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**COMPUTER SCIENCE**

**9608/43**

Paper 4 Written Paper

**May/June 2019**

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.

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This document consists of **13** 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)	<div>1 mark for correct stack</div> <div><div></div><div></div><div></div><div>orange</div><div>purple</div><div>green</div><div>blue</div><div>red</div></div>	1
1(a)(ii)	<div>1 mark for correct stack</div> <div><div></div><div></div><div></div><div></div><div>black</div><div>green</div><div>blue</div><div>red</div></div>	1
1(b)	<div>1 mark per bullet point to max 3</div> <div><ul style="list-style-type: none"><li>• (Linear) data structure</li><li>• First in First out // FIFO // An item is added to the end of the queue <b>and</b> an item is removed from the front</li><li>• All items are kept in the order they are entered</li><li>• It has a head pointer and a tail pointer</li><li>• Can be static or dynamic</li><li>• A queue can be circular ...</li><li>• ...when the (tail) pointer reaches the last position it returns to the first</li></ul></div>	3

Question	Answer	Marks
2(a)(i)	<p>1 mark per bullet point</p> <ul style="list-style-type: none"> <li>• 95 to left of 97</li> <li>• 109 to left of 121</li> <li>• 135 to right of 125</li> <li>• 149 to right of 135</li> <li>• Null points in all places and no inappropriate pointers</li> </ul> <p>RootPointer</p>	5

Question	Answer	Marks																																												
2(a)(ii)	<p>1 mark per bullet point</p> <ul style="list-style-type: none"><li>• FreePointer as 8</li><li>• 99</li><li>• 125</li><li>• 121 and 97</li><li>• 109 and 95</li><li>• 135 and 149</li></ul> <table><tr><td>RootPointer</td></tr><tr><td>0</td></tr></table> <table><tr><td>FreePointer</td></tr><tr><td>8</td></tr></table> <table><tr><th>Index</th><th>LeftPointer</th><th>Data</th><th>RightPointer</th></tr><tr><td>[0]</td><td>3</td><td>99</td><td>1</td></tr><tr><td>[1]</td><td>2</td><td>125</td><td>6</td></tr><tr><td>[2]</td><td>4</td><td>121</td><td>null</td></tr><tr><td>[3]</td><td>5</td><td>97</td><td>null</td></tr><tr><td>[4]</td><td>null</td><td>109</td><td>null</td></tr><tr><td>[5]</td><td>null</td><td>95</td><td>null</td></tr><tr><td>[6]</td><td>null</td><td>135</td><td>7</td></tr><tr><td>[7]</td><td>null</td><td>149</td><td>null</td></tr><tr><td>[8]</td><td></td><td></td><td></td></tr></table>	RootPointer	0	FreePointer	8	Index	LeftPointer	Data	RightPointer	[0]	3	99	1	[1]	2	125	6	[2]	4	121	null	[3]	5	97	null	[4]	null	109	null	[5]	null	95	null	[6]	null	135	7	[7]	null	149	null	[8]				6
RootPointer																																														
0																																														
FreePointer																																														
8																																														
Index	LeftPointer	Data	RightPointer																																											
[0]	3	99	1																																											
[1]	2	125	6																																											
[2]	4	121	null																																											
[3]	5	97	null																																											
[4]	null	109	null																																											
[5]	null	95	null																																											
[6]	null	135	7																																											
[7]	null	149	null																																											
[8]																																														
2(b)	<p>1 mark for each completed section</p> <pre>FUNCTION FindElement(Item : INTEGER) RETURNS INTEGER     CurrentPointer ← RootPointer     WHILE CurrentPointer &lt;&gt; NullPointer         IF List[CurrentPointer].Data &lt;&gt; Item             THEN                 CurrentPointer ← List[CurrentPointer].Pointer             ELSE                 RETURN CurrentPointer             ENDIF     ENDWHILE     CurrentPointer ← NullPointer     RETURN CurrentPointer ENDFUNCTION</pre>	6																																												
2(c)(i)	<p>1 mark per bullet point to max 3</p> <p>e.g.</p> <ul style="list-style-type: none"><li>• A sequence of steps that change the state of the program</li><li>• The steps are in the order they should be carried out</li><li>• e.g. procedural programming/language</li><li>• Groups code into self-contained blocks // split the program into modules</li><li>• ... which are subroutines // by example</li></ul>	3																																												

