Cambridge Assessment International Education

Cambridge International AS & A Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

2390708169

COMPUTER SCIENCE **9618/21**

Paper 2 Fundamental Problem-solving and Programming Skills **October/November 2021**

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 **20** pages. Any blank pages are indicated.

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

1 Sylvia is testing a program that has been written by her colleague. Her colleague tells her that the program does not contain any syntax errors.

(a) (i) State what her colleague means by "does not contain any syntax errors".

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..... [1]

(ii) Identify **and** describe **one** other type of error that the program may contain.

Type of error .....

Description .....

.....

[2]

(b) Complete the following table by giving the appropriate data type in each case.

Use of variable	Data type
The average mark in a class of 40 students	
An email address	
The number of students in the class	
To indicate whether an email has been read	

[4]

(c) An airline wants to provide passengers with information about individual flights and allow them to book their flight using an online booking system.

(i) Tick (✓) **one** box in each row of the table to indicate whether each item of information would be essential for the customer when making the booking.

Information	Essential	Not essential
Departure time		
Flight number		
Departure airport		
Aircraft type		
Ticket price		
Number of seats in aircraft		

[3]

(ii) Identify the technique used to filter out information that is not essential when designing the booking system **and** state one benefit of this technique.

Technique .....

Benefit .....

.....

[2]

(iii) Identify **two additional** pieces of essential information that a passenger might need when booking a flight.

1 .....

2 .....

[2]

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2 **(a)** An algorithm to sort a 1D array into ascending order is described as follows:

- move the largest value to the end
- keep repeating until the array is sorted.

Apply the process of stepwise refinement to this algorithm in order to produce a more detailed description.

Write the more detailed description using **structured English**. Your explanation of the algorithm should not include pseudocode statements.

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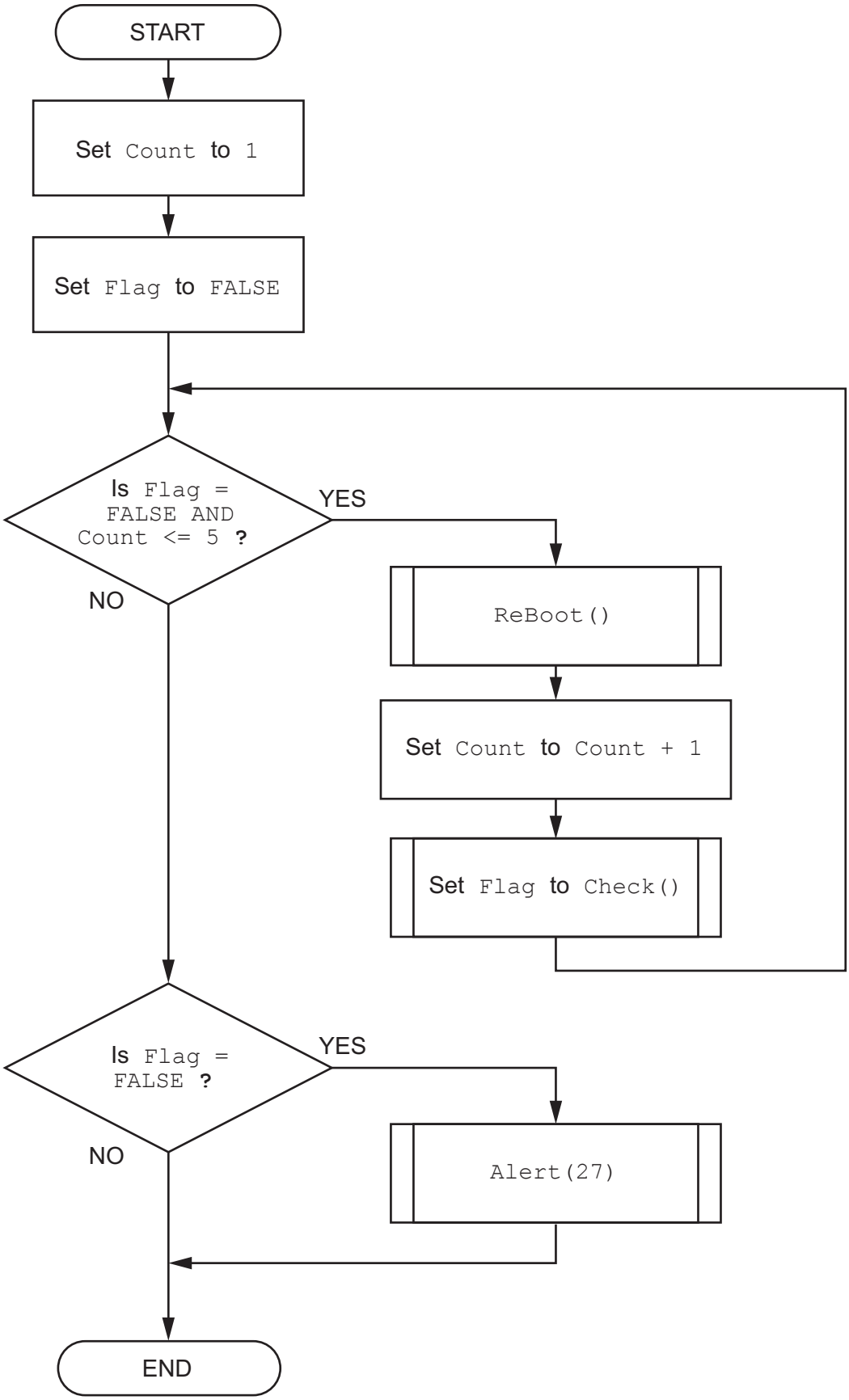
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..... [6]

