



Cambridge International AS & A Level

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COMPUTER SCIENCE

9608/23

Paper 2 Fundamental Problem-solving and Programming Skills

October/November 2020

2 hours

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use an HB pencil for any diagrams, graphs or rough working.
- Calculators must **not** be used in this paper.

INFORMATION

- The total mark for this paper is 75.
- The number of marks for each question or part question is shown in brackets [].
- No marks will be awarded for using brand names of software packages or hardware.

This document has **16** pages. Blank pages are indicated.

- 1 (a) A programmer uses the process of stepwise refinement to break down a problem.

Explain the purpose of stepwise refinement.

.....

 [2]

- (b) Programming languages support different data types. These usually include `STRING` and `REAL`.

Complete the table by giving **four other** data types **and** an example data value for each.

Data type	Example data value

[4]

- (c) An experienced programmer is working on a program that is written in a language she is not familiar with.

- (i) State **one** feature of the program that she should be able to recognise.

.....
 [1]

- (ii) State the type of skill that would allow her to recognise this feature.

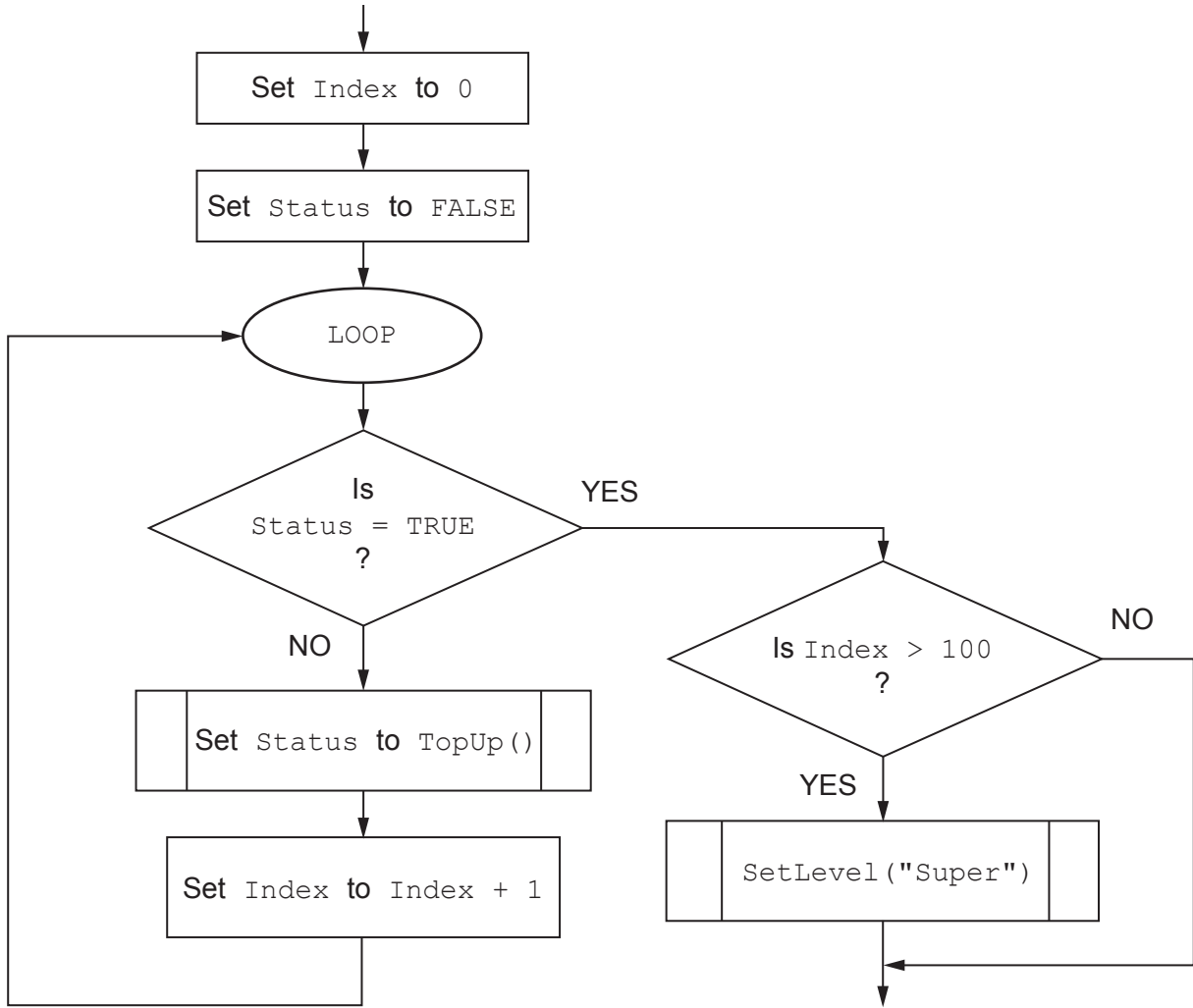
.....
 [1]

