CAMBRIDGE
International Education

Cambridge International AS & A Level

COMPUTER SCIENCE **9618/32**

Paper 3 Advanced Theory **May/June 2026**

MARK SCHEME

Maximum Mark: 75

Published

This mark scheme contains the instructions and marking guidance that our examiners used to mark candidate responses for this component.

Before they start marking, examiners complete a standardisation process. They review a range of candidate responses and discuss the mark scheme in detail to agree which answers can and cannot be accepted. Examiners award marks where it is clear that candidate responses have met the requirements of the mark scheme. These requirements may vary between different components or different versions of the same component, depending on the exact requirements of the question and the candidate responses seen during the standardisation process.

Sometimes, our mark schemes may allow marks to be awarded to responses which contain elements that are factually incorrect or for content not covered by the syllabus. We do this in response to the demands of a specific question to support candidates and make sure that our assessments are fair. However, these allowances should not be used as a guide for teaching and learning.

We cannot discuss the mark scheme with schools, and we recommend that schools read the mark scheme together with the assessment material and the Principal Examiner Report for Teachers.

Due to a series-specific issue during the live exam series, all candidates were awarded full marks for Question 10(a). The mark scheme for these questions was not used by examiners.

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[Turn over

General marking principles

All examiners must apply these marking principles when marking candidate responses.

1	Examiners must award marks for each response in line with: • the specific **content** defined in the mark scheme • the specific **skills** defined in the mark scheme or in the level descriptions • the **standard of response** required as exemplified by the standardisation scripts.
2	Examiners must award **whole marks** (not half marks, or other fractions).
3	Examiners must award marks **positively**. This means that: • marks are not deducted for errors or omissions • marks are awarded for correct/valid answers as defined in the mark scheme and also for **other valid answers** which go beyond the scope of the syllabus and mark scheme referring to your team leader as appropriate • the quality of spelling, punctuation and grammar are judged **only** when the mark scheme indicates that these features are **specifically assessed** in the question. However, the meaning of all responses must be unambiguous.
4	Examiners must **consistently** apply the requirements of the mark scheme and any rules for what to do when candidates have not followed instructions correctly.
5	Examiners must use the **full range of marks** defined in the mark scheme, unless limited by the quality of the candidate responses seen.
6	Examiners must award marks according to the mark scheme and **must not** award marks with grade thresholds or grade descriptions in mind.

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Annotations guidance for centres

Examiners use a system of annotations as a shorthand for communicating their marking decisions to one another. Examiners are trained during the standardisation process on how and when to use annotations. The purpose of annotations is to inform the standardisation and monitoring processes and guide the supervising examiners when they are checking the work of examiners within their team. The meaning of annotations and how they are used is specific to each component and is understood by all examiners who mark the component.

We publish annotations in our mark schemes to help centres understand the annotations they may see on copies of scripts. Note that there may not be a direct correlation between the number of annotations on a script and the mark awarded. Similarly, the use of an annotation may not be an indication of the quality of the response.

The annotations listed below were available to examiners marking this component in this series.

Annotations

Annotation	Meaning
	Correct
	Incorrect
	To indicate where a key word/phrase/code is missing.
	Not relevant or used to separate parts of an answer.
	Indicates a part of the answer that is incorrect.
Highlighter	To draw attention to a particular aspect or to indicate where parts of an answer have been combined.
	Too vague.
	Repetition
	No examples or not enough.