(b) The program flowchart shown describes a simple algorithm.



Write pseudocode for the simple algorithm shown on page 6.

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..... [6]

3 **(a)** The diagram below represents a queue Abstract Data Type (ADT) that can hold a maximum of eight items.

The operation of this queue may be summarised as follows:

- The front of queue pointer points to the next item to be removed.
- The end of queue pointer points to the last item added.
- The queue is circular so that empty storage elements can be reused.

0	Frog	← Front of queue pointer
1	Cat	
2	Fish	
3	Elk	← End of queue pointer
4		
5		
6		
7		

(i) Describe how "Octopus" is added to the given queue.

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..... [2]

(ii) Describe how the next item in the given queue is removed and stored in the variable `AnimalName`.

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..... [2]

(iii) Describe the state of the queue when the **front of queue** and the **end of queue** pointers have the same value.

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..... [1]

(b) Some operations are carried out on the original queue given in **part (a)**.

(i) The current state of the queue is:

0	Frog
1	Cat
2	Fish
3	Elk
4	
5	
6	
7	

Complete the diagram to show the state of the queue after the following operations:

Add “Wasp”, “Bee” and “Mouse”, and then remove two data items.

[3]

(ii) The state of the queue after other operations are carried out is shown:

0	Frog	
1	Cat	
2	Fish	
3	Elk	← Front of queue pointer
4	Wasp	
5	Bee	
6	Mouse	← End of queue pointer
7	Ant	

Complete the following diagram to show the state of the queue after the following operations:

Remove one item, and then add “Dolphin” and “Shark”.

0	
1	
2	
3	
4	
5	
6	
7	

[2]

(c) The queue is implemented using a 1D array.

Describe the algorithm that should be used to modify the **end of queue pointer** when adding an item to the queue.

Your algorithm should detect any potential error conditions.

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..... [3]

4 A program controls the heating system in a sports hall.

Part of the program involves reading a value from a sensor. The sensor produces a numeric value that represents the temperature. The value is an integer, which should be in the range 0 to 40 inclusive.

A program function has been written to validate the values from the sensor.

(a) A test plan is needed to test the function.

Complete the table. The first line has been completed for you.

You can assume that the sensor will generate only integer data values.

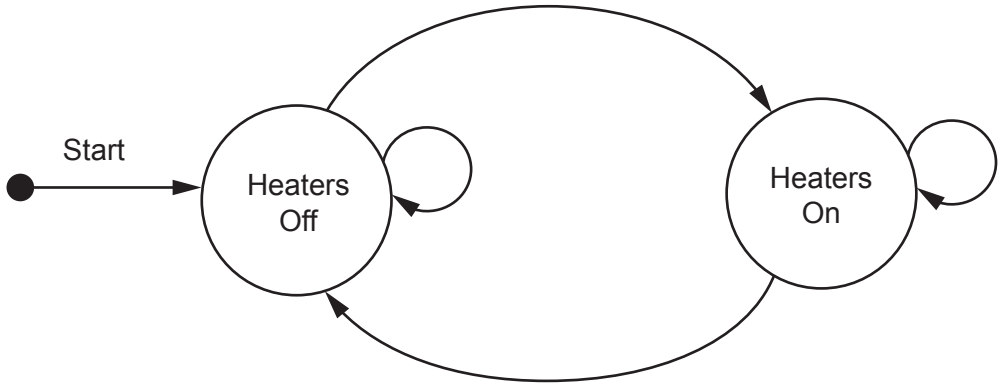
Test	Test data value	Explanation	Expected outcome
1	23	Normal data	Data is accepted
2			
3			
4			
5			

[4]

(b) A program module controls the heaters. This module operates as follows:

- If the temperature is below 10, switch the heaters on.
- If the temperature is above 20, switch the heaters off.