Question	Answer	Marks
2(c)(ii)	<p>1 mark per bullet point to max 3</p> <p>e.g.</p> <ul style="list-style-type: none"> <li>• Creates classes</li> <li>• ...as a blueprint for an object // objects are instances of classes</li> <li>• ...that have properties/attributes <b>and</b> methods</li> <li>• ... that can be private to the class // properties can <b>only</b> be accessed by the class's methods // encapsulation</li> <li>• <b>Subclasses</b> can inherit from <b>superclasses</b> (child and parent)</li> <li>• A <b>subclass</b> can inherit the methods and properties from the <b>superclass</b></li> <li>• A <b>subclass</b> can change the methods from the <b>superclass</b> // <b>subclass</b> can use polymorphism</li> <li>• Objects can interact with each other</li> </ul>	<b>3</b>
2(d)(i)	<p>1 mark per bullet point</p> <ul style="list-style-type: none"> <li>• Method header and close (where appropriate)</li> <li>• ...with InputPlayerID parameter</li> <li>• Initialise Score to 0</li> <li>• Initialise Category to "Not Qualified"</li> <li>• Initialise PlayerID to parameter</li> </ul> <p><b>PYTHON</b></p> <pre>def __init__(self, InputPlayerID):     self.__Score = 0     self.__Category = "Not Qualified"     self.__PlayerID = InputPlayerID</pre> <p><b>PASCAL</b></p> <pre>Constructor Player.Create(InputPlayerID); begin     Score := 0 ;     Category := 'Not Qualified' ;     PlayerID := InputPlayerID; end;</pre> <p><b>VB</b></p> <pre>Public Sub New (InputPlayerID)     Score = 0     Category = "Not Qualified"     PlayerID = InputPlayerID End Sub</pre>	<b>5</b>

Question	Answer	Marks
2(d)(ii)	<p>1 mark per bullet point</p> <ul style="list-style-type: none"> <li>• 1 get Method header without parameter (returning correct data type if given)</li> <li>• ...returning the property</li> <li>• A second working Get</li> <li>• A third working Get</li> </ul> <p><b>PYTHON</b></p> <pre>def GetScore(self):     return(self.__Score) def GetCategory(self):     return(self.__Category) def GetPlayerID(self):     return(self.__PlayerID)</pre> <p><b>PASCAL</b></p> <pre>function GetScore():Integer; begin     GetScore:= Score; end; function GetCategory():String; begin     GetCategory:= Category; end; function GetPlayerID():String; begin     GetPlayerID:= PlayerID; end;</pre> <p><b>VB</b></p> <pre>Public Function GetScore() As Integer     Return Score End Function Public Function GetCategory() As String     Return Category End Function Public Function GetPlayerID() As String     Return PlayerID End Function</pre>	<b>4</b>

Question	Answer	Marks
2(d)(iii)	<p>1 mark per bullet point</p> <ul style="list-style-type: none"> <li>• Set method header and close (where appropriate)</li> <li>• Input value</li> <li>• Looping until input value is correct length ...</li> <li>• ... storing <b>valid</b> input value in PlayerID</li> </ul> <p><b>PYTHON</b></p> <pre>def SetPlayerID(self)     self.PlayerID = input("Enter your player ID")     while len(self.PlayerID) &gt; 15 and len(self.PlayerID) &lt; 4         self.PlayerID = input("Must be &lt;=15 AND &gt;=4 characters         long. Enter your player ID")</pre> <p><b>PASCAL</b></p> <pre>Procedure SetPlayerID ()     WriteLn ('Enter your player ID');     ReadLn(PlayerID);     while length(PlayerID) &gt; 15 and length(PlayerID) &lt; 4 do     begin         WriteLn('Must be &lt;=15 AND &gt;=4 characters long. Enter         your player ID');         ReadLn(PlayerID);     end;</pre> <p><b>VB</b></p> <pre>Public Sub SetPlayerID()     Console.WriteLine ("Enter your player ID")     PlayerID = Console.ReadLine()     While Len(PlayerID) &gt; 15 and Len(PlayerID) &lt; 4         Console.WriteLine ("Must be &lt;=15 AND &gt;=4 characters         long. Enter your player ID")         PlayerID = Console.ReadLine()     End While End Sub</pre>	<b>4</b>



