# GCE

# Computer Science

## H046/02: Algorithms and problem solving

AS Level

# Mark Scheme for June 2024

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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.

# MARKING INSTRUCTIONS

## PREPARATION FOR MARKING

### SCORIS

1. Make sure that you have accessed and completed the relevant training packages for on-screen marking: *RM assessor Online Training*; *OCR Essential Guide to Marking*.

2. Make sure that you have read and understood the mark scheme and the question paper for this unit. These are posted on the RM Cambridge Assessment Support Portal http://www.rm.com/support/ca

3. Log-in to RM assessor and mark the **required number** of practice responses ("scripts") and the **number of required** standardisation responses.

   YOU MUST MARK 10 PRACTICE AND 10 STANDARDISATION RESPONSES BEFORE YOU CAN BE APPROVED TO MARK LIVE SCRIPTS.

## MARKING

1. Mark strictly to the mark scheme.

2. Marks awarded must relate directly to the marking criteria.

3. The schedule of dates is very important. It is essential that you meet the 50% and 100% deadlines. If you experience problems, you must contact your Team Leader (Supervisor) without delay.

4. If you are in any doubt about applying the mark scheme, consult your Team Leader by telephone or the RM assessor messaging system, or by email.

5. **Crossed Out Responses**
   Where a candidate has crossed out a response and provided a clear alternative then the crossed out response is not marked. Where no alternative response has been provided, examiners may give candidates the benefit of the doubt and mark the crossed out response where legible.

   **Rubric Error Responses – Optional Questions**
   Where candidates have a choice of question across a whole paper or a whole section and have provided more answers than required, then all responses are marked and the highest mark allowable within the rubric is given. Enter a mark for each question answered into RM assessor, which will select the highest mark from those awarded. *(The underlying assumption is that the candidate has penalised themselves by attempting more questions than necessary in the time allowed.)*

   **Multiple Choice Question Responses**
   When a multiple choice question has only a single, correct response and a candidate provides two responses (even if one of these responses is correct), then no mark should be awarded (as it is not possible to determine which was the first response selected by the candidate).

*When a question requires candidates to select more than one option/multiple options, then local marking arrangements need to ensure consistency of approach.*

**Contradictory Responses**
When a candidate provides contradictory responses, then no mark should be awarded, even if one of the answers is correct.

**Short Answer Questions** (requiring only a list by way of a response, usually worth only **one mark per response**)
Where candidates are required to provide a set number of short answer responses then only the set number of responses should be marked. The response space should be marked from left to right on each line and then line by line until the required number of responses have been considered. The remaining responses should not then be marked. Examiners will have to apply judgement as to whether a 'second response' on a line is a development of the 'first response', rather than a separate, discrete response. *(The underlying assumption is that the candidate is attempting to hedge their bets and therefore getting undue benefit rather than engaging with the question and giving the most relevant/correct responses.)*

**Short Answer Questions** (requiring a more developed response, worth **two or more marks**)
If the candidates are required to provide a description of, say, three items or factors and four items or factors are provided, then mark on a similar basis – that is downwards (as it is unlikely in this situation that a candidate will provide more than one response in each section of the response space.)

**Longer Answer Questions** (requiring a developed response)
Where candidates have provided two (or more) responses to a medium or high tariff question which only required a single (developed) response and not crossed out the first response, then only the first response should be marked. Examiners will need to apply professional judgement as to whether the second (or a subsequent) response is a 'new start' or simply a poorly expressed continuation of the first response.

6. Always check the pages (and additional objects if present) at the end of the response in case any answers have been continued there. If the candidate has continued an answer there then add a tick to confirm that the work has been seen.

7. Award No Response (NR) if:
   - there is nothing written in the answer space

   Award Zero '0' if:

   - anything is written in the answer space and is not worthy of credit (this includes text and symbols).

   Team Leaders must confirm the correct use of the NR button with their markers before live marking commences and should check this when reviewing scripts.

8. The RM assessor **comments box** is used by your team leader to explain the marking of the practice responses. Please refer to these comments when checking your practice responses. **Do not use the comments box for any other reason.**
   If you have any questions or comments for your team leader, use the phone, the RM assessor messaging system, or e-mail.

9. Assistant Examiners will send a brief report on the performance of candidates to their Team Leader (Supervisor) via email by the end of the marking period. The report should contain notes on particular strengths displayed as well as common errors or weaknesses. Constructive criticism of the question paper/mark scheme is also appreciated.