Complete the following state-transition diagram for the heating system:



[3]

5 The following data items will be recorded each time a student successfully logs on to the school network:

Data item	Example data
Student ID	`"CJL404"`
Host ID	`"Lib01"`
Time and date	`"08:30, June 01, 2021"`

The Student ID is six characters long. The other two data items are of variable length.

A single string will be formed by concatenating the three data items. A separator character will need to be inserted between items two and three.

For example:

```
"CJL404Lib01<separator>08:30, June 01, 2021"
```

Each string represents one log entry.

A programmer decides to store the concatenated strings in a 1D array `LogArray` that contains 2000 elements. Unused array elements will contain an empty string.

(a) Suggest a suitable separator character **and** give a reason for your choice.

Character .....

Reason .....

.....

[2]

(b) The choice of data structure was made during one stage of the program development life cycle.

Identify this stage.

..... [1]

(c) A function `LogEvents()` will:

- take a Student ID as a parameter
- for each element in the array that matches the Student ID parameter:
  - add the value of the array element to the existing text file `LogFile`
  - assign an empty string to the array element
- count the number of lines added to the file
- return this count.

Write pseudocode for the function `LogEvents()`.

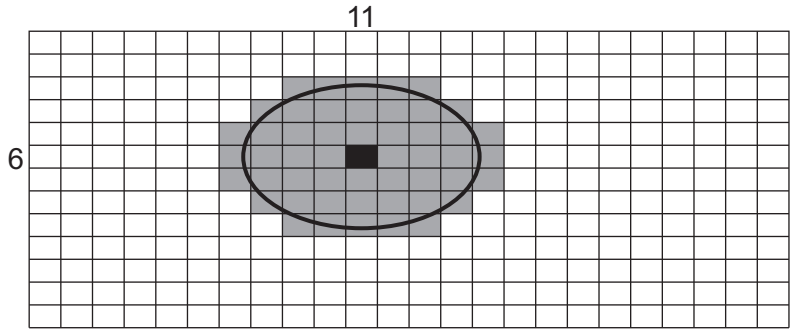
..... [7]

6 A mobile phone has a touchscreen. The screen is represented by a grid, divided into 800 rows and 1280 columns.

The grid is represented by a 2D array `Screen` of type `INTEGER`. An array element will be set to 0 unless the user touches that part of the screen.

Many array elements are set to 1 by a single touch of a finger or a stylus.

The following diagram shows a simplified touchscreen. The dark line represents a touch to the screen. All grid elements that are wholly or partly inside the outline will be set to 1. These elements are shaded.
The element shaded in black represents the centre point.



A program is needed to find the coordinates (the row and column) of the centre point. The centre point on the diagram above is row 6, column 11.

Assume:

- the user may only touch one area at a time
- screen rotation does not affect the touchscreen.

The programmer has started to define program modules as follows:

Module	Description
`SetRow()` (generates test data)	• Called with three parameters of type `INTEGER`: ◦ a row number ◦ the number of pixels to be skipped starting from column 1 ◦ the number of pixels that should be set to 1 • Sets the required number of pixels to 1 For example, `SetRow(3, 8, 5)` will give row 3 as in the diagram shown.
`SearchInRow()`	• Takes two parameters of type `INTEGER`: ◦ a row number ◦ a start column (1 or 1280) • Searches the given row from the start column (either left to right or right to left) for the first column that contains an element set to 1 • Returns the column number of the first element in the given row that is set to 1 • Returns −1 if no element is set to 1
`SearchInCol()`	• Takes two parameters of type `INTEGER`: ◦ a column number ◦ a start row (1 or 800) • Searches the given column from the start row (either up or down) for the first row that contains an element set to 1 • Returns the row number of the first element in the given column that is set to 1 • Returns −1 if no element is set to 1

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(a) Write pseudocode to implement the module `SetRow()`.

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..... [5]

(b) The module description of `SearchInRow()` is provided here for reference.

Module	Description
`SearchInRow()`	• Takes two parameters of type `INTEGER`: ◦ a row number ◦ a start column (1 or 1280) • Searches the given row from the start column (either left to right or right to left) for the first column that contains an element set to 1 • Returns the column number of the first element in the given row that is set to 1 • Returns −1 if no element is set to 1

Write pseudocode to implement the module `SearchInRow()`.

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..... [8]

(c) The following new module is introduced:

Module	Description
`GetCentreCol()`	• Called with a row number as an `INTEGER` • Uses `SearchInRow()` to find the first and last columns in the given row which have an array element set to 1 • Returns the index of the column midway between the first and last columns • Returns −1 if no element is set to 1

Write pseudocode to implement the module `GetCentreCol()`.

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