- (d) Give **three** methods that may be used to identify and locate errors in a program **after it has been written**.

You may include **one** feature found in a typical Integrated Development Environment (IDE).

1
 2
 3 [3]

(c) Part of a program flowchart is shown.



Write **program code** to implement the flowchart shown. Variable declarations are not required.

Programming language

Program code

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- 3 A global 1D array, `ProdNum`, of type `INTEGER` contains 5000 elements and is used to store product numbers.

A procedure is needed to sort `ProdNum` into ascending order using a bubble sort algorithm.

Write **program code** for the procedure `BubbleSort ()`.

Visual Basic and Pascal: You should include the declaration statements for variables.

Python: You should show a comment statement for each variable used with its data type.

Programming language

Program code

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- 4 (a) The following pseudocode includes a procedure that searches for a value in a 1D array and outputs each position in the array where the value is found.

Refer to the **Appendix** on page 16 for the list of built-in functions and operators.

```

DECLARE NameList : ARRAY [1:100] OF STRING
DECLARE SearchString : STRING

PROCEDURE Search()
  DECLARE Index : INTEGER

  FOR Index ← 1 TO 100
    IF NameList[Index] = SearchString
      THEN
        OUTPUT "Found at " & NUM_TO_STRING(Index)
      ENDIF
    ENDFOR
  ENDPROCEDURE

```

The specification of module `Search()` changes. The pseudocode needs to be amended to meet a new requirement.

The procedure needs to be implemented as a function, `Search()`, which will:

- take the search value as a parameter
- return an integer which is:
 - either the index value where the search value is **first** found
 - or `-1` if the search value is **not** found.

Write the **pseudocode** for the function `Search()`.

..... [6]

(b) A change to the specification in **part (a)** required a modification of the algorithm.

Give the term used for this type of modification.

..... [1]

(c) A change to the specification is only one reason to modify an algorithm.

Give **another** reason for the modification of an algorithm.

..... [1]

(d) Consider the following pseudocode:

```

10 DECLARE VarA : INTEGER
11 VarA ← 20
12
13 CALL ProcA(VarA)
14 OUTPUT VarA      // first value output
15
16 CALL ProcB(VarA)
17 OUTPUT VarA      // second value output
18
19
20 PROCEDURE ProcA(BYVALUE ThisValue : INTEGER)
21     ThisValue ← ThisValue + 5
22 ENDPROCEDURE
23
24 PROCEDURE ProcB(BYREF ThisValue : INTEGER)
25     ThisValue ← ThisValue + 5
26 ENDPROCEDURE

```

Procedures `ProcA()` and `ProcB()` use two methods of passing parameters.

Complete the following table.

	Output	Explanation
First value (line 14)
Second value (line 17)

[4]

(e) The procedures `ProcA` and `ProcB` in **part (d)** are examples of program modules.

Give **two** advantages of using program modules in program design.

1

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2

.....

[2]

- 5 A hashtag is used on a social media network to make it easier to find messages with a specific theme or content. A hashtag is a string consisting of a hash character '#' followed by a number of alphanumeric characters.

A message may contain several hashtag strings. A hashtag may be terminated by a space character, the start of the next hashtag, or by the end of the message.

For example, the following message contains three hashtags:

```
"#Alarm34 is the result of #BatteryFailure in the #PowerModule"
```

The hashtags in this message are "#Alarm34", "#BatteryFailure" and "#PowerModule".

