



## Cambridge International AS & A Level

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**COMPUTER SCIENCE**

**9618/23**

Paper 2 Problem Solving & Programming

**October/November 2021**

MARK SCHEME

Maximum Mark: 75

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**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.

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This document consists of **11** printed pages.

**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.

Question	Answer	Marks										
1(a)(i)	One from: <ul style="list-style-type: none"> <li>• The program obeys the rules / grammar of the programming language used</li> <li>• The program will run // it can be compiled / interpreted</li> <li>• Accept by example. e.g. 'no mis-spelt keywords' / 'all brackets match'</li> </ul>	<b>1</b>										
1(a)(ii)	One mark for type plus one for corresponding description  Type of error: A logic error  Description: <ul style="list-style-type: none"> <li>• An error in the algorithm / design of the solution</li> <li>• the program does not behave as expected / give the expected output.</li> <li>• Accept by example e.g. wrong arithmetic operator used / wrong loop count</li> </ul> <b>OR</b>  Type of error: Run-time error  Description: <ul style="list-style-type: none"> <li>• The program performs an illegal instruction / invalid operation</li> <li>• Accept by example: divide by zero or endless loop or simply 'crashes' / freezes</li> </ul>	<b>2</b>										
1(b)	<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th data-bbox="304 1133 906 1198" style="text-align: center;">Use of variable</th> <th data-bbox="906 1133 1096 1198" style="text-align: center;">Data type</th> </tr> </thead> <tbody> <tr> <td data-bbox="304 1198 906 1263">The average mark in a class of 40 students</td> <td data-bbox="906 1198 1096 1263" style="text-align: center;"><b>REAL</b></td> </tr> <tr> <td data-bbox="304 1263 906 1328">An email address</td> <td data-bbox="906 1263 1096 1328" style="text-align: center;"><b>STRING</b></td> </tr> <tr> <td data-bbox="304 1328 906 1393">The number of students in the class</td> <td data-bbox="906 1328 1096 1393" style="text-align: center;"><b>INTEGER</b></td> </tr> <tr> <td data-bbox="304 1393 906 1458">Indicate whether an email has been read</td> <td data-bbox="906 1393 1096 1458" style="text-align: center;"><b>BOOLEAN</b></td> </tr> </tbody> </table> <p data-bbox="304 1491 544 1525">One mark per row</p>	Use of variable	Data type	The average mark in a class of 40 students	<b>REAL</b>	An email address	<b>STRING</b>	The number of students in the class	<b>INTEGER</b>	Indicate whether an email has been read	<b>BOOLEAN</b>	<b>4</b>
Use of variable	Data type											
The average mark in a class of 40 students	<b>REAL</b>											
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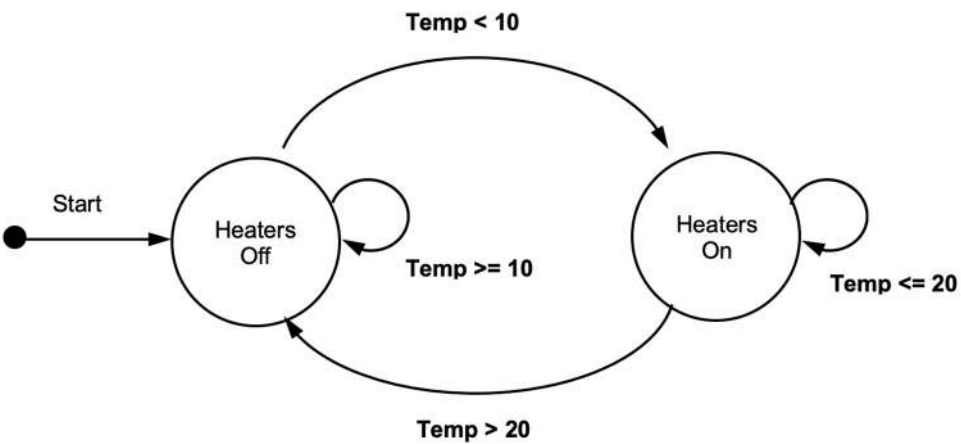
Question	Answer	Marks																					
1(c)(i)	<table border="1"> <thead> <tr> <th>Information</th> <th>Essential</th> <th>Not essential</th> </tr> </thead> <tbody> <tr> <td>Departure time</td> <td>✓</td> <td></td> </tr> <tr> <td>Flight Number</td> <td></td> <td>✓</td> </tr> <tr> <td>Departure airport</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> </tbody> </table> <p>One mark for two rows correct Two mark for four rows correct Three mark for all rows correct</p>	Information	Essential	Not essential	Departure time	✓		Flight Number		✓	Departure airport	✓		Aircraft type		✓	Ticket price	✓		Number of seats in aircraft		✓	3
Information	Essential	Not essential																					
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1(c)(ii)	<p>One mark for technique and one for benefit, <b>Max 1</b> mark for 'Benefit'</p> <p>Technique: Abstraction</p> <p>Benefit:</p> <ul style="list-style-type: none"> <li>The solution is simplified so easier / quicker to design / implement</li> <li>The system is tailored to the need of the user</li> </ul>	2																					
1(c)(iii)	<p>Answers include:</p> <ul style="list-style-type: none"> <li>Destination / arrival airport</li> <li>Arrival time / flight duration</li> <li>Date of flight</li> <li>Seat number</li> <li>Seat availability</li> </ul> <p><b>Max 2</b> marks</p>	2																					

