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COMPUTER SCIENCE

9618/22

Paper 2 Fundamental Problem-solving and Programming Skills

May/June 2024

2 hours

You must answer on the question paper.

You will need: Insert (enclosed)

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.
- The insert contains all the resources referred to in the questions.

This document has **24** pages. Any blank pages are indicated.

Refer to the **insert** for the list of pseudocode functions and operators.

1 (a) The following table contains pseudocode examples.

Each example may contain statements that relate to one or more of the following:

- selection
- iteration (repetition)
- input/output.

Complete the table by placing **one or more** ticks (✓) in each row.

Pseudocode example	Selection	Iteration	Input/Output
FOR Index ← 1 TO 10 Data[Index] ← 0 NEXT Index		✓	
WRITEFILE ThisFile, "*****"			✓
UNTIL Level > 25		✓	
IF Mark > 74 THEN READFILE OldFile, Data ENDIF	✓		✓

[4]

(b) Program variables have data types as follows:

Variable	Data type
MyChar	CHAR
MyString	STRING
MyInt	INTEGER

Complete the table by filling in each gap with a function (from the **insert**) so that each expression is valid.

Expression
MyInt ← INT (3.1415926)
MyChar ← MID ("Elwood", 3, 1)
MyString ← NUM-TO-STR (..... INT (27.509))
MyInt ← STR-TO-NUM (..... RIGHT ("ABC123", 3))

[4]

- (c) The variables given in part (b) are chosen during the design stage of the program development life cycle.

The choices are to be documented to simplify program maintenance.

State a suitable way of documenting the variables **and** give **one** piece of information that should be recorded, in addition to the data type.

Identifier Table

Explanation of what each variable is used for

[2]

2 A program is being developed.

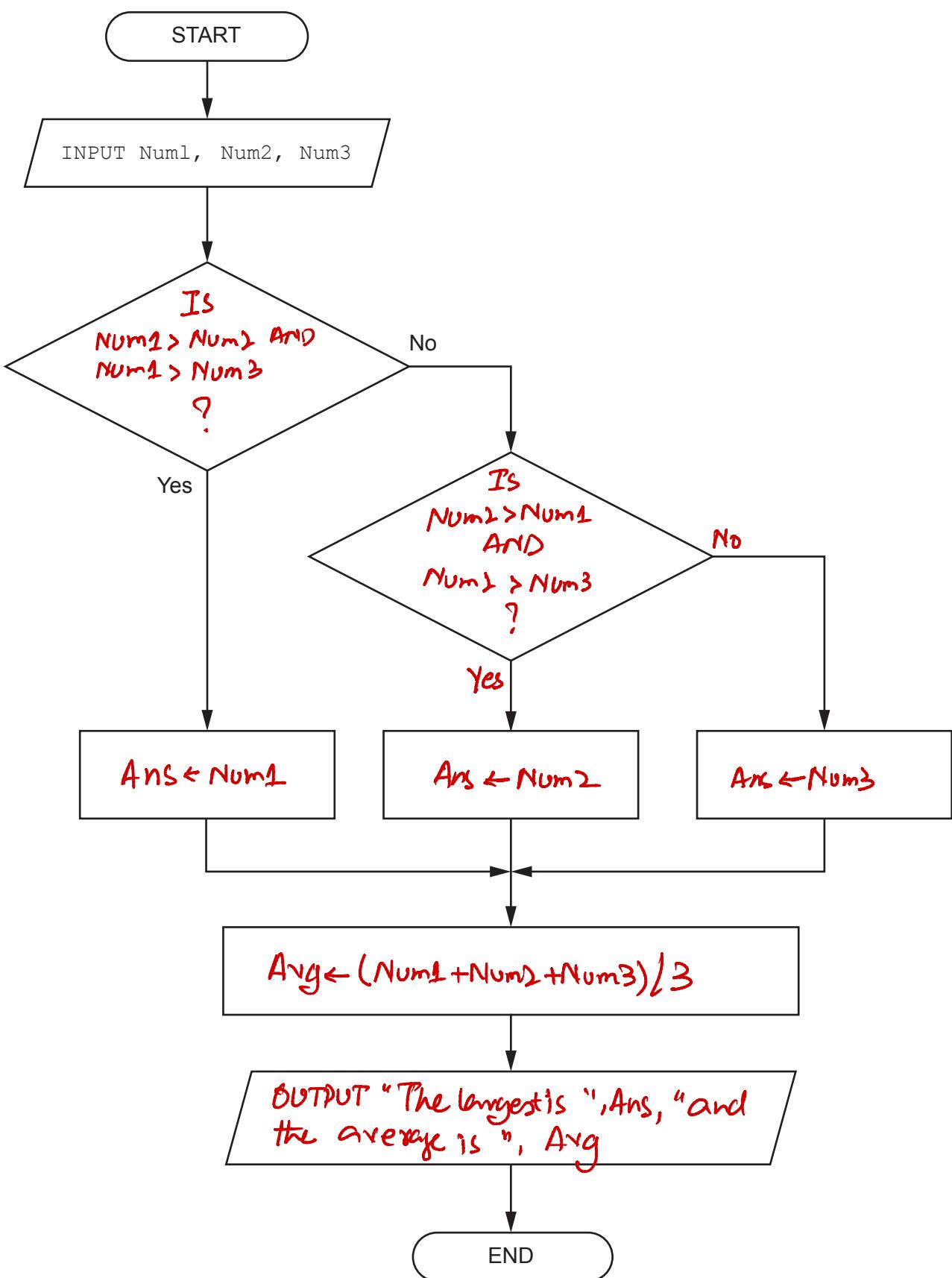
(a) An algorithm for part of the program will:

