Cambridge Assessment International Education

# Cambridge International AS & A Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

*1753414975*

**COMPUTER SCIENCE** **9608/23**

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 **20** pages. Blank pages are indicated.


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**1** **(a)** Algorithms are produced during program development.

State when you would produce an algorithm during program development **and** state its purpose.

When .....

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Purpose .....

.....
[2]

**(b)** Selection is one of the basic constructs used in algorithms.

Explain the term **selection**.

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..... [2]

**(c)** Explain the process of **problem decomposition**. State one reason it may be used.

Explanation .....

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Reason .....

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[2]

**(d)** Name **two** features provided by a typical Integrated Development Environment (IDE) that assist in the **debugging** stage of the program development cycle.

1 .....

2 .....
[2]

**2** **(a)** A structure chart is often produced as part of a modular program design. The chart shows the relationship between modules and the parameters that are passed between them.

Give **two other** features the structure chart can show.

Feature 1 .....

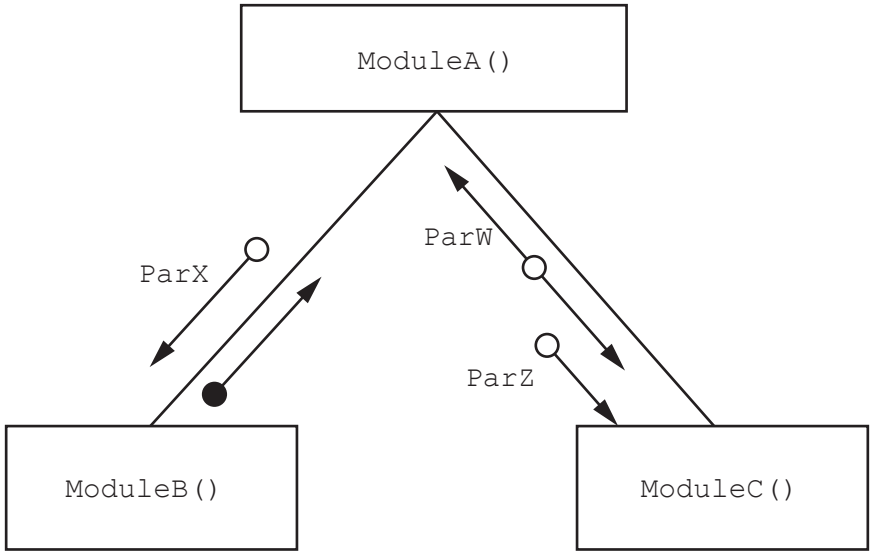
.....

Feature 2 .....

.....

[2]

**(b)** The following structure chart shows the relationship between three modules.




Parameter data types are:

```
ParW : REAL
ParX : INTEGER
ParZ : STRING
```

**(i)** Write the **pseudocode** header for module `ModuleB()`.

.....

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..... [3]

**(ii)** Write the **pseudocode** header for module `ModuleC()`.

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..... [3]

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**(c)** A student is developing an algorithm to count the number of times a given string, `SearchString`, appears in a 2D array. The array, `Item`, consists of 100 elements organised as 50 rows of 2 columns. `SearchString` could appear in any row or column.

The array is declared in pseudocode as follows:

```
DECLARE Item : ARRAY [1:50, 1:2] OF STRING
```

The structured English description of the algorithm is:

1. SET Count to 0.
2. Examine the first row of the array.
3. IF column 1 element value is equal to `SearchString`, ADD 1 to Count.
4. IF column 2 element value is equal to `SearchString`, ADD 1 to Count.
5. REPEAT from step 3 for next row, UNTIL row is last row.
6. OUTPUT a suitable message and Count.

Write **pseudocode** for the algorithm.

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**3** **(a)** Study the following pseudocode.

```
Error ← Delta(Plan, Actual)
CASE OF Error
    > 10 : Steer ← Steer - 10
       0 : ZCount ← ZCount + 1
   < -10 : Steer ← Steer + 10
   OTHERWISE OUTPUT "Unexpected Error"
ENDCASE
```

Draw a program flowchart to represent the pseudocode. Variable declarations are **not** required in program flowcharts.