10. For answers marked by levels of response: Not applicable in F501
    a. **To determine the level** – start at the highest level and work down until you reach the level that matches the answer
    b. **To determine the mark within the level**, consider the following:

| **Descriptor** | **Award mark** |
|---|---|
| On the borderline of this level and the one below | At bottom of level |
| Just enough achievement on balance for this level | Above bottom and either below middle or at middle of level (depending on number of marks available) |
| Meets the criteria but with some slight inconsistency | Above middle and either below top of level or at middle of level (depending on number of marks available) |
| Consistently meets the criteria for this level | At top of level |

11. Annotations

| Annotation | Meaning |
|---|---|
| ^ | Omission mark |
| BOD | Benefit of the doubt |
|  | Incorrect point |
| E | Expansion of a point |
| FT | Follow through |
| NAQ | Not answered question |
| NBOD | No benefit of doubt given |
| P | Point being made |
| REP | Repeat |
|  | Correct point |
| TV | Too vague |
| 0 | Zero (big) |
| 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 |

| Question | | | Answer | Mark | Guidance |
|---|---|---|---|---|---|
| 1 | (a) | (i) | 1 mark per bullet to max 2<br>• Removing unnecessary detail<br>• Simplifying a complex problem<br>• Focussing on only the necessary/main parts | 2 | |
| 1 | (a) | (ii) | 1 mark per bullet to max 3<br>e.g.<br>• The physical game **board/squares** can be replaced with a grid<br>• Physical **dice** can be replaced with two numbers<br>• Physical player **counters** can be replaced with simple 2D graphics<br>• Physical instruction **cards** can be replaced with text messages<br>• Physical **timer** can be replaced with a simple text based timer | 3 | Allow other suitable examples that are relevant to the scenario. |
| 1 | (a) | (iii) | 1 mark per bullet to max 2<br>e.g.<br>• Reduce programming time/cost<br>• Simpler to solve the problem<br>• Program requires less memory // computational power // faster program execution<br>• Reduces complexity of programming code<br>• Allows Eve to focus on core aspects | 2 | |

| | | | | | |
|---|---|---|---|---|---|
| **1** | **(b)** | | 1 mark per bullet to max 3<br>e.g.<br>• Initialising a new board with 100 squares<br>• Placing players on square 1 at the start<br>• Setting a new 30-minute timer<br>• Rolling two dice and displaying the total<br>• Moving the counters the number of places on the dice<br>• Choosing an instruction card and displaying the message<br>• Checking if a player has landed on square 100<br>• Checking if the timer is 0 | 3 | Allow other suitable examples that are relevant to the scenario. |
| **1** | **(c)** | | 1 mark for condition and 1 mark for outcome to max 4<br>e.g.<br>• **Condition:** Check if the square has an instruction …<br>• **Outcome:** … move the player the number of places specified<br><br>• **Condition:** Check if they have landed on square 100 …<br>• **Outcome:** … Announce the player as the winner<br><br>• **Condition:** Check if the timer is 0 …<br>• **Outcome:** … Announce the game as a draw | 4 | Allow other suitable examples that are relevant to the scenario.<br><br>The outcome must be related to the condition for a mark to be awarded. |

| Question | | | Answer | Mark | Guidance |
|---|---|---|---|---|---|
| 2 | (a) | | 1 mark for similarity:<br>• Both are data structures / store data<br>• Both allow data to be added/removed<br>• Both have identifier(s) / pointer values<br><br>1 mark for difference:<br>• Stack is LIFO and queue is FIFO<br>• Queue supports enqueue/dequeue operations whilst stack supports push/pop operations<br>• Queue require two pointers whilst stacks only require one pointer | 2 | Allow queue can be circular or linear, stack can only be linear |
| 2 | (b) | (i) | `item` | 1 | |
| 2 | (b) | (ii) | `tailPointer` | 1 | Allow `queue` |
| 2 | (b) | (iii) | 1 mark for benefit and 1 mark for expansion:<br>e.g.<br>• Simpler to program …<br>• … because values do not need to be passed/renamed/moved between different subroutines<br>• Do not need to worry about returning values // do not need to decide between byval/byref …<br>• … all parts of the program can access the (same) value (in the same way)<br><br>1 mark for drawback and 1 mark for expansion:<br>• Uses more memory …<br>• … because the memory space is declared when the program starts and remains in use throughout<br>• Makes testing / debugging more difficult …<br>• …. as it's difficult to test an individual block of code<br>• Reduces data accuracy / integrity …<br>• …. changing a global variable may have an impact on another module | 4 | 2 marks max for benefit<br>2 marks max for drawback |