- input three numeric values and assign them to identifiers Num1, Num2 and Num3
- assign the largest value to variable Ans
- output a message giving the largest value and the average of the three numeric values.

Assume the values are all different and are input in no particular order.

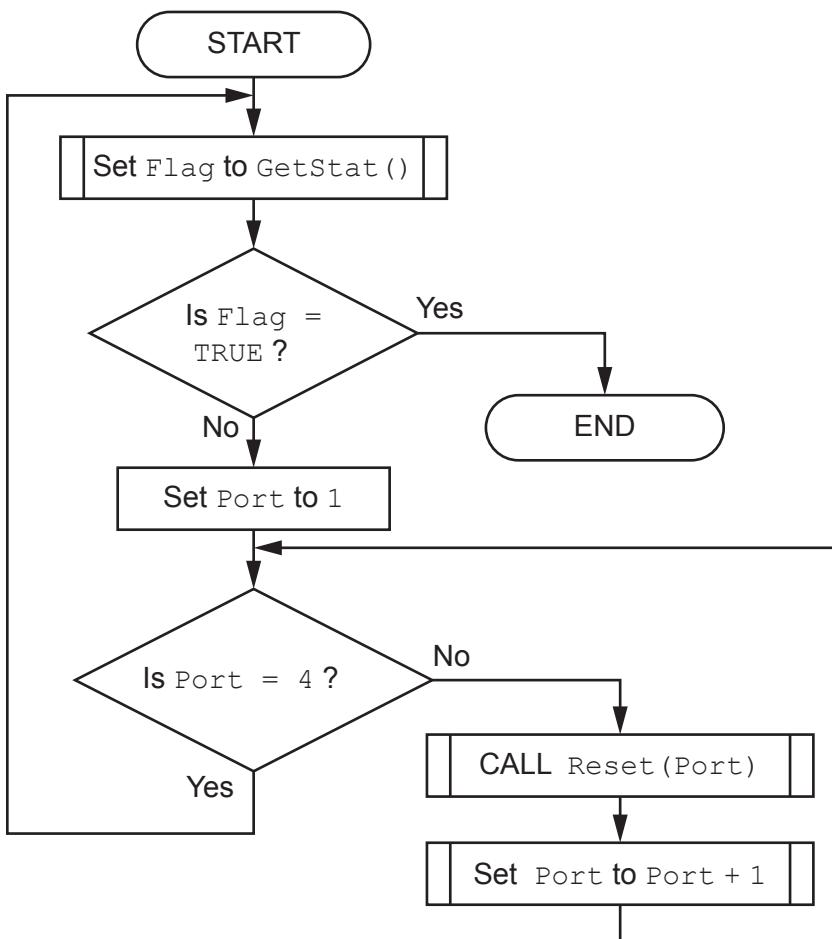
Complete the program flowchart on page 5 to represent the algorithm.

```
INPUT Num1, Num2, Num3
IF Num1 > Num2 AND Num1 > Num3 THEN
    Ans ← Num1
ELSE IF Num2 > Num1 AND Num2 > Num3 THEN
    Ans ← Num2
ELSE
    Ans ← Num3
ENDIF
Average ← (Num1 + Num2 + Num3) / 3
OUTPUT "The largest is ", Ans, " and the average is ", Average
```