Question	Answer	Marks
2(d)(iv)	<p>1 mark per bullet point</p> <ul style="list-style-type: none"> <li>• Function header and close (where appropriate) <b>and</b> takes <code>ScoreInput</code> as parameter</li> <li>• Check if <code>0 &lt;= ScoreInput &lt;= 150</code></li> <li>• ...if valid, set <code>Score</code> to parameter</li> <li>• ...if not valid, output error</li> <li>• Returns <code>TRUE</code> if valid <b>and</b> returns <code>FALSE</code> if not valid</li> </ul> <p><b>PYTHON</b></p> <pre>def __SetScore(self, ScoreInput):     if ScoreInput &gt;=0 and ScoreInput &lt;=150:         IsValid = True         self.__Score = ScoreInput     else:         print("Error")         IsValid = False     return(IsValid)</pre> <p><b>PASCAL</b></p> <pre>function Player.SetScore(ScoreInput: Integer) : Boolean; begin     If (ScoreInput &gt;=0) AND (ScoreInput &lt;=150) Then         IsValid := True;         result := ScoreInput;     Else         WriteLn('Error')         result := False; end;</pre> <p><b>VB</b></p> <pre>Public Function SetScore(ByVal ScoreInput As Integer) As Boolean      If (ScoreInput &gt;=0) And (ScoreInput &lt;=150) Then         Return True         Score = ScoreInput     Else         Console.WriteLine("Error")         Return False     End If End Function</pre>	<b>5</b>

Question	Answer	Marks
2(d)(v)	<p>1 mark per bullet point</p> <ul style="list-style-type: none"> <li>• Procedure header and close (where appropriate)</li> <li>• Accessing Score attribute</li> <li>• Correct selection to assign each category</li> <li>• ... storing in Category attribute</li> </ul> <p><b>PYTHON</b></p> <pre>def SetCategory(self)     if self.__Score &gt;120:         self.__Category = "Advanced"     elif self.__Score &gt;80:         self.__Category = "Intermediate"     elif self.__Score&gt;=50:         self.__Category = "Beginner"     else:         self.__Category = "Not Qualified"</pre> <p><b>PASCAL</b></p> <pre>procedure player.SetCategory() begin     If Score &gt;120 Then         Category := "Advanced";     Else If Score &gt;80 Then         Category := "Intermediate";     Else If Score &gt;= 50 Then         Category := "Beginner";     Else         Category := "Not Qualified"; end;</pre> <p><b>VB</b></p> <pre>Public Sub SetCategory()     If Score &gt;120 Then         Category = "Advanced"     ElseIf Score &gt;80 Then         Category = "Intermediate"     ElseIf Score &gt;=50 Then         Category = "Beginner"     Else         Category = "Not Qualified"     End If End Sub</pre>	<b>4</b>

Question	Answer	Marks
2(d)(vi)	<p>1 mark per bullet point</p> <ul style="list-style-type: none"> <li>• CreatePlayer() header and close (where appropriate)</li> <li>• Input of score and PlayerID with suitable prompts</li> <li>• Create instance of Player named JoannePlayer ...</li> <li>• ...with PlayerID as parameter</li> <li>• Call method SetScore for JoannePlayer with parameter Score</li> <li>• ...storing return value</li> <li>• ...outputting appropriate message for not valid</li> <li>• Call SetCategory for JoannePlayer</li> <li>• Output Category for JoannePlayer ...</li> <li>• ... using GetCategory for object Joanne</li> </ul> <p><b>PYTHON</b></p> <pre>def CreatePlayer():     InputPlayerID = input("Enter your chosen ID")     Score = int(input("Please enter the score"))     JoannePlayer = Player(InputPlayerID)     if JoannePlayer.SetScore(Score) == false:         print("Invalid score")     else:         JoannePlayer.SetCategory()         print(JoannePlayer.GetCategory)</pre> <p><b>PASCAL</b></p> <pre>procedure CreatePlayer(); var     playerID : String;     isValid : boolean;     JoannePlayer : Player;     score : integer; begin     Writeln(Enter Player ID: ');     Readln(playerID);     Writeln('Enter score: ');     Readln(score);     JoannePlayer := Player.Create(PlayerID);     isValid := JoannePlayer.SetScore(Score);     if isValid = true:         JoannePlayer.SetCategory();         Writeln(JoannePlayer.GetCategory());     else:         Writeln("Invalid score") end;</pre>	8

