Cambridge Assessment International Education

Cambridge International AS & A Level

CANDIDATE NAME									
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COMPUTER SCIENCE **9608/21**

Paper 2 Fundamental Problem-solving and Programming Skills **May/June 2021**

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 **24** pages. Any blank pages are indicated.

1 (a) (i) State how characters are represented using the ASCII character set.

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..... [2]

(ii) String values may be represented by a sequence of ASCII characters.

The following table shows consecutive memory locations.

Complete the table by adding the values to show how the string `"FADED"` may be stored in memory using the ASCII character set.

Refer to the **Appendix** on pages 22–23 for the list of built-in pseudocode functions and operators, which includes a reference to the `ASC( )` function.

Memory location	ASCII character value
100	
101	
102	
103	
104	

[2]

(b) Individual elements in a 1D array are referenced using an integer value.

In the pseudocode expression `StockID[n]`, the integer value is represented by the variable `n`.

(i) Give the technical terms for the minimum and maximum values for the variable `n`.

Minimum value .....

Maximum value .....
[1]

(ii) Give the correct term for the variable `n` in the pseudocode expression `StockID[n]`.

..... [1]

(c) Each pseudocode statement in the following table may contain an error due to the incorrect use of the function or operator.

Describe the error in each case, **or** write 'NO ERROR' if the statement contains no error.

Refer to the **Appendix** on pages 22–23 for the list of built-in pseudocode functions and operators.

Statement	Error
`Code ← LEFT("Cat", 4)`	
`Status ← MID("Aardvark", 0, 5)`	
`Size ← LENGTH("Password)`	
`Stock[n] ← Stock[n+1]`	
`Result ← 3 OR 4`	

[5]

2 **(a)** The following pseudocode algorithm counts the number of each alphabetic character in the string `Msg`. The character count values are stored in an array `CharCount`.

Variable declarations are not shown.

```
FOR Index ← 1 TO 26
   CharCount[Index] ← 0
ENDFOR

FOR Index ← 1 TO LENGTH(Msg)
   ThisChar ← MID(Msg, Index, 1)
   ThisChar ← LCASE(ThisChar)
   IF ThisChar >= 'a' AND ThisChar <= 'z'
      THEN
         ThisIndex ← ASC(ThisChar) – 96 // value from 1 to 26
         CharCount[ThisIndex] ← CharCount[ThisIndex] + 1
   ENDIF
ENDFOR
```

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Draw a program flowchart to represent the algorithm.

Variable declarations are not required in program flowcharts.

[5]

(b) The character count values have been assigned to the array in **part (a)**.

Use **structured English** to describe an algorithm to:

- search the array
- output the alphabetic character that occurs most often (the highest character count value)
- output a suitable message if more than one alphabetic character has the same highest count value.

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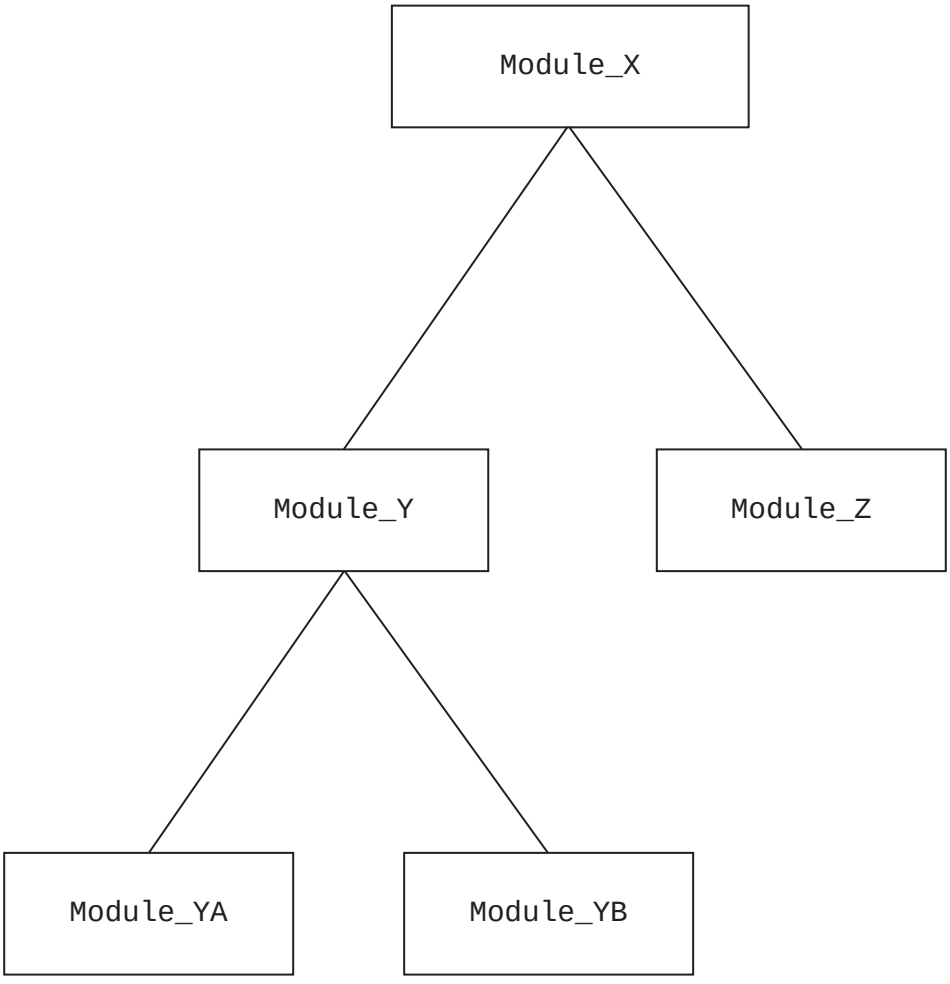
3 **(a)** The following table contains information about five modules in a program. It describes the calls made and the parameters passed.