[5]

- (b) A different part of the program contains an algorithm represented by the following program flowchart:



Write pseudocode for the algorithm.

```

// Declarations .....  

DECLARE Flag : BOOLEAN .....  

DECLARE Port : INTEGER .....  

// Initializations .....  

Flag <- GetStat() .....  

// Main loop .....  

WHILE Flag <> TRUE .....  

  FOR Port <- 1 TO 3 .....  

    CALL Reset(Port) .....  

  NEXT Port .....  

  Flag <- GetStat() .....  

ENDWHILE .....  

  
```

[5]

- 3 A factory needs a program to help manage its production of items.

Data will be stored about each item.

The data for each item will be held in a record structure of type Component.

The programmer has started to define the fields that will be needed as shown in the table.

Field	Example value	Comment
Item_Num	123478	a numeric value used as an array index
Reject	FALSE	TRUE if this item has been rejected
Stage	'B'	a letter to indicate the stage of production
Limit_1	13.5	any value in the range 0 to 100 inclusive
Limit_2	26.4	any value in the range 0 to 100 inclusive

- (a) (i) Write pseudocode to declare the record structure for type Component.

TYPE Component

```
DECLARE Item_Num : INTEGER .....  
DECLARE Reject : BOOLEAN .....  
DECLARE Stage : CHAR .....  
DECLARE Limit_1 : REAL .....  
DECLARE Limit_2 : REAL .....
```

ENDTYPE

[4]

- (ii) A 1D array Item of 2000 elements will store the data for all items.

Write pseudocode to declare the Item array.

DECLARE Item : ARRAY [1 : 2000] OF Component

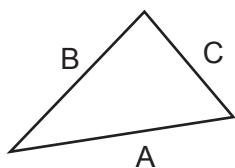
[2]

- (b) State three benefits of using an array of records to store the data for all items.

- 1 Simplifies the code as different datatypes under one identifier are managed.
- 2 Reduces duplication of code
- 3 Allows for iteration over the items easily.

[3]

- 4 A triangle has sides of length A, B and C.



In this example, A is the length of the longest side.

This triangle is said to be right-angled if the following equation is true:

$$A \times A = (B \times B) + (C \times C)$$

A procedure will be written to check whether three lengths represent a right-angled triangle. The lengths will be input in any sequence.

The procedure IsRA() will:

- prompt and input three integer values representing the three lengths
- test whether the three lengths correspond to the sides of a right-angled triangle
- output a suitable message.

The length of the longest side may **not** be the first value input.

```

PROCEDURE IsRA()
  DECLARE a, b, c : INTEGER

  OUTPUT "Input length of the first side"
  INPUT a
  OUTPUT "Input length of the second side"
  INPUT b
  OUTPUT "Input length of the third side"
  INPUT c

  IF (a * a = (b * b) + (c * c)) OR
    (b * b = (a * a) + (c * c)) OR
    (c * c = (a * a) + (b * b)) THEN
    OUTPUT "It is right-angled"
  ELSE
    OUTPUT "Not right-angled"
  ENDIF
ENDPROCEDURE

```

Write pseudocode for the procedure IsRA () .