[5]

**(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 five characters
- contain at least one numeric digit
- contain at least one upper case letter
- contain at least one other character (not a numeric digit or an upper case letter).

```
10 FUNCTION Check(InString : STRING) RETURNS BOOLEAN
11
12   DECLARE Index : INTEGER
13   DECLARE StrLen : INTEGER
14   DECLARE NumUpper, NumDigit : INTEGER
15   DECLARE NextChar : CHAR
16   DECLARE NumOther : INTEGER
17
18   NumUpper ← 0
19   NumDigit ← 0
20
21   StrLen ← LENGTH(InString)
22   IF StrLen < 6
23      THEN
24         RETURN FALSE
25      ELSE
26         FOR Index ← 1 TO StrLen - 1
27            // loop for each character
28            NextChar ← MID(InString, Index, 1)
29            IF NextChar >= '0' AND NextChar <= '9'
30               THEN
31                  NumDigit ← NumDigit + 1 // count digits
32               ELSE
33                  IF NextChar >= 'A' AND NextChar <= 'Z'
34                     THEN
35                        NumUpper ← NumUpper + 1 // count upper case
36                  ENDIF
37            ENDIF
38         ENDFOR
39   ENDIF
40
41   NumOther ← StrLen – (NumDigit – NumUpper)
42   IF NumDigit >= 1 AND NumUpper >= 1 AND NumOther >= 1
43      THEN
44         RETURN TRUE
45      ELSE
46         RETURN FALSE
47   ENDIF
48
49 ENDFUNCTION
```

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The pseudocode does not work under all circumstances.

The function was dry run with the string `"1234AP"` and the following trace table was produced. The string is an invalid password, but the pseudocode returned the value `TRUE`.

| Trace table row | StrLen | Index | NextChar | NumUpper | NumDigit | NumOther |
|---|---|---|---|---|---|---|
| 1 | 6 | | | 0 | 0 | |
| 2 | | 1 | '1' | | | |
| 3 | | | | | 1 | |
| 4 | | 2 | '2' | | | |
| 5 | | | | | 2 | |
| 6 | | 3 | '3' | | | |
| 7 | | | | | 3 | |
| 8 | | 4 | '4' | | | |
| 9 | | | | | 4 | |
| 10 | | 5 | 'A' | | | |
| 11 | | | | 1 | | |
| 12 | | | | | | 3 |

**(i)** The pseudocode algorithm contains two errors.

State how the given trace table indicates the existence of each error.

Error 1 .....

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Error 2 .....

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.....

.....

[2]

**(ii)** Give the line number of each error in the pseudocode algorithm **and** write the modified pseudocode to correct each error.

Line number for error 1 .....

Correct pseudocode .....

.....

Line number for error 2 .....

Correct pseudocode .....

.....
[2]

**(c)** The term **adaptive maintenance** refers to amendments that are made in response to changes to the program specification. These changes usually affect the program algorithm.

Name **one other** part of the design that can change as a result of adaptive maintenance.

..... [1]

**4** A global 1D array, `Contact`, of type `STRING` is used to store a list of names and email addresses. There are 1000 elements in the array. Each element stores one data item. The format of each data item is as follows:

```
<Name>':'<EmailAddress>
```

`Name` and `EmailAddress` are both variable-length strings.

For example:

```
"Wan Zhu:zwan99@mymail.com"
```

A function, `Extract()`, is part of the program that processes the array. A string data item is passed to the function as a parameter. The function will return the `Name` part. Validation is **not** necessary.

**(a)** Write **program code** for the function `Extract()`.

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)** The original function, `Extract()`, needs to be modified to separate the name from the email address. The calling program can then use **both** of these values.

Write, in **pseudocode**, the header for the modified subroutine. Explain the changes you have made.

Subroutine header .....

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Explanation .....

