OCR
Oxford Cambridge and RSA

GCE

Computer Science

Unit **H046/02**: Algorithms and problem solving

Advanced Subsidiary GCE

Mark Scheme for June 2018

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This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by examiners. It does not indicate the details of the discussions which took place at an examiners' meeting before marking commenced.

All examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the report on the examination.

Annotations

Annotation	Meaning
∧	Omission mark
BOD	Benefit of the doubt
✗	Incorrect point
FT	Follow through
NAQ	Not answered question
NBOD	No benefit of doubt given
REP	Repeat
✔	Correct point
TV	Too vague
BP	Blank Page – this annotation must be used on all blank pages within an answer booklet (structured or unstructured) and on each page of an additional object where there is no candidate response.
L1	Level 1
L2	Level 2
L3	Level 3

Subject - specific Marking Instructions

INTRODUCTION

Your first task as an Examiner is to become thoroughly familiar with the material on which the examination depends. This material includes:

- the specification, especially the assessment objectives
- the question paper and its rubrics
- the mark scheme.

You should ensure that you have copies of these materials.

You should ensure also that you are familiar with the administrative procedures related to the marking process. These are set out in the OCR booklet Instructions for **Examiner**s. If you are examining for the first time, please read carefully Appendix 5 Introduction to Script Marking: **Notes for New Examiners**.

Please ask for help or guidance whenever you need it. Your first point of contact is your Team Leader.

USING THE MARK SCHEME

Please study this Mark Scheme carefully. The Mark Scheme is an integral part of the process that begins with the setting of the question paper and ends with the awarding of grades. Question papers and Mark Schemes are developed in association with each other so that issues of differentiation and positive achievement can be addressed from the very start.

This Mark Scheme is a working document; it is not exhaustive; it does not provide 'correct' answers. The Mark Scheme can only provide 'best guesses' about how the question will work out, and it is subject to revision after we have looked at a wide range of scripts.

The Examiners' Standardisation Meeting will ensure that the Mark Scheme covers the range of candidates' responses to the questions, and that all Examiners understand and apply the Mark Scheme in the same way. The Mark Scheme will be discussed and amended at the meeting, and administrative procedures will be confirmed. Co-ordination scripts will be issued at the meeting to exemplify aspects of candidates' responses and achievements; the co-ordination scripts then become part of this Mark Scheme.

Before the Standardisation Meeting, you should read and mark in pencil a number of scripts, in order to gain an impression of the range of responses and achievement that may be expected.

In your marking, you will encounter valid responses which are not covered by the Mark Scheme: these responses must be credited. You will encounter answers which fall outside the 'target range' of Bands for the paper which you are marking. Please mark these answers according to the marking criteria.

Please read carefully all the scripts in your allocation and make every effort to look positively for achievement throughout the ability range. Always be prepared to use the full range of marks.

LEVELS OF RESPONSE QUESTIONS:

The indicative content indicates the expected parameters for candidates' answers, but be prepared to recognise and credit unexpected approaches where they show relevance.

Using 'best-fit', decide first which set of BAND DESCRIPTORS best describes the overall quality of the answer. Once the band is located, adjust the mark concentrating on features of the answer which make it stronger or weaker following the guidelines for refinement.

- **Highest mark**: If clear evidence of all the qualities in the band descriptors is shown, the HIGHEST Mark should be awarded.
- **Lowest mark**: If the answer shows the candidate to be borderline (i.e. they have achieved all the qualities of the bands below and show limited evidence of meeting the criteria of the band in question) the LOWEST mark should be awarded.
- **Middle mark**: This mark should be used for candidates who are secure in the band. They are not 'borderline' but they have only achieved some of the qualities in the band descriptors.

Be prepared to use the full range of marks. Do not reserve (e.g.) high Band 3 marks 'in case' something turns up of a quality you have not yet seen. If an answer gives clear evidence of the qualities described in the band descriptors, reward appropriately.