[5]

- 5 A program is being designed in pseudocode.

The program contains a global 1D array Data of type string containing 200 elements.

The first element has the index value 1.

A procedure Process() is written to initialise the values in the array:

```

PROCEDURE Process(Label : STRING)
DECLARE Index : INTEGER
Index ← 0
INPUT Data[Index]
WHILE Index < 200
    Index ← Index + 1
    CASE OF (Index MOD 2)
        0 : Data[Index] ← TO_UPPER(Label)
        1 : Data[Index] ← TO_LOWER(Label)
    OTHERWISE : OUTPUT "Alarm 1201"
ENDCASE
NEXT Index ENDWHILE
OUTPUT "Completed " & Index & " times"
ENDPROCEDURE

```

Initial index is 1 and not 0.

~~you can't concatenate a string with integer.~~

- (a) (i) The pseudocode contains two syntax errors and one other error.

Identify the errors.

Syntax error 1 ~~*1~~

Syntax error 2 ~~*2~~

Other error ~~*3~~

It will access array element 0, which doesn't exist.

[3]

- (ii) The procedure contains a statement that is not needed.

Identify the pseudocode statement and explain why it is not needed.

Statement ~~OTHERWISE : OUTPUT "Alarm 1201"~~

Explanation ~~The result of MOD 2 will always be 0 or 1. So, the OTHERWISE case will be useless and never used.~~

[2]

- (b) After correcting all syntax errors, the pseudocode is translated into program code which compiles without generating any errors.

When the program is executed it unexpectedly stops responding.

Identify the type of error that has occurred.

Runtime.

[1]

- 6 A music player stores music in a digital form and has a display which shows the track being played.

- (a) Up to 16 characters can be displayed. Track titles longer than 16 characters will need to be trimmed as follows:
- Words must be removed from the end of the track title until the resulting title is less than 14 characters.
 - When a word is removed, the space in front of that word is also removed.
 - Three dots are added to the end of the last word displayed when one or more words have been removed.

The table below shows some examples:

Original title	Display string															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Bat out of Hull	B	a	t		o	u	t		o	f		H	u	I	I	
Bohemian Symphony	B	o	h	e	m	i	a	n	.	.	.					
Paperbook Writer	P	a	p	e	r	b	o	o	k		W	r	i	t	e	r
Chris Sings the Blues	C	h	r	i	s		S	i	n	g	s	.	.	.		
Green Home Alabama	G	r	e	e	n		H	o	m	e	.	.	.			

A function `Trim()` will:

- take a string representing the original title
- return the string to be displayed.

Assume:

- Words in the original title are separated by a single space character.
- There are no spaces before the first word or after the last word of the original title.
- The first word of the original title is less than 14 characters.

Write pseudocode for the function Trim().

```
FUNCTION Trim(Name : STRING) RETURNS STRING
    CONSTANT Dots = "..."
    CONSTANT Space = " "

    IF LENGTH(Name) <= 16 THEN
        RETURN Name
    ENDIF

    WHILE LENGTH(Name) >= 13
        REPEAT
            Name ← LEFT(Name, LENGTH(Name) - 1) // strip last char
            UNTIL RIGHT(Name, 1) = Space           // back to SPACE
    ENDWHILE

    Name ← LEFT(Name, LENGTH(Name) - 1) // remove the space
    Name ← Name & Dots
    RETURN Name
ENDFUNCTION
```

.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
..... [7]

- (b) Music is stored as a sequence of digital samples.

Each digital sample is a denary value in the range 0 to 99999999 (8 digits).

The samples are to be stored in a text file. Each sample is converted to a numeric string and 32 samples are concatenated (joined) to form a single line of the text file.

Each numeric string is 8 characters in length; leading '0' characters are added as required.

