Cambridge Assessment International Education

Cambridge International AS & A Level

COMPUTER SCIENCE **9618/21**

Paper 2 Problem Solving & Programming **October/November 2021**

MARK SCHEME

Maximum Mark: 75

Published

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge International will not enter into discussions about these mark schemes.

Cambridge International is publishing the mark schemes for the October/November 2021 series for most Cambridge IGCSE™, Cambridge International A and AS Level components and some Cambridge O Level components.

[Turn over

Generic Marking Principles

These general marking principles must be applied by all examiners when marking candidate answers. They should be applied alongside the specific content of the mark scheme or generic level descriptors for a question. Each question paper and mark scheme will also comply with these marking principles.

GENERIC MARKING PRINCIPLE 1:

Marks must be awarded in line with:

- the specific content of the mark scheme or the generic level descriptors for the question
- the specific skills defined in the mark scheme or in the generic level descriptors for the question
- the standard of response required by a candidate as exemplified by the standardisation scripts.

GENERIC MARKING PRINCIPLE 2:

Marks awarded are always **whole marks** (not half marks, or other fractions).

GENERIC MARKING PRINCIPLE 3:

Marks must be awarded **positively**:

- marks are awarded for correct/valid answers, as defined in the mark scheme. However, credit is given for valid answers which go beyond the scope of the syllabus and mark scheme, referring to your Team Leader as appropriate
- marks are awarded when candidates clearly demonstrate what they know and can do
- marks are not deducted for errors
- marks are not deducted for omissions
- answers should only be judged on the quality of spelling, punctuation and grammar when these features are specifically assessed by the question as indicated by the mark scheme. The meaning, however, should be unambiguous.

GENERIC MARKING PRINCIPLE 4:

Rules must be applied consistently, e.g. in situations where candidates have not followed instructions or in the application of generic level descriptors.

GENERIC MARKING PRINCIPLE 5:

Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen).

GENERIC MARKING PRINCIPLE 6:

Marks awarded are based solely on the requirements as defined in the mark scheme. Marks should not be awarded with grade thresholds or grade descriptors in mind.

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>1(a)(i)</td><td>One from:

• The program obeys the rules / grammar of the programming language used
• The program will run // it can be compiled / interpreted
• Accept by example. e.g. 'no mis-spelt keywords' / 'all brackets match'</td><td>1</td></tr>
<tr><td>1(a)(ii)</td><td>One mark for type plus one for corresponding description

Type of error: A logic error

Description:
• An error in the algorithm / design of the solution
• the program does not behave as expected / give the expected output.
• Accept by example e.g. wrong arithmetic operator used / wrong loop count

OR

Type of error: Run-time error

Description:
• The program performs an illegal instruction / invalid operation
• Accept by example: divide by zero or endless loop or simply 'crashes' / freezes</td><td>2</td></tr>
<tr><td>1(b)</td><td><table><tr><th>Use of variable</th><th>Data type</th></tr><tr><td>The average mark in a class of 40 students</td><td>REAL</td></tr><tr><td>An email address</td><td>STRING</td></tr><tr><td>The number of students in the class</td><td>INTEGER</td></tr><tr><td>Indicate whether an email has been read</td><td>BOOLEAN</td></tr></table>
One mark per row</td><td>4</td></tr>
</table>

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>1(c)(i)</td><td>
<table>
<tr><th>Information</th><th>Essential</th><th>Not essential</th></tr>
<tr><td>Departure time</td><td>✓</td><td></td></tr>
<tr><td>Flight Number</td><td></td><td>✓</td></tr>
<tr><td>Departure airport</td><td>✓</td><td></td></tr>
<tr><td>Aircraft type</td><td></td><td>✓</td></tr>
<tr><td>Ticket price</td><td>✓</td><td></td></tr>
<tr><td>Number of seats in aircraft</td><td></td><td>✓</td></tr>
</table>
One mark for two rows correct
Two mark for four rows correct
Three mark for all rows correct
</td><td>3</td></tr>
<tr><td>1(c)(ii)</td><td>One mark for technique and one for benefit, Max 1 mark for 'Benefit'