	AO1	AO2	AO3
High (thorough)	Precision in the use of question terminology. Knowledge shown is consistent and well-developed. Clear appreciation of the question from a range of different perspectives making extensive use of acquired knowledge and understanding.	Knowledge and understanding shown is consistently applied to context enabling a logical and sustained argument to develop. Examples used enhance rather than detract from response.	Concerted effort is made to consider all aspects of a system/problem or weigh up both sides to an argument before forming an overall conclusion. Judgements made are based on appropriate and concise arguments that have been developed in response resulting in them being both supported and realistic.
Middle (reasonable)	Awareness of the meaning of the terms in the question. Knowledge is sound and effectively demonstrated. Demands of question understood although at times opportunities to make use of acquired knowledge and understanding not always taken.	Knowledge and understanding applied to context. Whilst clear evidence that an argument builds and develops through response there are times when opportunities are missed to use an example or relate an aspect of knowledge or understanding to the context provided.	There is a reasonable attempt to reach a conclusion considering aspects of a system/problem or weighing up both sides of an argument. However the impact of the conclusion is often lessened by a lack of supported judgements which accompany it. This inability to build on and develop lines of argument as developed in the response can detract from the overall quality of the response.
Low (basic)	Confusion and inability to deconstruct terminology as used in the question. Knowledge partial and superficial. Focus on question narrow and often one-dimensional.	Inability to apply knowledge and understanding in any sustained way to context resulting in tenuous and unsupported statements being made. Examples if used are for the most part irrelevant and unsubstantiated.	Little or no attempt to prioritise or weigh up factors during course of answer. Conclusion is often dislocated from response and any judgements lack substance due in part to the basic level of argument that has been demonstrated throughout response.

	Assessment Objective
AO1	Demonstrate knowledge and understanding of the principles and concepts of computer science, including abstraction, logic, algorithms and data representation.
AO1.1	Demonstrate knowledge of the principles and concepts of abstraction, logic, algorithms, data representation or other as appropriate.
AO1.2	Demonstrate understanding of the principles and concepts of abstraction, logic, algorithms, data representation or other as appropriate.
AO2	Apply knowledge and understanding of the principles and concepts of computer science including to analyse problems in computational terms.
AO2.1	Apply knowledge and understanding of the principles and concepts of computer science.
AO2.2	Analyse problems in computational terms.
AO3	Design, program and evaluate computer systems that solve problems, making reasoned judgements about these and presenting conclusions.
AO3.1	Design computer systems that solve problems.
AO3.2	Program computer systems that solve problems.
AO3.3	Evaluate computer systems that solve problems, making reasoned judgements about these and presenting conclusions.

Question			Answer/Indicative content	Mark	Guidance
1	a		1 mark per bullet to max 2 • `top` = 6 (allow FT if numbers entered incorrectly) • Numbers entered in order	**2** **AO1.2** **(1)** **AO2.2** **(1)**	

index	stackItem
9	
8	
7	
6	
5	1000
4	59
3	2
2	13
1	22
0	20

top	6

Question			Answer/Indicative content	Mark	Guidance
1	b	i	A procedure does not return a value / a function has to return a value	**1 AO1.2 (1)**	

1	b	ii	1 mark per bullet, max 2 for by value, max 2 for by reference
			by value:
			   • A local copy of the data is used
			   • Data is discarded when the subprogram exits
			   • Does not override/change the original data
			
