11.3.1 Functions, and choosing between a procedure and a function

Name: _____ Class: _____ Date: _____ **Total: 46 marks**

KEY WORDS function • return value • interface • parameter • argument

Objective

Learn to define and to use a **function** : a module that works out **one value** and **returns** it to the statement that called it. You also learn to choose between a procedure and a function, and to use the correct words for the parts of a module. Sheet 11.3 taught procedures; sheet 11.3.2 deals with passing parameters by value and by reference.

You must be able to:

- define a function with `FUNCTION … RETURNS … ENDFUNCTION`, and return a value with `RETURN`
- call a function inside an expression
- explain where in an algorithm it is appropriate to use a function, and where a procedure
- use the terms **header**, **interface** , **parameter** , **argument** and **return value**

1 Worked examples

Study these first. Each one shows a **method** that a question later on this sheet needs.

What a function is

A **function** is a module that **returns a value**. You have used built-in functions such as `LENGTH()`; now you write your own.

```
FUNCTION Square(Number : INTEGER) RETURNS INTEGER
    RETURN Number * Number
ENDFUNCTION

Result ← Square(5) + 1
OUTPUT Square(3)
```

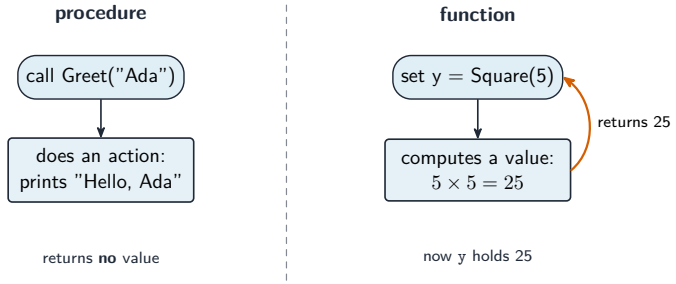
- The header ends with `RETURNS` and the **data type** of the value that comes back.
- `RETURN` gives the value back and **ends** the function.
- A function is **not** called with `CALL`. It is used **inside an expression**, and the **return value replaces the call**: `Square(5) + 1` becomes `25 + 1`, so `Result` is 26; `OUTPUT Square(3)` outputs 9.

A function that **outputs** its answer instead of returning it is wrong: `Result ← Square(5)` would have nothing to store.

Procedure or function?

Ask one question: **does the caller need a value back?**

- **No, it only needs something done** (display a menu, print a report) → a **procedure**, called on a line of its own with `CALL`.
- **Yes, it uses one value that the module works out** (a total, a grade, TRUE or FALSE) → a **function**, used inside an expression: `IF IsValid(Code) THEN`.



The words the mark scheme uses

```
FUNCTION Area(SideLength : REAL, Width : REAL) RETURNS REAL     ← header
    RETURN SideLength * Width                                   ← return
    ↪  value
ENDFUNCTION

Total ← Area(3.5, 2.0)                                          ← call, with
↪  arguments
```

- **header**: the first line: the keyword, the name, the parameters and, for a function, `RETURNS` and its type
- **interface**: what a caller must know: the name, the parameters with their types and order, and what is returned
- **parameter**: the variable **inside** the module that receives a value: `SideLength`, `Width`
- **argument**: the value that the **caller** supplies: `3.5`, `2.0`
- **return value**: the value handed back, which replaces the call in the expression: here `7.0`

The parameter is in the **definition**; the argument is in the **call**. If you say it the

other way round, you lose the mark.

■ Writing a function that scores

A "write a function" question is marked point by point. Write the points in this order:

1. the **header**: keyword, name, every parameter with its type, and `RETURNS <type>`;
2. **declare the local variables**, including a loop counter;
3. **initialise** any total, count or string **before** a loop;
4. the **loop** and the **test** inside it, using the **parameter**, not a fixed value;
5. **close** every construct: `ENDIF`, `NEXT`, `ENDWHILE`, `ENDFUNCTION`;
6. `RETURN` the result.

```
FUNCTION CountAbove(BYVAL Limit : INTEGER) RETURNS INTEGER
    DECLARE Index, Count : INTEGER
    Count ← 0
    FOR Index ← 1 TO 50
        IF Score[Index] > Limit THEN
            Count ← Count + 1
        ENDIF
    NEXT Index
    RETURN Count
ENDFUNCTION
```

header: name, parameters, return type
local variables declared with a type
total initialised before the loop
loop over every element
the condition, with the right boundary
the update, inside the IF
every construct closed
the return value, after the loop