A program is being developed to monitor their use.

The program will include two global arrays each containing 10 000 elements:

- A 1D array, `TagString`, of type `STRING` storing each hashtag in a single element of the array. All unused array elements contain an empty string ("").
- A 1D array, `TagCount`, of type `INTEGER` storing a count of the number of times each hashtag is used. The count value in a given element relates to the hashtag value stored in the element in the `TagString` array with the corresponding index value.

A developer has started to define the modules. Module `GetStart()` has already been written.

Module	Description
<code>GetStart()</code>	<ul style="list-style-type: none"> • Called with two parameters: <ul style="list-style-type: none"> ◦ a message of type <code>STRING</code> ◦ an integer giving the number of the required hashtag; for example, <code>GetStart(Message, 3)</code> would search for the third hashtag in the string <code>Message</code> • Returns an integer value representing the start position of the hashtag in the message, or value <code>-1</code> if that hashtag does not exist
<code>AddHashtag()</code>	<ul style="list-style-type: none"> • Called with a hashtag of type <code>STRING</code> • Copies the hashtag to the next free element of the <code>TagString</code> array, and sets the corresponding element of the <code>TagCount</code> array to 1 • Returns <code>FALSE</code> if there are no unused elements in the <code>TagString</code> array, otherwise returns <code>TRUE</code>
<code>CountHashtag()</code>	<ul style="list-style-type: none"> • Called with a message of type <code>STRING</code> • Searches the message for hashtags using <code>GetStart()</code> • Returns a value representing the number of hashtags in the message
<code>IncrementHashtag()</code>	<ul style="list-style-type: none"> • Called with a hashtag of type <code>STRING</code> • Increments the value of the appropriate element in the <code>TagCount</code> array if the hashtag is found • Returns <code>TRUE</code> if the hashtag is found, or <code>FALSE</code> if the hashtag is not found

(c) Write **program code** for the module `IncrementHashtag()`.

The module description is repeated here for reference.

Module	Description
<code>IncrementHashtag()</code>	<ul style="list-style-type: none">• Called with a hashtag of type <code>STRING</code>• Increments the value of the appropriate element in the <code>TagCount</code> array if the hashtag is found• Returns <code>TRUE</code> if the hashtag is found, or <code>FALSE</code> if the hashtag is not found

Visual Basic and Pascal: You should include the declaration statements for variables.
Python: You should show a comment statement for each variable used with its data type.

Programming language

Program code

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Appendix

Built-in functions (pseudocode)

Each function returns an error if the function call is not properly formed.

`LENGTH(ThisString : STRING)` RETURNS INTEGER
returns the integer value representing the length of string `ThisString`

Example: `LENGTH("Happy Days")` returns 10

`LEFT(ThisString : STRING, x : INTEGER)` RETURNS STRING
returns leftmost `x` characters from `ThisString`

Example: `LEFT("ABCDEFGH", 3)` returns string "ABC"

`RIGHT(ThisString: STRING, x : INTEGER)` RETURNS STRING
returns rightmost `x` characters from `ThisString`

Example: `RIGHT("ABCDEFGH", 3)` returns string "FGH"

`MID(ThisString : STRING, x : INTEGER, y : INTEGER)` RETURNS STRING
returns a string of length `y` starting at position `x` from `ThisString`

Example: `MID("ABCDEFGH", 2, 3)` returns string "BCD"

`INT(x : REAL)` RETURNS INTEGER
returns the integer part of `x`

Example: `INT(27.5415)` returns 27

`NUM_TO_STRING(x : REAL)` RETURNS STRING
returns a string representation of a numeric value.
Note: This function will also work if `x` is of type `INTEGER`

Example: `NUM_TO_STRING(87.5)` returns "87.5"

Operators (pseudocode)

Operator	Description
&	Concatenates (joins) two strings Example: "Summer" & " " & "Pudding" produces "Summer Pudding"
AND	Performs a logical AND on two Boolean values Example: TRUE AND FALSE produces FALSE
OR	Performs a logical OR on two Boolean values Example: TRUE OR FALSE produces TRUE

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