			by reference:
			   • Memory location of data is sent
			   • Changes are made to the original data
			   • Changes remain after the subprogram exits
				4 AO1.2 (4)	
| 1 | b | iii | 1 mark for each completed space to max 5<br><br>```
function addItem (number)
    if top = 20 then
        return false
    else
        numStack[top] = number
        top = top + 1
        return true
    endif
endfunction
``` | **5 AO2.2 (2) AO3.2 (3)** | Accept `numStack.length()` instead of `20` |

Question			Answer/Indicative content	Mark	Guidance
1	b	iv	1 mark for each bullet to max 6 • Initialising `total` to 0 and `add` to true • `top` = 4 and `total` = 8 • `total` = 20 and `add` = false • `top` = 3, `total` = 14, `add` = true • `top` 2, 1. `Total` 16, -4, `add` false, true • Output = -4	6 AO1.2 (3) AO2.2 (3)	

	numStack								
top	**0**	**1**	**2**	**3**	**4**	**5**	**total**	**add**	**Output**
5	20	2	6	12	8				
							0	true	
4							8		
							20	false	
3							14	true	
2							16	false	
1							-4	true	
0									-4

Question			Answer/Indicative content	Mark	Guidance
2	a	i	1 mark per bullet to max 2 • Can store multiple values under one identifier • The data can be of different data types	**2** **AO1.1** **(2)**	
2	a	ii	1 mark per bullet to max 1 • Allows easy access/indexing/manipulation of each data item in turn • 1D Array can hold multiple items of same data type • Maximum number of array elements is known	**1** **AO2.2** **(1)**	
2	a	iii	1 mark per bullet to max 1 • Queue • List • Tuple	**1** **AO1.1** **(1)**	Graph Tree Linked list
2	b		1 mark per bullet to max 2 • It does not need to be passed between subroutines • It can be accessed/updated at any point/place in the program • It allows it to be updated as a running total	**2** **AO2.1** **(1)** **AO2.2** **(1)**	

Question			Answer/Indicative content	Mark	Guidance

2	c	i	1 mark per bullet to max 7
			• Inputting the number of players
			• …with validation between 1 and 10
			• Inputting and storing the name of the correct number of players
			• Outputting the round number at the start of all 8 rounds
			• Outputting each player's number, in each round
			• Inputting the players' score for each round
			• Add the score to their `totalScore`
			
			e.g,
			`Do`
			  `numberOfPlayers = input("Enter the number of players between 1 and 10")`
			`until numberOfPlayers >= 1 AND numberOfPlayers <= 10`
			
			`for player = 0 to numberOfPlayers - 1`
			  `scores[player].playerName = input("Enter player name")`
			`next player`
			
			`for roundNum = 0 to 7`
			  `print("Round " + str(roundNum + 1))`
			  `for player = 0 to numberOfPlayers – 1`
			    `score = input("Enter player " + str(player + 1) + " score")`
			    `scores[player].totalScore = scores[player].totalScore + score`
			  `next player`
			`next roundNum`
				7
				AO2.2
				(1)
				AO3.2
				(6)	

Question			Answer/Indicative content	Mark	Guidance

2	c	ii	1 mark per bullet to max 4
			• Outputting the total of each player…
			• …with an appropriate message
			• Calculating and outputting the average of each player…
			• …with an appropriate message
			
			e.g.
			
			``
			for player = 0 to numberOfPlayers – 1
			  print(scores[player].playerName + " total is " +
			str(scores[player].totalScore))
			
			  averageScore = scores[player].totalScore / 8
			  print(scores[player].playerName + "'s average is " +
			str(averageScore))
			
			next player
			``
				4
				AO2.2
				(1)
				AO3.2
				(3)	

2	d	i	1 mark per bullet to max 2 • Bubble sort is an inefficient algorithm… • Meaning it will take more time/processing cycles to sort the list. • Generally outperformed by Insertion sort/quick sort/ merge sort (accept any other sensible sorting algorithm) • The item to be sorted is at the end of the list (and so can only move back one place per pass) which is the worst case scenario for bubble sort.	**2** **AO1.2** **(1)** **AO2.2** **(1)**	
2	d	ii	There are only a small number of data items	**1** **AO2.2** **(1)**	

Question			Answer/Indicative content	Mark	Guidance

2	d	iii	1 mark per bullet to max 6
			   - Procedure declaration - Outer loop until no swaps made using flag - Inner loop to iterate through the list… …allowance for largest value at end (in bounds) - Comparing elements - Swapping elements
			e.g.
			<pre>procedure sort_scores()
			  swapped = True
			  while swapped:
			      swapped = False
			      for i = 1 to 9
			          if scores[i-1] < scores[i]:
			              # swap pair being compared
			              temp = scores[i-1]
			              scores[i-1] = scores[i]
			              scores[i] = temp
			              swapped = True
			end procedure</pre>
				6
				AO1.2
				(2)
				AO2.2
				(1)
				AO3.2
				(3)	

Question			Answer/Indicative content	Mark	Guidance

2	d	iv	1 mark for each completed space
			
			``
			procedure insertionSort()
			    for count = 0 to numbers.length-1
			        position = count
			         while position > 0 and numbers[position]<numbers[position-1]
			            temp = numbers[position-1]
			            numbers[position-1] = numbers[position]
			            numbers[position] = temp
			            position = position-1
			        endwhile
			    next count
			endprocedure
			``
				4
				AO2.2
				(3)
				AO3.2
				(1)	

