FOR WRITE
WRITEFILE "log.txt", "first"
CLOSEFILE "log.txt"
OPENFILE "log.txt" FOR APPEND
WRITEFILE "log.txt", "second"
CLOSEFILE "log.txt"
OUTPUT "Both lines saved"
```

- One `WRITEFILE` writes **one line**.
- `CLOSEFILE` is not optional. An unclosed file can lose the data still waiting to be written, and that is a stock exam answer.

Common mistakes

- `FOR WRITE` when you meant `FOR APPEND`, which silently destroys the old contents.
- Forgetting `CLOSEFILE`.
- Opening a file that is already open.

10.2 Reading a file to the end

`READFILE` takes one line into a variable. The variable must be declared first.

```
OPENFILE <file identifier> FOR READ
READFILE <file identifier>, <variable>
CLOSEFILE <file identifier>
```

Normally you do not know how many lines there are, so you read **until the end of the file** — which is what the `EOF` function reports.

```
OPENFILE "names.txt" FOR WRITE
WRITEFILE "names.txt", "Mei"
WRITEFILE "names.txt", "Sam"
WRITEFILE "names.txt", "Ana"
CLOSEFILE "names.txt"

DECLARE Line : STRING
OPENFILE "names.txt" FOR READ
WHILE NOT EOF("names.txt") DO
    READFILE "names.txt", Line
    OUTPUT Line
ENDWHILE
CLOSEFILE "names.txt"
```

`EOF("names.txt")` is `TRUE` once every line has been read, so `WHILE NOT EOF(...)` means *while there is still something to read.*

10.2.1 Counting while reading

```
OPENFILE "marks.txt" FOR WRITE
WRITEFILE "marks.txt", 40
WRITEFILE "marks.txt", 65
WRITEFILE "marks.txt", 88
CLOSEFILE "marks.txt"

DECLARE Mark, Count, Total : INTEGER
Count ← 0
Total ← 0
OPENFILE "marks.txt" FOR READ
WHILE NOT EOF("marks.txt") DO
    READFILE "marks.txt", Mark
    Count ← Count + 1
    Total ← Total + Mark
ENDWHILE
CLOSEFILE "marks.txt"
OUTPUT Count, " marks, mean ", Total / Count
```

Common mistakes

- A `WHILE EOF(...)` loop — that runs only when there is nothing left. You want `NOT`.
- Reading past the end because the loop has no `EOF` guard.
- Opening `FOR READ` a file that was never written.

11 A-Level 9618: what changes

11.1 Layout and operators

Cambridge publishes **two** pseudocode specifications, and they disagree. Everything in topics 1-10 is **IGCSE 0478**. A-Level **9618** changes the details below — and a student who studies both loses marks by writing one in the other's paper.

	IGCSE 0478	**A-Level 9618**
`THEN`	on its **own line**, indented 2	on the **`IF` line**
constants	`CONSTANT Pi ← 3.142`	`CONSTANT Pi = 3.142`
`DIV` / `MOD`	functions: `DIV(10, 3)`	operators: `10 DIV 3`
joining strings	commas in `OUTPUT`	the `&` operator
identifiers	must start with a **capital**	mixed case allowed 混合大小写
`NEXT`	must name its counter	good practice
`ROUND`, `RANDOM()`	both published	**neither** exists

This is the 0478 form, and it runs here:

```
DECLARE Total : REAL
CONSTANT Rate ← 0.5
Total ← 10
IF MOD(7, 2) = 1
  THEN
    OUTPUT "Odd, half rate ", Total * Rate
ENDIF
```

The 9618 form of the same algorithm is written like this — note `THEN` on the `IF` line, `=` in the `CONSTANT`, and `MOD` between its two values:

```
DECLARE Total : REAL
CONSTANT Rate = 0.5
Total ← 10
IF 7 MOD 2 = 1 THEN
    OUTPUT "Odd, half rate " & STR(Total * Rate)
ENDIF
```

△ **Which one is right depends only on which paper you are sitting.** Neither is a mistake; each is a mistake in the other's exam. The playground on this page runs the **0478** rules, so a 9618 construct is refused with a message naming the syllabus it belongs to — which is a quick way to check your own habits.

Common mistakes

- Writing `THEN` on the `IF` line in an 0478 answer, because that is what a textbook or

a website showed. It is the single commonest cross-syllabus slip.
- `10 MOD 3` in 0478. There it is `MOD(10, 3)`.
- `ROUND(3.14159, 2)` in a 9618 answer. 9618 has no `ROUND` at all.

11.2 Parameters: BYVAL and BYREF

0478 passes **every** parameter by value 传值 (topic 9). 9618 lets you choose, and says so in the header.

- `BYVAL` — the procedure gets a **copy**. Changing it changes nothing outside. This is the default when neither word is written.
- `BYREF` — the procedure works on the caller's **own variable** 引用, so a change is visible after the call.

This is 9618 only. It does not run here, and it is not accepted in an 0478 answer:

```
PROCEDURE Increase(BYREF Value : INTEGER)
    Value ← Value + 1
ENDPROCEDURE

DECLARE Count : INTEGER
Count ← 5
CALL Increase(Count)
OUTPUT Count      // prints 6
```

11.2.1 The 0478 way to get a value back

Use a `FUNCTION` and assign what it returns. This is the whole of the 0478 answer, and it runs:

```
FUNCTION Increased(Value : INTEGER) RETURNS INTEGER
    RETURN Value + 1
ENDFUNCTION

DECLARE Count : INTEGER
Count ← 5
Count ← Increased(Count)
OUTPUT Count
```

Common mistakes

- Writing `BYREF` in an 0478 answer. The keyword is not in that syllabus.
- Expecting a plain 9618 parameter to behave like `BYREF`. Without the word it is `BYVAL`.

11.3 Records and other types

9618 has data structures 数据结构 that 0478 does not. You will meet them only at A-Level, and none of them runs under the 0478 rules of this page.

A **record** 记录 groups fields of different types under one name (9618 section 4):

```
TYPE Student
    DECLARE Name : STRING
    DECLARE Mark : INTEGER
ENDTYPE

DECLARE Candidate : Student
Candidate.Name ← "Mei"
Candidate.Mark ← 91
OUTPUT Candidate.Name, " scored ", Candidate.Mark
```

An **enumerated type** 枚举类型 lists the only values a variable may take:

```
TYPE Vehicle = (Car, Bus, Taxi)
DECLARE MyRide : Vehicle
MyRide ← Taxi
```

9618 also adds a `DATE` data type, random-access files (`OPENFILE … FOR RANDOM`), pointers, and classes with `CLASS … ENDCLASS` for its object-oriented paper.

△ 0478 has **five** data types and arrays, and nothing else (topic 2). A 0478 answer that declares a record is answering a different syllabus.

Common mistakes

- Using a record in an 0478 answer. Use parallel arrays instead — one array per field, sharing an index.
- Thinking `TYPE` means the same as `DECLARE`. `TYPE` defines a **new type**; `DECLARE` creates a **variable** of an existing one.