Cambridge Assessment International Education

Done

Cambridge International AS & A Level

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COMPUTER SCIENCE **9618/21**

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.

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

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

1 An algorithm is developed in pseudocode before being coded in a programming language.

(a) The following table shows four valid pseudocode assignment statements.

Complete the table by giving an appropriate data type to declare each of the variables `A`, `B`, `C` and `D`.

Assignment statement	Data type
`A ← LEFT(MyName, 1)`	Char
`B ← Total * 2`	Integer
`C ← INT(ItemCost) / 3`	Real
`D ← "Odd OR Even"`	String

[4]

(b) Other variables in the program have example values as shown:

Variable	Value
`Sorted`	`False`
`Tries`	`9`
`ID`	`"ZGAC001"`

Complete the table by evaluating each expression, using the example values.

Expression	Evaluates to
`Tries < 10 AND NOT Sorted`	True
`Tries MOD 4`	1
`TO_LOWER(MID(ID, 3, 1))`	a
`LENGTH(ID & "xx") >= Tries`	True

[4]

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(c) The variable names `A`, `B`, `C` and `D` in part **(a)** are **not** good programming practice.

(i) State why these variable names are **not** suitable.

Not meaningful

..... [1]

(ii) Identify **one** problem that these variable names might cause.

Difficult to maintain

..... [1]

(iii) The choice of suitable variable names is one example of good programming practice.

Give **one other** example.

Comments

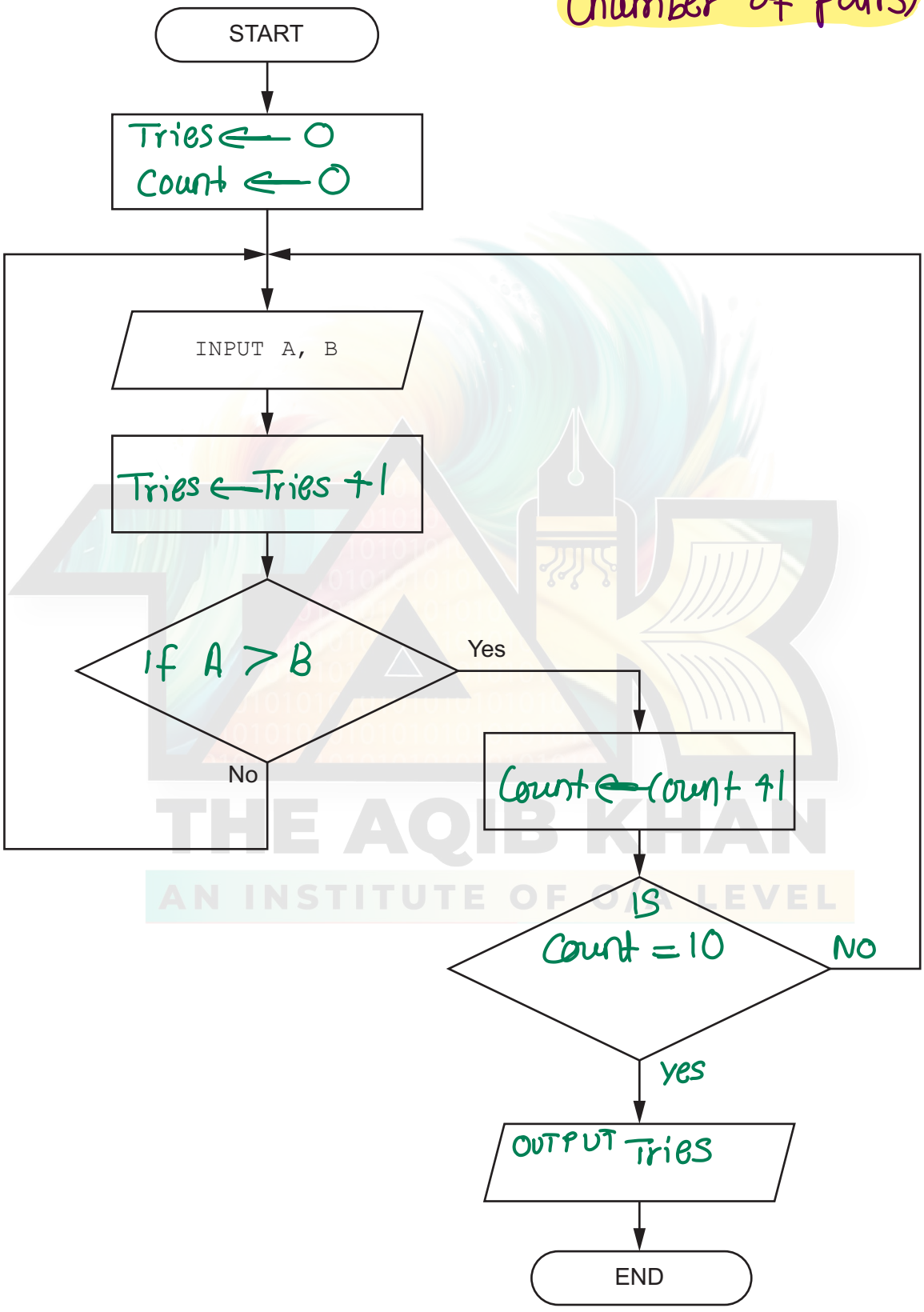
..... [1]