Question	Answer	Marks
2(a)	<p>One mark for reference to:</p> <ol style="list-style-type: none"> <li>The use a variable as an index to the array</li> <li>A loop to iterate through the array</li> <li>An Inner loop (with a reducing range)</li> <li>Test if current element is greater than next element</li> <li>if so then swap elements</li> <li>Description of swap</li> <li>Attempt at efficient algorithm</li> </ol> <p><b>Max 6</b> marks</p>	6

Question	Answer	Marks
2(b)	<pre>Count ← 1 Flag ← FALSE WHILE Flag = FALSE AND Count &lt;= 5   CALL ReBoot()   Count ← Count + 1   Flag ← Check() ENDWHILE  IF Flag = FALSE THEN   CALL Alert(27) ENDIF</pre> <p>One mark per point:</p> <ol style="list-style-type: none"> <li>1 Initialisation of Count <b>AND</b> Flag</li> <li>2 WHILE ... ENDWHILE // REPEAT ... UNTIL loop</li> <li>3 ... including both conditions</li> <li>4 Call ReBoot() <b>AND</b> increment Count <b>inside the loop</b></li> <li>5 Assign return value from Check() to Flag <b>inside the loop</b></li> <li>6 Final test of Flag <b>AND</b> call to Alert(27) <b>not in a loop</b></li> </ol>	6

Question	Answer	Marks									
3(a)(i)	<p>One mark per point:</p> <ul style="list-style-type: none"> <li>• EoQ pointer will move to point to location 4 // incremented EoQ (by 1)</li> <li>• Data value "Octopus" will be stored in location pointed to be EoQ / location 4</li> </ul>	2									
3(a)(ii)	<p>One mark for each bullet</p> <ul style="list-style-type: none"> <li>• Value "Frog" // value pointed to by FoQ / location 0 is assigned to variable AnimalName</li> <li>• FoQ pointer will move to point to location 1 / point to "Cat" // incremented FoQ (by 1)</li> </ul> <table border="1" style="display: inline-table; vertical-align: middle;"> <tbody> <tr> <td style="text-align: center;">0</td> <td style="text-align: center;">Frog</td> <td rowspan="4" style="vertical-align: middle; padding-left: 10px;">← <b>Front of queue pointer</b></td> </tr> <tr> <td style="text-align: center;">1</td> <td style="text-align: center;">Cat</td> </tr> <tr> <td style="text-align: center;">2</td> <td style="text-align: center;">Fish</td> </tr> <tr> <td style="text-align: center;">3</td> <td style="text-align: center;">Elk</td> </tr> </tbody> </table> <p style="text-align: right; margin-top: 10px;">← <b>End of queue pointer</b></p>	0	Frog	← <b>Front of queue pointer</b>	1	Cat	2	Fish	3	Elk	2
0	Frog	← <b>Front of queue pointer</b>									
1	Cat										
2	Fish										
3	Elk										
3(a)(iii)	There is only one data item in the queue	1									

Question	Answer	Marks																
3(b)(i)	<p>One mark for data values plus one mark for pointers</p> <table border="1" data-bbox="308 315 550 840"> <tr><td>0</td><td>Frog</td></tr> <tr><td>1</td><td>Cat</td></tr> <tr><td>2</td><td>Fish</td></tr> <tr><td>3</td><td>Elk</td></tr> <tr><td>4</td><td><b>Wasp</b></td></tr> <tr><td>5</td><td><b>Bee</b></td></tr> <tr><td>6</td><td><b>Mouse</b></td></tr> <tr><td>7</td><td></td></tr> </table> <p>← <b>Front of queue pointer</b></p> <p>← <b>End of queue pointer</b></p> <p>One mark for each pointer One mark for three new data values</p>	0	Frog	1	Cat	2	Fish	3	Elk	4	<b>Wasp</b>	5	<b>Bee</b>	6	<b>Mouse</b>	7		<b>3</b>
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3(b)(ii)	<table border="1" data-bbox="308 972 550 1496"> <tr><td>0</td><td><b>Shark</b></td></tr> <tr><td>1</td><td>(Cat)</td></tr> <tr><td>2</td><td>(Fish)</td></tr> <tr><td>3</td><td>(Elk)</td></tr> <tr><td>4</td><td>Wasp</td></tr> <tr><td>5</td><td>Bee</td></tr> <tr><td>6</td><td>Mouse</td></tr> <tr><td>7</td><td><b>Dolphin</b></td></tr> </table> <p>← <b>End of queue pointer</b></p> <p>← <b>Front of queue pointer</b></p> <p>One mark for BOTH pointers One mark for all data values as shown</p>	0	<b>Shark</b>	1	(Cat)	2	(Fish)	3	(Elk)	4	Wasp	5	Bee	6	Mouse	7	<b>Dolphin</b>	<b>2</b>
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3(c)	<p>One mark per point:</p> <ol style="list-style-type: none"> <li>1 If incremented <math>E_{OQ} = F_{OQ}</math> then error condition: queue is full</li> <li>2 Increment the <math>E_{OQ}</math></li> <li>3 Manage wrap-around</li> </ol>	<b>3</b>																