Worked example: write a function ***`IsLeap`*** *that takes a year and returns TRUE if it is a leap year. A year is a leap year when it divides by 4, except that a century year must divide by 400.*

```
FUNCTION IsLeap(Year : INTEGER) RETURNS BOOLEAN
    IF Year MOD 400 = 0 THEN
        RETURN TRUE
    ENDIF
    IF Year MOD 100 = 0 THEN
        RETURN FALSE
    ENDIF
    IF Year MOD 4 = 0 THEN
        RETURN TRUE
    ENDIF
    RETURN FALSE
ENDFUNCTION
```

`RETURN` ends the function at once, so the tests are written in order of priority and no nested `IF` is needed. The call is then used as a value, for example as the condition of an `IF`: `IsLeap(2028)`.

2 Practice

Now use the methods above. The first questions need one idea each.

2.1 State **one** difference between a **procedure** and a **function**. [1]

procedure | function

2.2 Study this pseudocode.

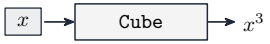
```
FUNCTION Double(Number : INTEGER) RETURNS INTEGER
    RETURN Number * 2
ENDFUNCTION

Value ← Double(4) + Double(1)
OUTPUT Value
```

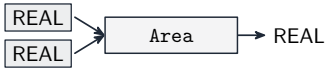
(a) State the value that is output. [1]

(b) State the **return value** of the call `Double(4)`. [1]

2.3 Define a function `Cube(x)` that returns `x` cubed. [2]



2.4 Write the **header** for a function `Area` that takes two real numbers and returns a real number. [2]

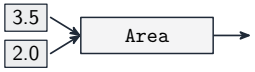


2.5 State the difference between an **argument** and a **parameter**. [2]

```
FUNCTION Area(SideLength : REAL, Width : REAL)
```

```
Area(3.5, 2.0)
```

2.6 A program contains the statement `Total ← Area(3.5, 2.0)`. State the **arguments** in this call, and state what the **return value** replaces. [2]



2.7 A student writes this function. It should give back the larger of two numbers.

```
FUNCTION Larger(First : INTEGER, Second : INTEGER) RETURNS INTEGER
    IF First > Second THEN
        OUTPUT First
    ELSE
        OUTPUT Second
    ENDIF
ENDFUNCTION
```

State the error, and state how to correct it. [2]

2.8 For each task, state whether a **procedure** or a **function** is the better choice, and give a reason.

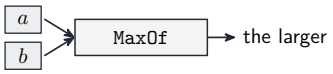
(a) display a menu of options on the screen [1]

(b) work out the discount on a price [1]

(c) exchange the values of two variables [1]

3 Exam-style questions

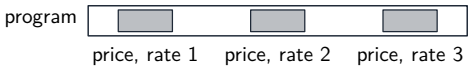
3.1 Write a **function** `MaxOf(a, b)` that returns the larger of two integers. [3]



3.2 Explain what is meant by the **interface** of a function. [2]

3.3 A program works out a discounted price in three different places. The same three lines of code are used each time, but on different prices and rates. The programmer decides to replace them with a function `Discount()`.

(a) Write the **header** for `Discount()`. [2]

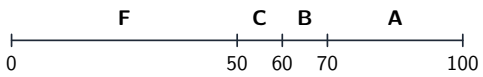


(b) Write the statement that calls `Discount()` for a price of `80.00` at a rate of `15`, storing the result in `Final`. [1]

(c) State why a **function** suits this better than a procedure. [1]

3.4 A function `Grade()` takes an integer mark from 0 to 100 and returns a grade as a string: `"A"` for 70 or more, `"B"` for 60 or more, `"C"` for 50 or more, and `"F"` below 50.

Write the function, and write it so that no mark is tested more than it needs to be. [5]



3.5 Write a **function** `Initials()` that takes a person's full name as a string of two or more words separated by single spaces, and returns a string of their initials in capitals with no spaces. For example, `"ada byron lovelace"` returns `"ABL"`.

You may use `LENGTH`, `MID` and `UCASE`. [6]

3.6 A cinema program works out the price of a ticket. A ticket costs 12.00. A customer under 16 pays half. On a Tuesday, every customer gets 2.00 off the price (after the half price, if there is one).

(a) Write a function `TicketPrice` that takes the customer's age and a Boolean value that is TRUE on a Tuesday, and returns the price of the ticket. [6]

(b) Write a statement that uses your function to store, in `Total`, the price of one ticket for a customer aged 12 **plus** one ticket for a customer aged 40, on a day that is not a Tuesday. [2]

(c) **Explain** why `TicketPrice` is better written as a function than as a procedure. [2]