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COMPUTER SCIENCE **9608/21**

Paper 2 Fundamental Problem-solving and Programming Skills **May/June 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 **24** pages. Blank pages are indicated.

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[Turn over

1 **(a)** Complete this definition of the term **algorithm**.

An algorithm is a solution to a problem expressed as .....

.....

..... [2]

(b) A program design includes the use of subroutines (functions and procedures).

Give **three** advantages of using subroutines in a program.

1 .....

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2 .....

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[3]

(c) Draw lines on the following diagram to connect each computing term with the appropriate description.

Term	Description
Selection	Checking that a program performs as expected
Black-box testing	A method for increasing the level of detail of an algorithm
Stepwise refinement	To test a condition to determine the path of program execution
Iteration	A method of executing certain lines of code more than once

[3]

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2 **(a)** Three modules form part of a program for a car rental company. A description of the relationship between the modules is summarised as follows:

Module name	Description
`RentCar()`	A customer will pay for each car rental either by bank card or by using their account with the rental company.
`PayByCard()`	Called with parameter `HireCost`, representing the cost of the rental. Returns a `BOOLEAN` value to indicate whether or not the card payment was successful.
`PayByAccount()`	Called with parameters `HireCost`, `AccountNumber`, `CurrentBalance` and `AccountLimit`. • Checks whether `HireCost` plus the `CurrentBalance` would exceed the `AccountLimit`. If so, then the rental is not authorised. • If the rental is authorised, then the `CurrentBalance` is updated. • Returns a `BOOLEAN` value to indicate whether or not the rental was authorised.

Draw a structure chart to show the relationship between the **three** modules and the parameters passed between them.

[5]

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[Turn over

(b) The following pseudocode algorithm has been developed to check whether a string contains a valid password.

To be a valid password, a string must:

- be longer than 6 characters
- contain at least one lower case letter
- contain at least one upper case letter
- contain at least one non-alphabetic character.

```
10 FUNCTION Check(InString : STRING) RETURNS BOOLEAN
11
12   DECLARE Index : INTEGER
13   DECLARE StrLen : INTEGER
14   DECLARE NumUpper, NumLower : INTEGER
15   DECLARE NumNonAlpha : INTEGER
16   DECLARE NextChar : CHAR
17
18   NumUpper ← 0
19   NumLower ← 0
20   NumNonAlpha ← 0
21
22   StrLen ← LENGTH(InString)
23   IF StrLen < 7
24      THEN
25         RETURN FALSE
26      ELSE
27         FOR Index ← 1 TO StrLen
28            NextChar ← MID(InString, Index, 1)
29            IF NextChar >= 'a' AND NextChar <= 'z'
30               THEN
31                  NumLower ← NumLower + 1
32               ELSE
33                  IF NextChar > 'A' AND NextChar <= 'Z'
34                     THEN
35                        NumUpper ← NumUpper + 1
36                     ELSE
37                        NumNonAlpha ← NumNonAlpha + 1
38                  ENDIF
39            ENDIF
40         ENDFOR
41   ENDIF
42
43   IF (NumUpper >= 1) AND (NumLower >= 1) AND (NumNonAlpha >= 1)
44      THEN
45         RETURN TRUE
46      ELSE
47         RETURN FALSE
48   ENDIF
49
50 ENDFUNCTION
```

Refer to the **Appendix** on page 21 for a list of built-in pseudocode functions and operators.

The pseudocode does not work under all circumstances.

A dry run performed on the function `Check()`, with the string `"crAsh99"`, produced the following trace table.

The string is a valid password, but the pseudocode would return the value `FALSE`.

Trace table row	StrLen	Index	NextChar	NumUpper	NumLower	NumNonAlpha
1	7			0	0	0
2		1	'c'			
3					1	
4		2	'r'			
5					2	
6		3	'A'			
7						1
8		4	's'			
9					3	
10		5	'h'			
11					4	
12		6	'9'			
13						2
14		7	'9'			
15						3

(i) Describe how the completed trace table may be used to identify the error in the pseudocode. In your answer, refer to the trace table row number(s).

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.....

..... [2]

(ii) State the **pseudocode** line number that has to be changed to correct the error **and** write the correct pseudocode for the complete line.

Line number .....

Correct pseudocode .....

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[2]

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(iii) Rewrite lines 29 to 39 of the original pseudocode using a `CASE` structure.