Question	Answer				Marks
4(a)	<b>Test</b>	<b>Test data value</b>	<b>Explanation</b>	<b>Expected Outcome</b>	<b>4</b>
	1	23	Normal Data	Data is accepted	
	2	<b>0</b>	<b>Boundary Data</b>	<b>Data is accepted</b>	
	3	<b>40</b>	<b>Boundary Data</b>	<b>Data is accepted</b>	
	4	<b>&gt;= 41</b>	<b>Abnormal Data</b>	<b>Data is rejected</b>	
	5	<b>&lt;= -1</b>	<b>Abnormal Data</b>	<b>Data is rejected</b>	
	One mark per row for rows 2 to 5.				
4(b)	 <p>One mark for each label:</p> <ul style="list-style-type: none"> <li>• Temp &lt; 10 (Heaters Off to Heaters On)</li> <li>• Temp &gt; 20 (Heaters On to Heaters Off)</li> <li>• on <b>BOTH</b> loops (non-contradictory values)</li> </ul>				<b>3</b>

Question	Answer	Marks
5(a)	One mark for the character and one for the corresponding reason. <ul style="list-style-type: none"> <li>• Character: Any except alphabetic, numeric, ',' ':' or space</li> <li>• Reason: character doesn't occur in data to be recorded</li> </ul>	<b>2</b>
5(b)	Design	<b>1</b>

Question	Answer	Marks
5(c)	<pre> 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 </pre> <p>1 mark for each of the following:</p> <ol style="list-style-type: none"> <li>1 Function heading and ending including parameter <b>and</b> return type</li> <li>2 OPEN file LogFile for APPEND and subsequent CLOSE</li> <li>3 Loop for 2000 iterations</li> <li>4 Extract first 6 characters from array element <b>in a loop</b></li> <li>5 Compare first 6 characters with parameter <b>in a loop</b></li> <li>6 If equal:       <ul style="list-style-type: none"> <li>• write whole array element string to file <b>and</b></li> <li>• increment Count <b>and</b></li> <li>• clear array element <b>in a loop</b></li> </ul> </li> <li>7 Return Count (must have been declared <b>and</b> initialised)</li> </ol>	7



Question	Answer	Marks
6(a)	<pre> 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 &gt; 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 <b>in a loop</b> </pre>	<b>5</b>

Question	Answer	Marks
6(b)	<pre> 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 &lt;&gt; EndCol AND Found = FALSE     IF Screen[ThisRow, ThisCol] &lt;&gt; 1 THEN       ThisCol ← ThisCol + Step     ELSE       Found ← TRUE     ENDIF   ENDWHILE    IF Found = FALSE THEN     ThisCol ← -1   ENDIF    RETURN ThisCol  ENDFUNCTION </pre> <p>Mark as follows:</p> <ol style="list-style-type: none"> <li>1 Interpreting <code>StartCol</code> parameter to determine direction of search</li> <li>2 An attempt at searching both up and down</li> <li>3 Conditional Loop / Count-controlled loop with use of <code>ThisCol</code> index</li> <li>4 Using correct values for <code>StartCol</code>, <code>EndCol</code> and <code>Step</code></li> <li>5 Reference a <code>Screen</code> element and compare with 1 <b>in a loop</b></li> <li>6 If equal save column or immediately Return column <b>in a loop</b></li> <li>7 Return column number or -1</li> </ol> <p>Loop(s) terminate when element with value = 1 found</p> <p><b>Max 7</b> marks if function heading, including return type, and ending is incorrect or incomplete</p>	8

Question	Answer	Marks
6(c)	<pre> 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 </pre> <p>Mark as follows:</p> <ol style="list-style-type: none"> <li>1 Declaration of local INTEGER for return value</li> <li>2 Use SearchInRow() with correct parameters and check for -1</li> <li>3 Use SearchInRow(ThisRow, 1) and SearchInRow(ThisRow, 1280)</li> <li>4 Calculate centre column</li> <li>5 Use of INT() function // use of DIV</li> <li>6 Return -1 or centre value</li> </ol> <p><b>Max 5</b> marks if function heading, including return type, and ending is incorrect or incomplete</p>	<b>6</b>