2	e		1 mark per bullet to max 3 e.g. • Provides a text editor / allows the code to be written • Provides debugging tools / allows the code to be tested • Provides a translator/compiler/interpreter / provides a run-time environment / allows the code to be run • Description of key feature e.g. colour coding keywords, autocomplete, breakpoints etc.	**3** **AO1.2** **(3)**	

Question			Answer/Indicative content	Mark	Guidance
3	a	i	Removing characteristics/elements/detail from a problem	**1** **AO1.1** **(1)**	
3	a	ii	1 mark per bullet to max 2 • Reduce processing requirements • Simplify programming • Reduce memory requirements	**2** **AO1.2** **(1)** **AO2.1** **(1)**	
3	a	iii	1 mark per identifying difference, 1 for expansion e.g. • Removal of feature • e.g. no stations/signals • Symbols/keys are used to represent elements • E.g. the train • May not be to scale • Relative distances may not be true	**2** **AO2.1** **(1)** **AO2.2** **(1)**	
3	b	i	The data needs to be sorted / in alphabetical order	**1** **AO2.1** **(1)**	
3	b	ii	1 mark per bullet to max 4 • Start at the first item (Cavalry) • Compare with departure station 'Bridge Heights' • If matched, report found • Otherwise continue to the next item in list (Bridge) • Continue until item found, or end of list reached… • and then False returned	**4** **AO2.1** **(2)** **AO2.2** **(2)**	

Question	Answer/Indicative content	Mark	Guidance

4	**Mark Band 3–High Level**
	(7-9 marks)
	The candidate demonstrates thorough knowledge and understanding of reasons for the use of different methodologies; the material is generally accurate and detailed.
	The candidate is able to apply their knowledge and understanding directly and consistently to the context provided. Evidence/examples will be explicitly relevant to the explanation.
	The candidate provides a thorough discussion which is well-balanced. Evaluative comments are consistently relevant and well-considered.
	There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.
	
	Mark Band 2-Mid Level
	(4-6 marks)
	The candidate demonstrates reasonable knowledge and understanding of reasons for the use of different methodologies; the material is generally accurate but at times underdeveloped.
	The candidate is able to apply their knowledge and understanding directly to the context provided although one or two opportunities are missed. Evidence/examples are for the most part relevant to the explanation.
	The candidate provides a reasonable discussion, the majority of which is focused. Evaluative comments are for the most part appropriate, although one or two opportunities for development are missed.
	There is a line of reasoning presented with some structure. The information presented is in the most part relevant and supported by some evidence.
		9
		AO1.1
		(2)
		AO1.2
		(2)
		AO2.1
		(2)
		AO3.3
		(3)
			AO1: Knowledge and Understanding
			The following is indicative of possible factors/evidence that candidates may refer to but is not prescriptive or exhaustive:
			• Waterfall
			   o Series of stages
			   o Followed in order
			   o Can go back up the order
			   o Then needs to follow back down in order
			   o Formal, documented stages
			• Rapid application
			   o Use of prototypes
			   o No formal analysis, design stages
			   o More feedback used to influence future stages
			   o Faster development
			
			AO2.1: Application
			The selected knowledge/examples should be directly related to the specific question. The following is indicative of possible factors/evidence that candidates may refer to but is not prescriptive or exhaustive.
			• Discussion of how the methodologies would support the development
			• Discussion of the disadvantages of using each methodology
			
			AO3.3: Evaluation
			Candidates will need to consider a variety of viewpoints in relation to testing strategies and will make evaluative comments about the issues and solutions they are discussing
			e.g.
			• The benefits of a method
			• The disadvantages of a method

Question			Answer/Indicative content	Mark	Guidance
			Mark Band 1-Low Level **(1-3 marks)** The candidate demonstrates a basic knowledge of methodologies, with limited understanding shown; the material is basic and contains some inaccuracies. The candidate makes a limited attempt to apply acquired knowledge and understanding to the context provided. The candidate provides a limited discussion which is narrow in focus. Judgments if made are weak and unsubstantiated. The information is basic and communicated in an unstructured way. The information is supported by limited evidence and the relationship to the evidence may not be clear. **0 marks** No attempt to answer the question or response is not worthy of credit.		

Assessment Objectives (AO) Grid

Question	AO1.1	AO1.2	AO2.1	AO2.2	AO3.1	AO3.2	AO3.3	Total
1a		1		1				2
1bi		1						1
1bii		4						4
1biii m				2		3		5
1biv m		3		3				6
2ai	2							2
2aii				1				1
2aiii	1							1
2b			1	1				2
2ci m				1		6		7
2cii m				1		3		4
2di		1		1				2
2dii				1				1
2diii m		2		1		3		6
2div				3		1		4
2e		3						3
3ai	1							1
3aii		1	1					2
3aiii			1	1				2
3bi			1					1
3bii			2	2				4
4*	2	2	2				3	9
Total	6	18	8	19	0	16	3	70

* = extended response
m = mathematical content

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