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..... [4]

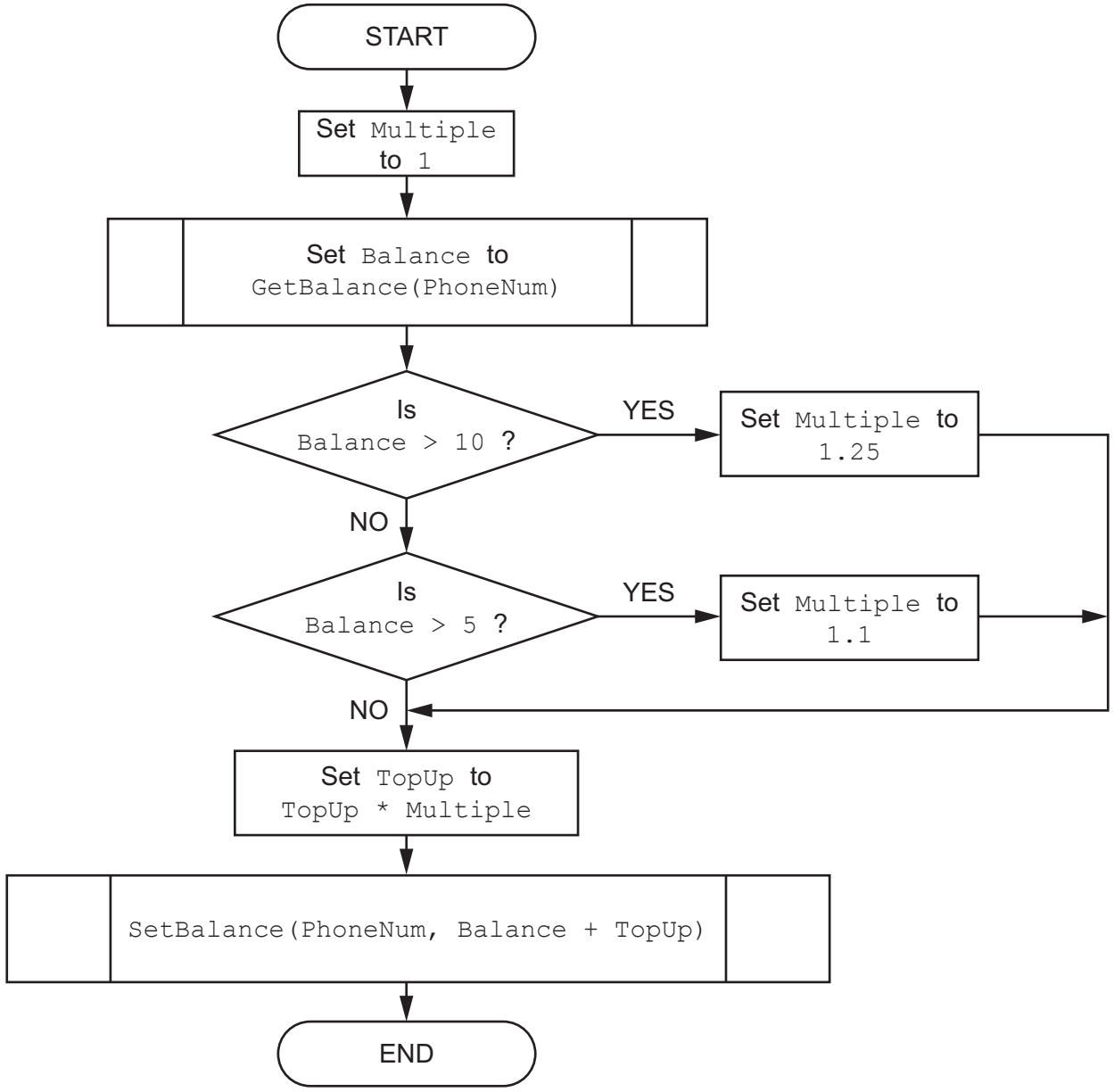
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Question 3 begins on the next page.

3 (a) A mobile phone provider has developed an account management program. The program includes a procedure, `AddCredit()`. The procedure is called with two parameters, `TopUp` and `PhoneNum`.

The relevant part of the identifier table and the program flowchart for the procedure are as shown:

Identifier	Type	Description
`TopUp`	`REAL`	The amount of credit to be added
`PhoneNum`	`STRING`	The unique customer phone number
`Balance`	`REAL`	The current amount of credit
`Multiple`	`REAL`	The amount of credit bonus
`GetBalance()`	`FUNCTION`	Takes the phone number as a parameter and returns the current balance
`SetBalance()`	`PROCEDURE`	Takes the phone number and the new balance as parameters and updates the account with the new balance



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Write **pseudocode** to implement the procedure `AddCredit()`. The pseudocode must follow the algorithm represented by the flowchart. Declare any local variables used.

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(b) The following pseudocode searches for a string `"Chris"` in a 1D array and outputs the index positions where the string is found.

```
DECLARE NameList : ARRAY [1:100] OF STRING
DECLARE n : INTEGER

FOR n ← 1 TO 100
   IF NameList[n] = "Chris"
      THEN
         OUTPUT "Found at: " & NUM_TO_STRING(n)
   ENDIF
ENDFOR
```

The pseudocode needs to be modified as follows:

- Write the search as a procedure, `Search()`, that takes the search string as a parameter.
- Change the array to a 2D array. The first dimension contains names and the second dimension contains the corresponding status.

  For example:

```
NameList[23, 1] ← "Chris"         // name
NameList[23, 2] ← "On Holiday"    // status
```

- Detect a match only when the name contains the search string **and** the status contains `"Active"`.
- If a match has been detected, the procedure will output a **single** message giving all of the index positions where a match occurred. For example, `"Found at: 3 6 22"`.
- If no match has been detected, the procedure will output a suitable message.