Technique: Abstraction

Benefit:
• The solution is simplified so easier / quicker to design / implement
• The system is tailored to the need of the user</td><td>2</td></tr>
<tr><td>1(c)(iii)</td><td>Answers include:

• Destination / arrival airport
• Arrival time / flight duration
• Date of flight
• Seat number
• Seat availability

Max 2 marks</td><td>2</td></tr>
</table>

Question	Answer	Marks
2(a)	One mark for reference to: 1 The use a variable as an index to the array 2 A loop to iterate through the array 3 An Inner loop (with a reducing range) 4 Test if current element is greater than next element 5 if so then swap elements 6 Description of swap 7 Attempt at efficient algorithm **Max 6** marks	**6**

Question	Answer	Marks

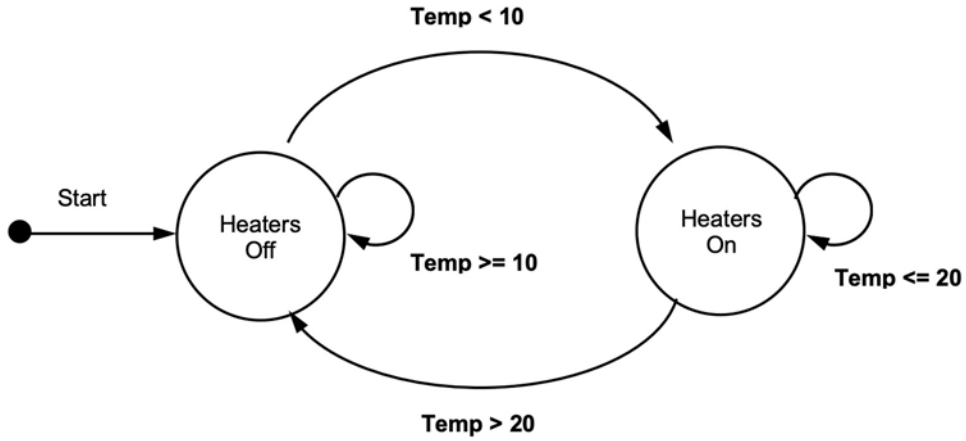
2(b)	`Count ← 1`
	`Flag ← FALSE`
	`WHILE Flag = FALSE AND Count <= 5`
	`  CALL ReBoot()`
	`  Count ← Count + 1`
	`  Flag ← Check()`
	`ENDWHILE`
	
	`IF Flag = FALSE THEN`
	`  CALL Alert(27)`
	`ENDIF`
	
	One mark per point:
	
	1 Initialisation of `Count` **AND** `Flag`
	2 `WHILE ... ENDWHILE // REPEAT ... UNTIL` loop
	3 ... including both conditions
	4 Call `ReBoot()` **AND** increment `Count` **inside the loop**
	5 Assign return value from `Check()` to `Flag` **inside the loop**
	6 Final test of `Flag` **AND** call to `Alert(27)` **not in a loop**
		6

Question	Answer	Marks
3(a)(i)	One mark per point: • `EoQ` pointer will move to point to location 4 // incremented `EoQ` (by 1) • Data value "Octopus" will be stored in location pointed to be `EoQ` / location 4	**2**
3(a)(ii)	One mark for each bullet • Value "Frog" // value pointed to by `FoQ` / location 0 is assigned to variable `AnimalName` • `FoQ` pointer will move to point to location 1 / point to "Cat" // incremented `FoQ` (by 1) **0** Frog ← **Front of queue pointer** **1** Cat **2** Fish **3** Elk ← **End of queue pointer**	**2**
3(a)(iii)	There is only one data item in the queue	**1**

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>3(b)(i)</td><td>One mark for data values plus one mark for pointers