Example:

Sample	Denary value	String
1	456	"00000456"
2	48	"00000048"
3	37652	"00037652"
32	673	"00000673"

The example samples will be stored in the text file as a single line:

"000004560000004800037652...00000673"

- (i) Identify one drawback of adding leading '0' characters to each numeric string.

A very large file is created as redundant zeros are stored. [1]

- (ii) Suggest an alternative method of storing the samples which does **not** involve adding leading '0' characters but which would still allow each individual sample to be extracted.

Values are separated by a special character.

[1]

- (iii) State **one** drawback of the alternative method given in part (b)(ii).

The algorithm will become complex as it will extract individual values. It takes longer. [1]

- 7 A fitness club has a computerised membership system.

The system stores information for each club member: name, home address, email address, mobile phone number, date of birth and exercise preferences.

Many classes are full, and the club creates a waiting list for each class. The club adds details of members who want to join a class that is full to the waiting list for that class.

When the system identifies that a space is available in one of the classes, a new module will send a text message to each member who is on the waiting list.

- (a) Decomposition will be used to break the new module into sub-modules (sub-problems).

Identify **three** sub-modules that could be used in the design **and** describe their use.

Sub-module 1 *IdentifyMember()*

Use *identifies a club member who has expressed an interest in a given class.*

Sub-module 2 *GetMemberPhoneNumber()*

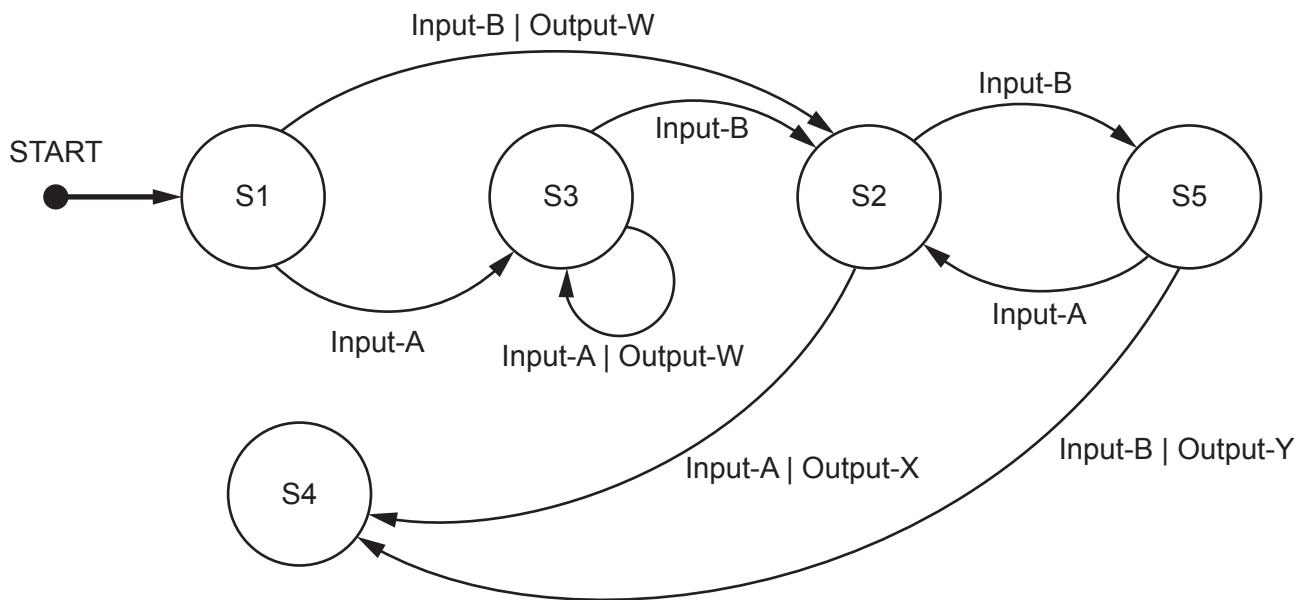
Use *Gets the mobile number of the member.*

Sub-module 3 *CreateMessage()*

Use *Generates a text message to a member.*

[3]

- (b) A different part of the program is represented by the following state-transition diagram.