Refer to the **Appendix** on page 21 for a list of built-in pseudocode functions and operators.

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Write the **pseudocode** for the procedure `Search()`. Assume the array has been declared globally.

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4 **(a)** An inexperienced user buys a games program. A program fault occurs while the user is playing the game.

Explain what is meant by a **program fault**.

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(b) Give **three** ways to minimise the risk of faults when writing programs.

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(c) Three types of program error are syntax, logic and run-time.

Define these **three** types.

Syntax error .....

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Logic error .....

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Run-time error .....

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[3]

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Question 5 begins on the next page.

5 **(a)** A 1D array, `Directory`, of type `STRING` is used to store a list of school internal telephone numbers. There are 1000 elements in the array. Each element stores a single data item. The format of each data item is as follows:

`<Number><Name>`

`Number` is a four-digit numeric string.
`Name` is a variable-length string.

For example:

`"1024Collins Robbie"`

The following pseudocode is an initial attempt at defining a procedure `SortContacts()` that will perform a bubble sort on `Directory`. The array is to be sorted in ascending order of `Name`.

Fill in the gaps to complete the pseudocode.

Refer to the **Appendix** on page 21 for a list of built-in pseudocode functions and operators.

```
PROCEDURE SortContacts ()
DECLARE Temp : STRING
DECLARE FirstName, SecondName : STRING
DECLARE NoSwaps : ……
DECLARE Boundary, J : INTEGER
Boundary ← ……
REPEAT
   NoSwaps ← TRUE
   FOR J ← 1 TO Boundary
      FirstName ← ……(Directory[J], LENGTH(Directory[J]) – …… )
      SecondName ← RIGHT(Directory[J + 1], LENGTH(Directory[J + 1]) – 4)
      IF FirstName ……
        THEN
          Temp ← Directory[J]
          Directory[J] ← Directory ……
          Directory[J + 1] ← Temp
          NoSwaps ← ……
      ENDIF
   ENDFOR
   Boundary ← ……
UNTIL NoSwaps = TRUE
ENDPROCEDURE
```

[8]

(b) The pseudocode contains a mechanism designed to make this an efficient bubble sort.

Describe the mechanism **and** explain why it may be considered to be efficient.

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6 A company hires out rowing boats on a lake. The company has ten boats, numbered from 1 to 10.

The company is developing a program to help manage and record the hiring out process.

Hire information is stored in three global 1D arrays when a boat is hired out. Each array contains 10 elements representing each of the ten boats.

The three 1D arrays are summarised as follows:

Array	Data type	Description	Example data value
`HireTime`	`STRING`	The time the boat was hired out	`"10:15"`
`Duration`	`INTEGER`	The number of minutes of the hire	`30`
`Cost`	`REAL`	The cost of the hire	`5.75`

If an individual boat is not currently on hire, the corresponding element of the `HireTime` array will be set to `"Available"`.

The programmer has started to define program modules as follows:

Module	Description

`AddTime()`	• Called with two parameters:
	  o a `STRING` value representing a time
	  o an `INTEGER` value representing a duration in minutes
	• Adds the duration to the time to give a new time
	• Returns the new time as a `STRING`

`ListAvailable()`	• Called with a `STRING` value representing the time the hire will start
	• Outputs the boat numbers that will be available for hire at the given start time. A boat will be available for hire if it is either:
	  o currently not on hire, or
	  o due back before the given hire start time
	• Outputs the number of each boat available
	• Outputs the total number of boats available or a suitable message if there are none

`RecordHire()`	• Called with four parameters:
	  o an `INTEGER` value representing the boat number
	  o a `STRING` value representing the hire start time
	  o an `INTEGER` value representing the hire duration in minutes
	  o a `REAL` value representing the cost of hire
	• Updates the appropriate element in each array
	• Adds the cost of hire to the global variable `DailyTakings`
	• Converts the four input parameters to strings, concatenated using commas as separators, and writes the resulting string to the end of the existing text file `HireLog.txt`

(a) Write **pseudocode** for the module `ListAvailable()`.

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(b) Write **program code** for the module `RecordHire()`.

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

Module	Description

`AddTime()`	• Called with two parameters:
	  ○ a `STRING` value representing a time
	  ○ an `INTEGER` value representing a duration in minutes
	• Adds the duration to the time to give a new time
	• Returns the new time as a `STRING`

(i) Write **program code** for a statement that uses the `AddTime()` function to add a duration of 60 minutes to a start time contained in variable `BeginTime` and to assign the new time to variable `EndTime`.

Programming language .....

Program code

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..... [2]

(ii) The function `AddTime()` is to be tested using black-box testing.

Complete the following **two** tests that can be performed to check the operation of the function. Note that test 1 and test 2 are different.

Test 1 – Boat is returned during the same hour as rental starts

Start time value ..... Duration value .....

Expected new time value .....

Test 2 – Boat is returned during the hour after the rental starts

Start time value ..... Duration value .....

Expected new time value .....

[2]

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Appendix

Built-in functions (pseudocode)

`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`

`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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