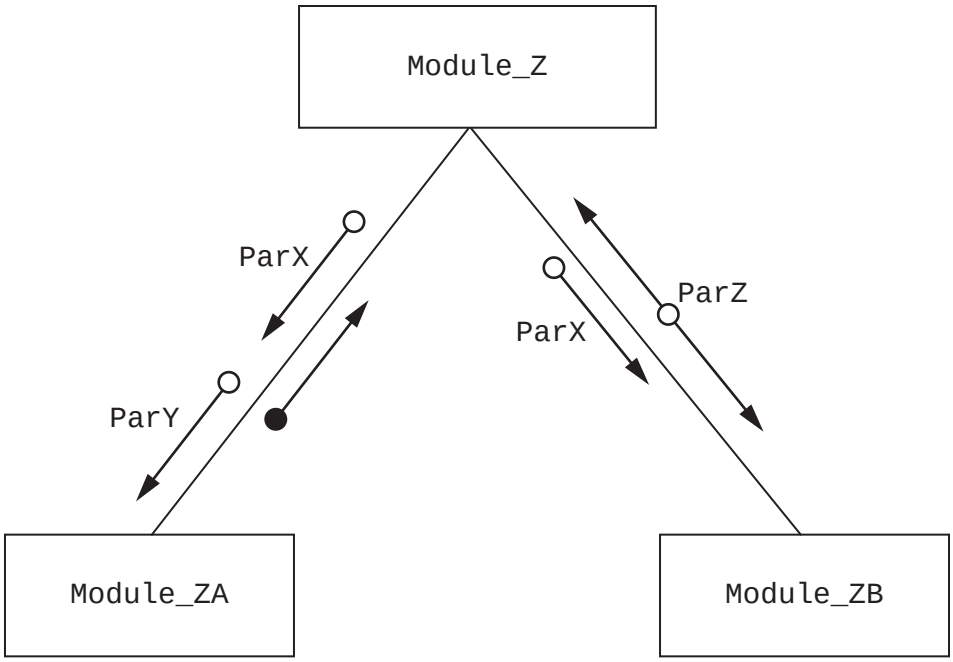
Module	Description
`Module_X`	• repeatedly calls `Module_Y` then `Module_Z` • passes a parameter of type `REAL` to `Module_Y` • passes two parameters of type `INTEGER` to `Module_Z`
`Module_Y`	calls either `Module_YA` or `Module_YB`
`Module_Z`	called with two parameters of type `INTEGER`
`Module_YA`	• called with a parameter of type `REAL` • parameter is passed by reference
`Module_YB`	• called with a parameter of type `INTEGER` • returns a `BOOLEAN` value

Complete the structure chart to include the information given about the five modules.



[5]

(b) Two more modules are added to the chart below `Module_Z` as shown:



Parameter data types are:

```
ParX  : REAL
ParY  : INTEGER
ParZ  : STRING
```

(i) State whether `Module_ZA()` is a function or a procedure **and** justify your choice.

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(ii) Write the **pseudocode** header for `Module_ZB()`.

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4 The following is part of a program written in pseudocode:

```
DECLARE ThisArray : ARRAY[1:1000] OF STRING
DECLARE ArrayResult : INTEGER

PROCEDURE ScanArray(SearchString : STRING)

  DECLARE Index, Total : INTEGER
  DECLARE Error : BOOLEAN

  Index ← 1
  Total ← 0
  Error ← FALSE

  WHILE Index <= 1000 AND Error <> TRUE
     IF LENGTH(ThisArray[Index]) > 5
        THEN
           IF ThisArray[Index] = SearchString
              THEN
                 Total ← Total + LENGTH(ThisArray[Index])
           ENDIF
           Index ← Index + 1
        ELSE
           Error ← TRUE
     ENDIF
  ENDWHILE

  ArrayResult ← INT(Total / (Index - 1))

ENDPROCEDURE
```

The procedure `ScanArray()` is amended as follows:

- `SearchString` is compared with just the first **four** characters of each array element.
- The total ignores the first **five** characters of each array element.
- When calculating `ArrayResult`, prevent any possible division by zero.