<table><tr><td>0</td><td>Frog</td><td></td></tr><tr><td>1</td><td>Cat</td><td></td></tr><tr><td>2</td><td>Fish</td><td>← Front of queue pointer</td></tr><tr><td>3</td><td>Elk</td><td></td></tr><tr><td>4</td><td>Wasp</td><td></td></tr><tr><td>5</td><td>Bee</td><td></td></tr><tr><td>6</td><td>Mouse</td><td>← End of queue pointer</td></tr><tr><td>7</td><td></td><td></td></tr></table>
One mark for each pointer
One mark for three new data values</td><td>3</td></tr>
<tr><td>3(b)(ii)</td><td><table><tr><td>0</td><td>Shark</td><td>← End of queue pointer</td></tr><tr><td>1</td><td>(Cat)</td><td></td></tr><tr><td>2</td><td>(Fish)</td><td></td></tr><tr><td>3</td><td>(Elk)</td><td></td></tr><tr><td>4</td><td>Wasp</td><td>← Front of queue pointer</td></tr><tr><td>5</td><td>Bee</td><td></td></tr><tr><td>6</td><td>Mouse</td><td></td></tr><tr><td>7</td><td>Dolphin</td><td></td></tr></table>
One mark for BOTH pointers
One mark for all data values as shown</td><td>2</td></tr>
<tr><td>3(c)</td><td>One mark per point:

1 If incremented EoQ = FoQ then error condition: queue is full
2 Increment the EoQ
3 Manage wrap-around</td><td>3</td></tr>
</table>

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>4(a)</td><td>
<table>
<tr><th>Test</th><th>Test data value</th><th>Explanation</th><th>Expected Outcome</th></tr>
<tr><td>1</td><td>23</td><td>Normal Data</td><td>Data is accepted</td></tr>
<tr><td>2</td><td>0</td><td>Boundary Data</td><td>Data is accepted</td></tr>
<tr><td>3</td><td>40</td><td>Boundary Data</td><td>Data is accepted</td></tr>
<tr><td>4</td><td>>= 41</td><td>Abnormal Data</td><td>Data is rejected</td></tr>
<tr><td>5</td><td><= −1</td><td>Abnormal Data</td><td>Data is rejected</td></tr>
</table>
One mark per row for rows 2 to 5.
</td><td>4</td></tr>
<tr><td>4(b)</td><td>


One mark for each label:

Temp < 10 (Heaters Off to Heaters On)
Temp > 20 (Heaters On to Heaters Off)
on BOTH loops (non-contradictory values)

</td><td>3</td></tr>
</table>

Question	Answer	Marks
5(a)	One mark for the character and one for the corresponding reason. • Character: Any except alphabetic, numeric, ',' ':' or space • Reason: character doesn't occur in data to be recorded	**2**
5(b)	Design	**1**

Question	Answer	Marks

5(c)	`FUNCTION LogEvents(StudentID : STRING) RETURNS INTEGER`
	
	`  DECLARE FileData : STRING`
	`  DECLARE Index, Count : INTEGER`
	
	`  CONSTANT LogFile = "LogFile"`
	
	`  Count ← 0`
	`  OPENFILE LogFile FOR APPEND`
	`  FOR Index ← 1 TO 2000`
	`  FileData ← LogArray[Index]`
	
	`  IF LEFT(FileData, 6) = StudentID THEN`
	`  WRITEFILE (LogFile, FileData) //brackets optional`
	`  Count ← Count + 1`
	`  LogArray[Index] ← ""  // clear the element`
	`  ENDIF`
	`  NEXT Index`
	
	`  CLOSEFILE LogFile`
	
	`  RETURN Count`
	
	`ENDFUNCTION`
	
	1 mark for each of the following:
	
	1 Function heading and ending including parameter **and** return type
	2 `OPEN` file `LogFile` for `APPEND` and subsequent `CLOSE`
	3 Loop for 2000 iterations
	4 Extract first 6 characters from array element **in a loop**
	5 Compare first 6 characters with parameter **in a loop**
	6 If equal:
	• write whole array element string to file **and**
	• increment `Count` **and**
	• clear array element **in a loop**
	7 Return Count (must have been declared **and** initialised)
		7