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[3]

**5** A company hires out rowing boats on a lake. The company has 20 boats, numbered from 1 to 20.

For safety reasons, the boats have to be serviced (checked and any damage repaired) regularly.

The company is developing a program to help manage the servicing of the boats.

Every time a boat is serviced, details are added at the end of the text file, `ServiceLog.txt`, as a single line of information. Each boat is serviced before it is hired out for the first time.

The format of each line is as follows:

```
<BoatNumber><Date>
```

`BoatNumber` and `Date` are as follows:

- `BoatNumber` is a two-digit numeric string in the range `"01"` to `"20"`
- `Date` is an 8-digit numeric string in the format YYYYMMDD

The programmer has defined the first module as follows:

| Module | Description |
|---|---|
| `GetLastService()` | • Called with a string parameter representing the `BoatNumber`<br>• Searches through the file `ServiceLog.txt`<br>• Returns the date of the last service in the form "YYYYMMDD" |

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

Refer to the **Appendix** on page 19 for a list of built-in pseudocode functions and operators.

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**(b) (i)** Every time a boat is hired out, details of the hire are added at the end of a text file, `Hirelog.txt`. Each line of the text file corresponds to information about the hire of one boat.

The format of each line of information is as follows:

```
<Date><BoatNumber><HireDuration>
```

- `Date` is an 8-digit numeric string in the format YYYYMMDD
- `BoatNumber` is a two-digit numeric string in the range `"01"` to `"20"`
- `HireDuration` is a variable-length string representing a numeric value in hours. For example, the string `"1.5"` would represent a hire duration of 1½ hours.

A module `GetHours()` is defined as follows:

| Module | Description |
|---|---|
| `GetHours()` | • Takes two parameters:<br>◦ the `BoatNumber` as a string<br>◦ the date of the last service for that boat ("YYYYMMDD") as a string<br>• Searches through file `Hirelog.txt` and calculates the sum of the hire durations for the given boat **after** the given date (hire durations **on or before** the given date are ignored)<br>• Returns the total of the hire durations as a real |

Note:

Standard comparison operators may be used with dates in this format.
For example:

`"20200813" > "20200812"` would evaluate to `TRUE`

Parameter validation is **not** required.

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Write **pseudocode** for the module `GetHours()`.

Refer to the **Appendix** on page 19 for a list of built-in pseudocode functions and operators.

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**(ii)** An additional module, `Validate()`, has been written to check that a given string corresponds to a valid `BoatNumber`. A valid `BoatNumber` is a two-digit numeric string in the range `"01"` to `"20"`.

Give **three** test strings that are **invalid** for different reasons. Explain your choice in each case.

String 1 .....

Reason .....

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.....

String 2 .....

Reason .....

.....

.....

String 3 .....

Reason .....

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[6]

**(c)** A new module is described as follows:

| Module | Description |
|---|---|
| `ServiceList()` | • Takes an integer as a parameter that represents the maximum number of hours before a boat must be serviced<br>• Uses `GetLastService()` and `GetHours()`<br>• Outputs:<br>◦ a suitable heading<br>◦ the `BoatNumber` of each boat hired for more than the maximum number of hours since its last service<br>◦ the total hire duration for each of these boats<br>An example output list is:<br>`Boat Service List`<br>`4: 123`<br>`17: 117`<br>If no boats are due to be serviced, the output is:<br>`Boat Service List`<br>`No boats are due to be serviced` |

Write **program code** for the module `ServiceList()`.

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

Programming language .....

Program code

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**(d) (i)** A team of programmers will work on the program. Before they begin, the team meet to discuss ways in which the risk of program faults may be reduced during the design and coding stages.

State **two** ways to minimise program faults during the design and coding stages.

1 .....

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2 .....

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[2]

**(ii)** During development, the team test the program using a process known as stub testing.

Explain this process.

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..... [2]

**(iii)** Explain how single stepping may be used to help find a logic error in a program.

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..... [2]

## 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 `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"`

`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"`

`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"`

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

Example: `STRING_TO_NUM("23.45")` returns `23.45`

### Operators (pseudocode)

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

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