Refer to the **Appendix** on pages 22–23 for the list of built-in pseudocode functions and operators.

(a) Write **program code** to implement this **amended** procedure `ScanArray()`.

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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(b) Context-sensitive prompts are a feature of a typical Integrated Development Environment (IDE).

Explain the term **context-sensitive prompt**.

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(c) **(i)** Identify the first stage in the program development cycle.

State the tasks that are completed during this stage.

First stage .....

Tasks .....

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(ii) A program will be translated using a compiler.

Identify the stage of the program development cycle where a syntax error may occur.

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5 Alice is developing an algorithm for a game. The game will count the number of attempts by a player to guess the secret number generated by the built-in random number function.

She will use pseudocode to develop a procedure, `GuessNum()`, that will:

1. generate a secret number that is a random integer in the range 1 to 20 inclusive
2. prompt and input the player's guess
3. output a message if the guess is not the same as the secret number and repeat from step 2
4. count the number of attempts it takes to guess the secret number
5. output a message when the secret number has been guessed correctly, giving the number of attempts.

(a) (i) Write **pseudocode** for the procedure `GuessNum()`.

Refer to the **Appendix** on pages 22–23 for the list of built-in pseudocode functions and operators.

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(ii) Suggest **two** different validation checks that could be applied to the input of the procedure `GuessNum()` to ensure invalid guesses are not counted.

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[2]

(b) Alice is converting her pseudocode into a high-level language for use in a larger modular program.

She wants to start testing the program before all the subroutines (procedures and functions) have been implemented.

(i) Identify this type of testing.

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(ii) Her program contains a function `Status()` that she has not yet written, but will be called from several places within the program.

Explain what Alice needs to do to allow the program to be tested.

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(iii) Alice compiles her program.

Explain the function of the compiler.

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6 A program stores stock data in four global arrays as follows:

Array	Data type	Description	Example data value	Initial data value
`StockID`	`STRING`	The stock item ID (Eight alpha-numeric characters)	`"HWDM0001"`	`""`
`Description`	`STRING`	A description of the item (Alphabetic characters only)	`"Candle"`	`""`
`Quantity`	`INTEGER`	The number in stock	`4`	`0`
`Cost`	`REAL`	The cost of the item	`2.75`	`0`

- Each array contains 10 000 elements.
- Elements with the same index relate to the same stock item. For example, `StockID[4]` contains the ID for the product whose description is in `Description[4]`.
- The `StockID` array is not sorted and unused elements may occur at any index position.
- Unused elements are assigned the initial data value shown in the table above.

The program is to be modified so that the data from the arrays can be stored in a text file for backup.

The programmer has started to define program modules as follows:

Module	Description
`GetValidFilename()`	• prompts, inputs and returns a valid filename
`Check()`	• called with an array index as a parameter • checks that the data values for the stock item with the given index are valid • returns `TRUE` if the values are valid, otherwise returns `FALSE`
`Backup()`	• calls `GetValidFilename()` to get the name of the backup file • combines the data values for each stock item to form a single string. Inserts an asterisk character '*' as a separator between data values • writes the string to the backup file • calls `Check()` to validate the data values. If there is an error then also writes the string to the file `"ERRORLOG.TXT"` • repeats for all stock items • returns `TRUE` if nothing was written to `"ERRORLOG.TXT"`, otherwise returns `FALSE`
`Unpack()`	• called with two parameters: o an array index o a string value read from one line of the backup file • extracts the four data values from the string and assigns each to the appropriate array

(a) Write **program code** for the module `Check()`.

Data values relating to an individual stock item are valid if:

- the `StockID` element is of length 8
- the `Description` is not an empty string
- the `Quantity` is zero or above.

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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(b) Write **pseudocode** for the module `Backup()`.

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(c) The module description of `Unpack()` is repeated here for reference.

Module	Description
`Unpack()`	• called with two parameters: o an array index o a string value read from one line of the backup file • extracts the four data values from the string and assigns each to the appropriate array

Write **program code** for the module `Unpack()`. You may assume that the backup file contains only valid stock information.

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.

`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 `"BCD"`

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

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

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

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

Example: `INT(27.5415)` returns `27`

`LCASE(ThisChar : CHAR) RETURNS CHAR`
returns the character value representing the lower case equivalent of `ThisChar`
If `ThisChar` is not an upper case alphabetic character, it is returned unchanged.

Example: `LCASE('W')` returns `'w'`

`ASC(ThisChar : CHAR) RETURNS INTEGER`
returns the ASCII value of character `ThisChar`

Example: `ASC('A')` returns `65`

`RAND(x : INTEGER) RETURNS REAL`
returns a real number in the range `0` to `x` (not inclusive of `x`).

Example: `RAND(87)` could return `35.43`

`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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