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| **2** | **(b)** | **(iv)** | 1 mark per bullet to max 3<br>• False is returned if the queue is full …<br>• … the main will not attempt to add another item<br>• True is returned if the item is successfully added …<br>• … so the main program can try to add another item | 3 | |
| **2** | **(b)** | **(v)** | 1 mark for error **and** correction to max 3<br>• **Line 01** There is no need to pass in a parameter<br>• **Line 02** has != instead of **==**<br>**Line 04** has elseif and no condition // replace with **else**<br>• **Line 06** should be h`eadpointer = headpointer + 1` // Swap lines 06 and 07<br>• **Line 07** should be `return value` | 3 | Do not award marks for the line number. The error must be related to the line number stated. |
| **2** | **(b)** | **(vi)** | 1 mark per bullet to max 3<br>• Use of loop to call dequeue()….<br>• …to output the return value…<br>• ...until “EMPTY” is returned<br><br>e.g.<br>`elementsLeft = true`<br>`while elementsLeft == true`<br>`  value = dequeue()`<br>`  if not(value = "EMPTY") then`<br>`  print(value)`<br>`  else`<br>`  elementsLeft = false`<br>`  endif`<br>`endwhile` | 3 | |

| Question | | | Answer | Mark | Guidance |
|---|---|---|---|---|---|
| 3 | (a) | | **Mark Band 3–High Level**<br>**(7-9 marks)**<br>The candidate demonstrates thorough knowledge and understanding of suitability of algorithms; the material is generally accurate and detailed.<br>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.<br>There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.<br><br>**Mark Band 2-Mid Level**<br>**(4-6 marks)**<br>The candidate demonstrates reasonable knowledge and understanding of suitability of algorithms; the material is generally accurate but at times underdeveloped.<br>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 implicitly relevant to the explanation.<br>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. | 9 | **AO1: Knowledge and Understanding**<br>e.g.<br>• Kofi's algorithm reads data from the text file and writes these value to an array. It cannot be called by different programs, doesn't work with different text files and does not consider the number of items in the file.<br>• Zac's program also reads data from the text file and writes these values to an array. It can be called by different programs, works with different file names and does consider the number of items in the file.<br><br>**AO2.1: Application**<br>e.g.<br>Kofi's algorithm:<br>• Has additional/unnecessary variables<br>• …e.g. fileName, dataValue<br>• Loops 1000 times which is inappropriate when it needs to be used with unknown quantity<br>• Will not read any lines after the first 1000<br>Zac's algorithm:<br>• Uses a function so that is can be used in different programs // is independent<br>• Takes file name as parameter so that it can be called with different files<br>• The array size is 100. Therefore, if the data being read is greater than 100 the program will crash.<br>• Does not close the file<br><br>**AO3.3: Evaluation**<br>e.g.<br>• Zac's is more memory efficient as it uses fewer variables<br>• Kofi's is more suitable in that it closes the file so it does not remain open in memory<br>• Zac's is more suitable to be used in different programs due to function and not hard coding the file name |

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| | | | There is a line of reasoning presented with some structure. The information presented is in the most part relevant and supported by some evidence.<br><br>**Mark Band 1-Low Level**<br>**(1-3 marks)**<br>The candidate demonstrates a basic knowledge of suitability of algorithms, 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.<br>The candidate provides a limited discussion which is narrow in focus. Judgments if made are weak and unsubstantiated.<br>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.<br><br>**0 marks**<br>No attempt to answer the question or response is not worthy of credit. | | • Zac's is easier to alter for a different file size as fewer lines of code would need to be altered |

| Question | | | Answer | Mark | Guidance |
|---|---|---|---|---|---|
| 4 | (a) | | 1 mark per bullet to max 2 for each method<br>e.g.<br>Extreme:<br>• The programming stage is the main focus / priority<br>• Is a form of agile development<br>• Includes planning, design, code, test<br>• Testing is focused throughout development<br>• Prioritises code quality…<br>• ... over documentation<br>• Encourages the use of pair programming<br><br>Waterfall:<br>• Includes analysis, design, implementation/programming, testing, evaluation *(accept any sensible variant of these phases)*<br>• Each phase is moved down in turn // linear process<br>• Phases can be revisited back in turn<br><br>Spiral:<br>• Incremental design<br>• Includes planning, design, programming and evaluation<br>• At the end of all 4 phases it repeats<br>• Each phase usually adds a new element to the problem<br>• Is used to manage risk<br>• Prioritises riskiest elements first | 6 | |