Question	Answer	Marks

6(a)	`PROCEDURE SetRow(Row, SkipNum, SetNum : INTEGER)`
	`  DECLARE Col : INTEGER`
	
	`  // array is 1280 x 800`
	
	`  FOR Col ← SkipNum + 1 TO SkipNum + SetNum`
	`  Screen[Row, Col] ← 1`
	`  NEXT Index`
	
	`ENDPROCEDURE`
	
	ALTERNATIVE 1:
	
	`  FOR Col ← 1 TO SetNum`
	`  Screen[Row, SkipNum + Col] ← 1`
	`  NEXT Col`
	
	ALTERNATIVE 2:
	
	`  WHILE SetNum > 0`
	`  Screen[Row, SkipNum + SetNum] ← 1`
	`  SetNum ← SetNum - 1`
	`  ENDWHILE`
	
	Mark as follows:
	
	1 Procedure heading and ending including parameters
	2 Declaration of local Integer for `Col`
	3 Count-controlled loop with meaningful start number
	4 correct stop number
	5 Reference Screen Array element and set to 1 **in a loop**
		5

Question	Answer	Marks

6(b)	`FUNCTION SearchInRow(ThisRow, StartCol : INTEGER) RETURNS INTEGER`
	`  DECLARE ThisCol, Step : INTEGER`
	`  DECLARE Found: BOOLEAN`
	
	`  // array is 1280 x 800`
	
	`  Found ← FALSE`
	`  ThisCol ← StartCol`
	
	`  // first decide which way to search`
	`  IF StartCol = 1 THEN`
	`  Step ← 1`
	`  EndCol ← 1281`
	`  ELSE`
	`  Step ← -1`
	`  EndCol ← 0`
	`  ENDIF`
	
	`  WHILE ThisCol <> EndCol AND Found = FALSE`
	`  IF Screen[ThisRow, ThisCol] <> 1 THEN`
	`  ThisCol ← ThisCol + Step`
	`  ELSE`
	`  Found ← TRUE`
	`  ENDIF`
	`  ENDWHILE`
	
	`  IF Found = FALSE THEN`
	`  ThisCol ← -1`
	`  ENDIF`
	
	`  RETURN ThisCol`
	
	`ENDFUNCTION`
	
	Mark as follows:
	
	1 Interpreting `StartCol` parameter to determine direction of search
	2 An attempt at searching both up and down
	3 Conditional Loop / Count-controlled loop with use of `ThisCol` index
	4 Using correct values for `StartCol`, `EndCol` and `Step`
	5 Reference a `Screen` element and compare with 1 **in a loop**
	6 If equal save column or immediately Return column **in a loop**
	7 Return column number or −1
	Loop(s) terminate when element with value = 1 found
	
	Max 7 marks if function heading, including return type, and ending is incorrect or incomplete
		8

Question	Answer	Marks

6(c)	`FUNCTION GetCentreCol(ThisRow : INTEGER) RETURNS INTEGER`
	`  DECLARE StartCol, EndCol, CentreCol : INTEGER`
	
	`  StartCol ← SearchInRow(ThisRow, 1)`
	`  IF StartCol = -1 THEN`
	`  CentreCol ← StartCol`
	`  ELSE`
	`  EndCol ← SearchInRow(ThisRow, 1280)`
	`  CentreCol ← INT((StartCol + EndCol)/2)`
	`  ENDIF`
	`  RETURN CentreCol`
	`ENDFUNCTION`
	
	Mark as follows:
	
	1 Declaration of local `INTEGER` for return value
	2 Use `SearchInRow()` with correct parameters and check for `-1`
	3 Use `SearchInRow(ThisRow, 1)` and `SearchInRow(ThisRow, 1280)`
	4 Calculate centre column
	5 Use of `INT()` function // use of `DIV`
	6 Return –1 or centre value
	
	Max 5 marks if function heading, including return type, and ending is incorrect or incomplete
		6