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2 An algorithm has three steps. It will:

1. repeatedly input a pair of numeric values `A` and `B`
2. count the number of pairs that are input until `A` has been greater than `B` 10 times
3. output the number of pairs that were input.

(a) Complete the program flowchart.



[5]

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(b) Step 1 of the algorithm is changed.

A variable `ThisSequence` is used to enter a sequence of 10 pairs of numeric values, using a single input statement.

Following the input of `ThisSequence` the revised algorithm will extract the pairs of numbers.

Describe the variable `ThisSequence` and how the numbers are extracted.

A variable (string) will be input. A special character need to seperate each numeric value.

..... [2]

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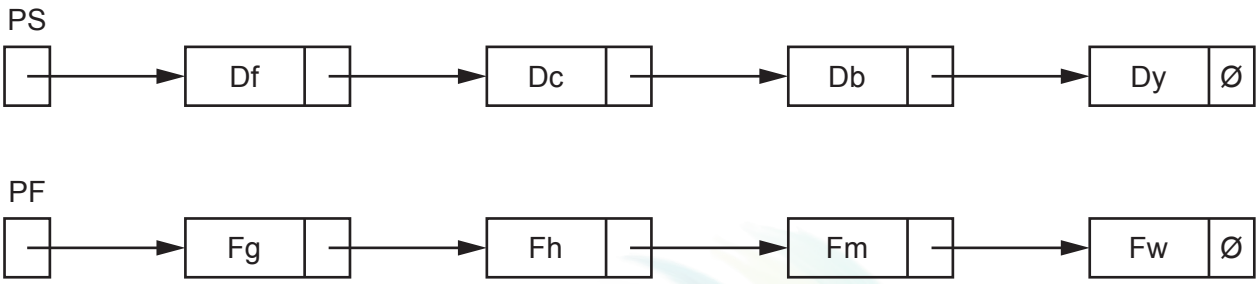
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Linked list

3 The diagram shows an Abstract Data Type (ADT) representation of a linked list after data items have been added.

- PS is the start pointer.
- PF is the free list pointer.
- Labels Df, Dc, Db and Dy represent the data items of nodes in the list.
- Labels Fg, Fh, Fm and Fw represent the data items of nodes in the free list.
- The symbol Ø represents a null pointer.



(a) Describe the linked list immediately after initialisation, before **any** data items are added.

1) PS contains a null pointer
2) PF points first element in free list.
3) All nodes are in free list before any dates items are colder.

[3]

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(b) A program will be written to include a linked list to store alphanumeric user IDs.

The design uses two variables and two 1D arrays to implement the linked list.
Each array element contains data of a single data type and **not** a record.

The statements below describe the design.

Complete the statements.

The two variables will be of type ..... Integer .....

The two variables will be used as ..... pointers ..... to the arrays.

The values stored in the two variables will indicate ..... the first element in each linked list .....

The first 1D array will be of type ..... String .....

The first 1D array will be used to ..... store data / user ID .....

The second 1D array will be of type ..... integer .....

The second 1D array will be used to ..... stores pointers value. .....

[5]

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4 A global 1D array `Data` contains 100 elements of type integer.

A function `Check()` will:

1) • total the element values in odd index locations (1, 3, 5 ... 97, 99)
2) • total the element values in even index locations (2, 4, 6 ... 98, 100)
3) • return one of three strings 'Odd', 'Even' or 'Same' to indicate which total is the greater, or whether the totals are the same.