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| **4** | **(b)** | | 1 mark per bullet to max 3<br>• Testing within the development company // testing by the developers<br>• Testing it in the way the end user would<br>• Used when the program is complete<br>• Used when white box/black box/system etc. testing is complete<br>• Takes place before Beta testing | 3 | |

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Mark</th><th>Guidance</th></tr>
<tr><td>5</td><td>(a)</td><td></td><td>1 mark for each completed statement<br><br>
<pre>
function binarySearch(array, numberToFind)
     lowerbound = 0
     upperbound = array.length - 1

     while true
          if(upperbound < lowerbound) then
               return -1
          else
               mid = (upperbound + lowerbound)DIV 2
               if(array[mid] < numberToFind) then
                    lowerbound = mid + 1
               elseif(array[mid] > numberToFind)
then
                    upperbound = mid - 1
               else
                    return mid
               endif
          endif
     endwhile
endfunction
</pre>
</td><td>6</td><td>Accept<br><code>mid = int((upperbound + lowerbound)/ 2)</code></td></tr>
<tr><td>5</td><td>(b)</td><td>(i)</td><td>1 mark per bullet to max 5<br>
• 20 becomes the sorted list // [20] is the sorted list<br>
• ... take 8 and compare against …<br>
• … it is less than 20 so keep it in place // [20 8] is now the sorted list<br>
• Take 33 and compare it to each value in the sorted list. It is greater than 20, so move 20 and 8 and insert 33 // 33 is compared and moved down and [33 20 8] is now the sorted list<br>
• Repeat for all other elements.</td><td>5</td><td>Max 4 if ascending and not descending<br><br>Zero marks if not provided a description and just shown data values</td></tr>
</table>

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|---|---|---|---|---|---|
| **5** | **(b)** | **(ii)** | 1 mark for each set of test data **and** purpose<br>e.g.<br>• **Test Data:** 7 6 5 4 3 2 1<br>**Purpose:** Testing that data is already in order<br><br>• **Test Data:** 1 7 2 6 3 5 4<br>**Purpose:** Testing that mixed data is sorted<br><br>• **Test Data:** Six One Seven Three Four Fix Two<br>• **Purpose:** Testing that words are rejected/ Testing words are sorted (alphabetically)<br><br>• **Test Data:** -1, 0, 2, -1, 3, -3<br>• **Purpose:** Testing the algorithm works with negative numbers. | 2 | Each purpose must be different.<br>Accept viable alternatives<br><br>The purpose must be relevant to the test data given.<br><br>A mark cannot be award unless both the test data and purpose are given. |

| Question | | | Answer | Mark | Guidance |
|---|---|---|---|---|---|
| 6 | | | 1 mark per bullet to max 8<br>• Looping through the numbers 1 to 100 inclusive<br>• Taking value as input<br>• Checking if loop value is divisible by both 3 and 5<br>• …if so, checking if user input is "fizz buzz" and outputting message if not<br>• Checking if loop value is divisible by 3<br>• …if so, checking if user input is "fizz" and outputting message if not<br>• Checking if loop value is divisible by 5<br>• …if so, checking if user input is "buzz" and outputting message if not<br>• Checking if the next number is input (if none of above) and outputting message if not<br><br>e.g.<br>`for count = 1 to 100`<br>`  valueInput = input("Enter the next number")`<br>`  if(count MOD 3 == 0 and count MOD 5 == 0) then`<br>`  if not(valueInput == "fizz buzz") then`<br>`  print("Incorrect, the answer is fizz buzz")`<br>`  endif`<br>`  elseif(count MOD 3 == 0) then`<br>`  if not(valueInput == "fizz") then`<br>`  print("Incorrect, the answer is fizz")`<br>`  endif`<br>`  elseif(count MOD 5 == 0) then`<br>`  if not(valueInput == "buzz") then`<br>`  print("Incorrect, the answer is buzz")`<br>`  endif`<br>`  else`<br>`  if not(valueInput == str(count)) then`<br>`  print("Incorrect, the answer is ", count)`<br>`  endif`<br>`  endif`<br>`next count` | 8 | Max 7 if solution will not logically work eg. Checking for fizz (divisible by 3) or buzz (divisible by 5) states before checking for fizzbuzz state (divisible by 3 and 5) |

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