- (i) Complete the table to show the inputs, outputs and next states.

Assume that the current state for each row is given by the 'Next state' on the previous row. For example, the first Input-A is made when in state S1.

If there is no output for a given transition, then the output cell should contain 'none'.

The first two rows have been completed.

Input	Output	Next state
		S1
Input-A	none	S3
Input-A	Output-W	S3
Input-B	none	S2
Input-B	none	S5
Input-A	none	S2
Input-A	Output-X	S4

[5]

- (ii) Identify the input sequence that will cause the minimum number of state changes in the transition from S1 to S4.

Input-B, Input-A

[1]

- 8 A teacher is designing a program to process pseudocode projects written by her students.

Each student project is stored in a text file.

The process is split into a number of stages. Each stage performs a different task and creates a new file.

For example:

File name	Comment
MichaelAday_src.txt	Student project file produced by student Michael Aday
MichaelAday_S1.txt	File produced by stage 1
MichaelAday_S2.txt	File produced by stage 2

- (a) Suggest a reason why the teacher's program has been split into a number of stages **and** give the benefit of producing a different file from each stage.

Reason *Easier to design, implement, test, and modify each stage.*

Benefit *Easier to check the stage has produced the expected output*

[2]

- (b) The teacher has defined the first program module as follows:

Module	Description
DeleteSpaces ()	<ul style="list-style-type: none"> • called with a parameter of type string representing a line of pseudocode from a student's project file • returns the line after removing any leading space characters <p>The following example shows a string before and after the leading spaces have been removed:</p> <p>Before: " IF X2 > 13 THEN" After: "IF X2 > 13 THEN"</p>

Complete the pseudocode for module `DeleteSpaces()`.

```
FUNCTION DeleteSpaces(Line : STRING) RETURNS STRING
```

```
FUNCTION DeleteSpaces(Line : STRING) RETURNS STRING
    DECLARE NewLine : STRING
    DECLARE Count, NumSpaces : INTEGER
    DECLARE NextChar : CHAR
    CONSTANT Space = " "
    .....  

    NumSpaces ← -1
    .....  

    FOR Count ← 1 TO LENGTH(Line)
        NextChar ← MID(Line, Count, 1)
        IF NextChar <> Space AND NumSpaces = -1 THEN
            NumSpaces ← Count - 1
        ENDIF
        NEXT Count
    .....  

    NewLine ← RIGHT(Line, LENGTH(Line) - NumSpaces)
    .....  

    RETURN NewLine
ENDEFUNCTION
```

ENDFUNCTION

[6]

(c) Two modules are defined:

Module	Description
DeleteComment () (already written)	<ul style="list-style-type: none"> called with a parameter of type string representing a line of pseudocode from a student's project file returns the line after removing any comment
Stage_2 ()	<ul style="list-style-type: none"> called with two parameters: <ul style="list-style-type: none"> a string representing an input file name a string representing an output file name copies each line from the input file to the existing output file having first removed all leading spaces and comments from that line does not write blank lines to the output file outputs a final message giving the number of blank lines removed

```

PROCEDURE Stage_2(F1, F2 : STRING)
DECLARE Line : STRING
DECLARE Count : INTEGER

Count ← 0

OPENFILE F1 FOR READ
OPENFILE F2 FOR APPEND

WHILE NOT EOF(F1)
    READFILE F1, Line
    Line ← DeleteSpaces(Line)
    Line ← DeleteComment(Line)
    IF Line <> "" THEN
        WRITEFILE F2, Line
    ELSE
        Count ← Count + 1
    ENDIF
ENDWHILE

CLOSEFILE F1
CLOSEFILE F2

OUTPUT Count, " blank lines were removed"
ENDPROCEDURE

```

Write pseudocode for module Stage_2().

Modules DeleteComment () and DeleteSpaces () must be used in your solution.

[8]

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