Write pseudocode for the function `Check()`.

```
Function Check () Return String
DECLARE Odd , Even , Index : Integer
Odd ← 0      , Even ← 0
    FOR Index ← 1 TO 100
        IF Index MOD 2 = 0    THEN
            Even ← Even + Data [Index]
        ELSE
            Odd ← Odd + Data [Index]
        ENDIF
    NEXT Index
        IF Even > Odd THEN Return "Even" End If
        IF Odd > Even THEN Return "Odd" End If
        IF Odd = Even THEN Return "Same" End If

END FUNCTION
```

[6]

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5 A global 1D array of strings contains three elements which are assigned values as shown:

```
Data[1] ← "aaaaaa"
Data[2] ← "bbbbbb"
Data[3] ← "cccccc"
```

Skip → Not done

Procedure `Process()` manipulates the values in the array.

The procedure is written in pseudocode as follows:

```
PROCEDURE Process(Format : STRING)
    DECLARE Count, Index, L : INTEGER
    DECLARE Result : STRING
    DECLARE C : CHAR

    Result ← "****"

    FOR Count ← 1 TO LENGTH(Format) STEP 2
        C ← MID(Format, Count, 1)
        L ← STR_TO_NUM(MID(Format, Count + 1, 1))

        Index ← (Count + 1) DIV 2

        CASE OF C
            'X' : Result ← TO_UPPER(Data[Index])
            'Y' : Result ← TO_LOWER(Data[Index])
            'Z' : Result ← "**" & Data[Index]
        ENDCASE

        Data[Index] ← LEFT(Result, L)
    NEXT Count

ENDPROCEDURE
```

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(a) Complete the trace table by dry running the procedure when it is called as follows:

```
CALL Process("X3Y2W4")
```

Count	C	L	Index	Result	Data[1]	Data[2]	Data[3]

[6]

(b) The procedure is to be modified. If variable `C` is assigned a value other than `'X'`, `'Y'` or `'Z'`, then procedure `Error()` is called and passed the value of variable `C` as a parameter.

This modification can be implemented by adding a **single line** of pseudocode.

(i) Write the single line of pseudocode.

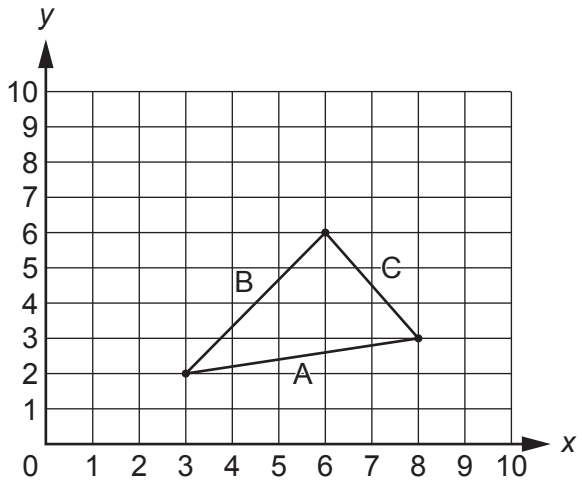
..... [1]

(ii) State where this new line should be placed.

..... [1]

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6 Three points on a grid form a triangle with sides of length A, B and C as shown in the example:



A triangle is said to be right-angled if the following test is true (where A is the length of the longest side):

$A^2 = B^2 + C^2$

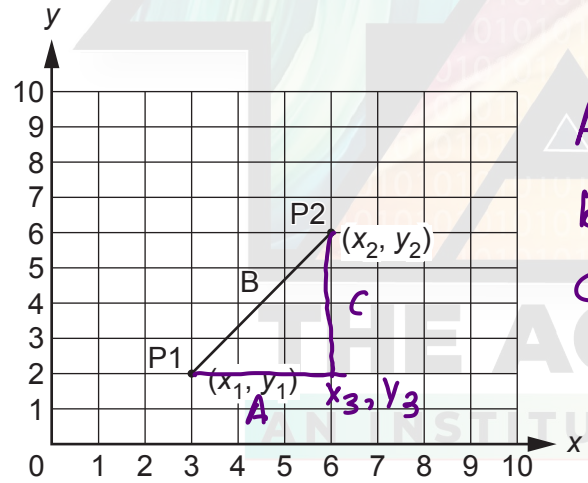
A^2 means A multiplied by A, for example 3^2 means 3×3 which evaluates to 9

You can calculate A^2, B^2 and C^2 by using the coordinates of the endpoints of each line.