Question	Answer	Marks																								
2(d)(vi)	<b>VB</b> <pre> Sub CreatePlayer()     Dim Score As Integer, InputPlayerID As String     Console.WriteLine("Please enter your chosen ID")     InputPlayerID = Console.ReadLine()     Console.WriteLine("Please enter the score")     Score = Console.ReadLine()      Dim JoannePlayer As New Player(InputPlayerID)     if JoannePlayer.SetScore(Score) = True then         JoannePlayer.SetCategory()         Console.WriteLine(JoannePlayer.GetCategory())     else         Console.WriteLine("Invalid score")     endif End Sub </pre>																									
2(e)	<p>1 mark per bullet point</p> <ul style="list-style-type: none"> <li>• 3 correct Normal test data</li> <li>• 3 correct Abnormal test data</li> <li>• 3 correct Boundary test data</li> </ul> <table border="1"> <thead> <tr> <th>Category</th><th>Type of test data</th><th>Example test data</th></tr> </thead> <tbody> <tr> <td rowspan="3">Beginner</td><td>Normal</td><td>e.g. 75</td></tr> <tr> <td>Abnormal</td><td>e.g. 85 / bob</td></tr> <tr> <td>Boundary</td><td>80, 50</td></tr> <tr> <td rowspan="3">Intermediate</td><td>Normal</td><td>e.g. 95</td></tr> <tr> <td>Abnormal</td><td>e.g. 70 / bob</td></tr> <tr> <td>Boundary</td><td>81, 120</td></tr> <tr> <td rowspan="3">Advanced</td><td>Normal</td><td>e.g. 125</td></tr> <tr> <td>Abnormal</td><td>e.g. 115 / bob</td></tr> <tr> <td>Boundary</td><td>121, 150</td></tr> </tbody> </table>	Category	Type of test data	Example test data	Beginner	Normal	e.g. 75	Abnormal	e.g. 85 / bob	Boundary	80, 50	Intermediate	Normal	e.g. 95	Abnormal	e.g. 70 / bob	Boundary	81, 120	Advanced	Normal	e.g. 125	Abnormal	e.g. 115 / bob	Boundary	121, 150	<b>3</b>
Category	Type of test data	Example test data																								
Beginner	Normal	e.g. 75																								
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Advanced	Normal	e.g. 125																								
	Abnormal	e.g. 115 / bob																								
	Boundary	121, 150																								
2(f)(i)	Insertion sort	<b>1</b>																								
2(f)(ii)	<b>One</b> from: <ul style="list-style-type: none"> <li>• Bubble sort</li> <li>• Merge sort</li> </ul>	<b>1</b>																								

Question	Answer									Marks
2(f)(iii)	1 mark per shaded section									7
	Item	NumberOfScores	InsertScore	Index	ArrayData					
					0	1	2	3	4	
					99	125	121	109	115	
	1	5	125	0		(125)				
	2		121	1			125			
				0		121				
	3		109	2				125		
				1			121			
				0		109				
	4		115	3					125	
				2				121		
				1			115			

Question	Answer	Marks
3(a)	<p>1 mark per bullet point to max 2</p> <ul style="list-style-type: none"> <li>It is defined in terms of itself // it calls itself</li> <li>It has a stopping condition // base case</li> <li>It is a self-contained subroutine</li> <li>It can return data to its previous call</li> </ul>	2
3(b)	<p>1 mark per bullet point to max 3</p> <ul style="list-style-type: none"> <li>(When the recursive call is made) all values/data are put on ...</li> <li>... the stack</li> <li>When the stopping condition/base case is met</li> <li>...the algorithm unwinds</li> <li>...the last set of values are taken off the stack (in reverse order)</li> </ul>	3