For example, B^2 is calculated as follows:

A = LEN1 , B = LEN2 , C = LEN3

A = (X1 - X3) ^ 2 + (Y1 - Y3) ^ 2
B = (X1 - X2) ^ 2 + (Y1 - Y2) ^ 2
C = (X2 - X3) ^ 2 + (Y2 - Y3) ^ 2



The endpoints, P1 and P2, have the coordinates (3, 2) and (6, 6).

The value B^2 is given by the formula:

$B^2 = (x_1 - x_2)^2 + (y_1 - y_2)^2$

In this example:

$B^2 = (3 - 6)^2 + (2 - 6)^2$
$B^2 = (-3)^2 + (-4)^2$
$B^2 = 9 + 16$
$B^2 = 25$

Logic
A = B + C
OR
B = A + C
or
C = A + B

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(a) A function `IsRA()` will:

- take three sets of integers as parameters representing the coordinates of the three endpoints that form a triangle
- return `TRUE` if the endpoints form a right-angled triangle, otherwise return `FALSE`.

In pseudocode, the operator '^' represents an exponent, which is the number of times a value is multiplied by itself. For example, the expression $Value^2$ may be written in pseudocode as `Value ^ 2`

Complete the pseudocode for the function `IsRA()`.

```
FUNCTION IsRA(x1, y1, x2, y2, x3, y3 : INTEGER) RETURNS BOOLEAN
DECLARE A, B, C : INTEGER
A ← (X1 - X3) ^ 2 + (Y1 - Y3) ^ 2
B ← (X1 - X2) ^ 2 + (Y1 - Y2) ^ 2
C ← (X2 - X3) ^ 2 + (Y2 - Y3) ^ 2
IF (A = B + C) OR (B = A + B)
  OR (C = A + B)
  THEN RETURN TRUE
ELSE
  RETURN FALSE
ENDIF
ENDFUNCTION
```

[6]

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(b) The test used to check if a triangle is right-angled can be written in two ways:

$A^2 = B^2 + C^2$

or

$A = \sqrt{(B^2 + C^2)}$

The symbol √ represents the square root operation. For example, √81 = 9

A new function `SQRT()` is written to perform the square root operation. The function takes an integer number as a parameter and returns a positive real value representing the square root of the number.

During testing it is found that the `SQRT()` function returns a value that is only accurate to 4 decimal places.

For example, `SQRT(25)` returns 5.0000125 rather than the correct value of 5.0

The function `IsRA()` from part **(a)** is modified to use the new `SQRT()` function to test if a triangle is right-angled.

Describe a problem that might occur when using the modified `IsRA()` function **and** suggest a solution that still allows the `SQRT()` function to be used.

Problem ..... The function will return incorrect value. .....

Solution ..... Round of the value to 1 or 2 decimal place .....

[2]

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7 A fitness club has a computerised membership system. The fitness club offers a number of different exercise classes.

The following information is stored for each club member: name, home address, email address, mobile phone number, date of birth and the exercise(s) they are interested in.

(a) When an exercise class is planned, a new module will send personalised text messages to each member who has expressed an interest in that exercise. Members wishing to join the class send a text message back. Members may decide **not** to receive future text messages by replying with the message 'STOP'.

The process of abstraction is used to filter out unnecessary information.

(i) State **one** advantage of applying abstraction to this problem.

Easier to maintain

[1]

(ii) Identify **three** items of information that will be required by the new module.
Justify your choices with reference to the given scenario.

Item 1 required Member Cell Number

Justification To send text message.

Item 2 required Member Name

Justification To personlize text message

Item 3 required Exercise intrest

Justification weather the member is intrested in exercise or not.

[3]

(iii) Identify **two** operations that would be required to process data when the new module receives a text message back from a member.

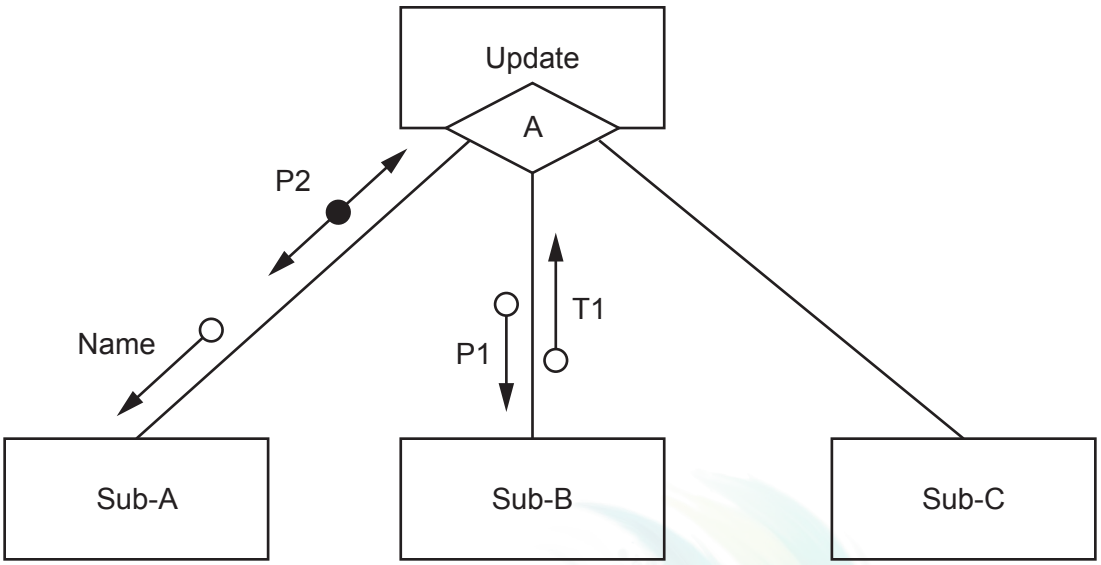
Operation 1 Add the consumer to the intrested exercise class.

Operation 2 Remove the customer's name from text list.

[2]

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(b) The structure chart illustrates part of the membership program:



Data item notes:

- Name contains the name of a club member
- P1 and T1 are of type real.

(i) Explain the meaning of the diamond symbol (labelled with the letter A) in the chart.

It's a selection statement Update will call Either Sub A, Sub B, Sub C.

[2]

(ii) Write the pseudocode module headers for Sub-A and Sub-B.

Sub-A

PROCEDURE Sub-A(Name : Str ; BYref P2 : BOOL)

Sub-B

Function SUB - B[P1 : Real) Returns Real.

[4]

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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 named as shown:

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

The teacher has defined the first program module as follows:

Module	Description
`DeleteComment()`	• called with a parameter of type string representing a line of pseudocode from a student's project file • returns the line after removing any comments Note on comments: A comment starts with two forward slash characters and includes all the remaining characters on the line. The following example shows a string before and after the comment has been removed: Before: `IF X2 > 13 THEN  //check if limit exceeded` After: `IF X2 >13 THEN`

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(a) Complete the pseudocode for module `DeleteComment()`.

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

```
DECLARE Flag : Boolean
DECLARE Count, Index : Integer
DECLARE Newline : String
Constant comment = "//"
Flag ← False
Newline ← line
Index ← -1
  WHILE Index <= Length(Line) AND Flag=False
  | X ← MID(Line, Index, 2)
  |   IF X = Comment
  |     THEN Count ← Index
  |          Flag ← TRUE
  |   ENDIF
  |   Index ← Index + 1
  ENDWHILE
  IF Flag = True
    THEN Newline ← Left(Line, Count-1)
  ENDIF
  Return Newline
```

```
ENDFUNCTION
```

[8]

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(b) A second module is defined:

Module	Description
`Stage_1()`	• called with a parameter of type string representing a student name • creates a new stage 1 file • copies each line from the student's project file to the stage 1 file after removing any comment from each line • does **not** write blank lines to the stage 1 file → Length (line) <> 0 • returns the number of lines written to the stage 1 file

Write pseudocode for module `Stage_1()`.

Module `DeleteComment()` must be used in your solution.

```
Function Stage_1 (StudentName: Str) Returns
                                        Integer
DECLARE Count : Integer
DECLARE Data : String
Count ← 0
OldFile ← StudentName & "Src.txt"
NewFile ← StudentName & "S1.txt"

    OPEN FILE OldFile FOR Read
    OPEN File NewFile FOR WRITE
WHILE Not Eof (OldFile)
    Read File (OldFile, Data)
  // Removing Comments from Data
  Line ← Delete Comment (Data)
  IF length (line) <> 0 THEN
    WriteFile (NewFile, Line)
    Count ← count + 1
  ENDIF
```

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ENDWHILE
CLOSE FILE (Old file)
CLOSE FILE (Newfile)
Return Count
END Function.

[7]

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