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Annotation	Meaning
BOD	Benefit of Doubt.
NAQ	Not Answered Question.
SEEN	Indicates that work or a page has been seen including blank answer spaces and blank pages.
FT	Follow through.
I	Ignore

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Question	Answer	Marks	Guidance
1(a)	**One** mark per mark point (**Max 2**) MP1 `TYPE Animals =` MP2 `(Alpaca, Chicken, Donkey, Duck, Goat, Pony, Sheep)` Example answer `TYPE Animals = (Alpaca, Chicken, Donkey, Duck, Goat, Pony, Sheep)`	**2**	Only allow equals sign Do not allow quotation marks around data elements. The order of the elements must be correct. Do not allow extra punctuation, such as underscore, between elements, or when going onto the next line.
1(b)(i)	Enumerated	**1**	
1(b)(ii)	**One** mark per mark point (**Max 2**) MP1 The list is complete / contains **all** possible values // Cannot change values of list after it is defined/declared // **The list is of fixed length** MP2 The list is ordinal / ordered / in alphabetical order MP3 Elements are unique / not repeated	**2**	Do not allow chronological order for MP2
2	**One** mark for each correct word in the correct place (**Max 4**) four packets link interconnects The TCP/IP protocol suite consists of **four** layers which can be thought of as a stack. It is designed to send **packets** of data across the internet. It is also used as a communications protocol to ensure accurate delivery of data over private networks. The lowest layer of the stack is the **link** layer. This is the layer that **interconnects** nodes in the network.	**4**	

Question	Answer	Marks	Guidance

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Question	Answer	Marks	Guidance
3(a)	**Two** marks for working (**Max 2**) • correct use of exponent seen • correct conversion method from binary to denary **One** mark for correct answer (**Max 1**) Working: 1011010.00110 (moving bp 6 places to right) // multiply by 64 / 2^6 Evaluation of two's complement −64 +16 + 8 + 2 + 0.125 + 0.0625 // −64 +16 + 8 + 2 + 1/8 + 1/16 // 32 + 4 + 1 + 0.5 + 0.25 + 0.0625 // 32 + 4 + 1 + 1/2 + 1/4 + 1/16 // –1 + 1/4 + 1/8 + 1/32 + 1/512 + 1/1024 x 64 Answer: −37.8125 // $-37^{13}/_{16}$	**3**	Allow other methods of working.
3(b)	**One** mark per mark point (**Max 2**) MP1 When a calculation is performed on a normalised floating-point number // allow a specific example MP2 … so that the result obtained is less than the lowest possible value that can be stored in the system an underflow will occur // the exponent is too small / too negative for the number of bits in the mantissa, so the result becomes zero	**2**	

Question	Answer	Marks	Guidance
4(a)	**One** mark for an appropriate use of sequential file organisation (**Max 1**) Batch processing tasks Recording log files Generating bills/payroll Backup A valid example where the data is **stored in a specified order**	**1**	Do not allow examples that simply describe sequential file organisation, such as 'records are stored one after the other'.

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Question	Answer	Marks	Guidance
4(b)	**One** mark per mark point (**Max 2**) MP1 Records are stored in a file one after the other / linearly MP2 … in a given order MP3 … usually based on a key field / unique identifier	**2**	Chronological order is not correct for MP2 – that would be serial organisation.
4(c)	**One** mark per mark point (**Max 3**) MP1 Each record in the file is searched, one after the other / linearly // Each record in the file is searched from the physical start of the file MP2 … using the record key MP3 … until the record is found. MP4 … until the value of the record key being searched has been exceeded // … until the end of the file is reached.	**3**	Candidates whose answer is about searching an index as for index sequential files do not answer this question.

Question	Answer	Marks	Guidance
5	**One** mark per mark point (**Max 4**) MP1 A VM is a standalone environment running on a physical computer // A VM is not a physical machine MP2 It can emulate the hardware/software **of another system** MP3 VM software has all the components of a physical computer system MP4 The **host** machine provides all the physical resources e.g. RAM/ROM MP5 … and is controlled via a **host** operating system MP6 The hypervisor runs between the **host** and **guest** operating systems MP7 … and creates and runs virtual machines / allocates resources from the **host** to the **guest** OS. MP8 A **guest** OS runs within the VM/**host** OS MP9 Multiple **guest** OS can run on the same VM // Multiple VMs can run on the same **host** OS MP10 The **guest** operating system controls/accesses the **virtual** hardware/software.	**4**	Do not allow benefits, drawbacks or uses, as the question is about the meaning of the term virtual machine, so requires a description.

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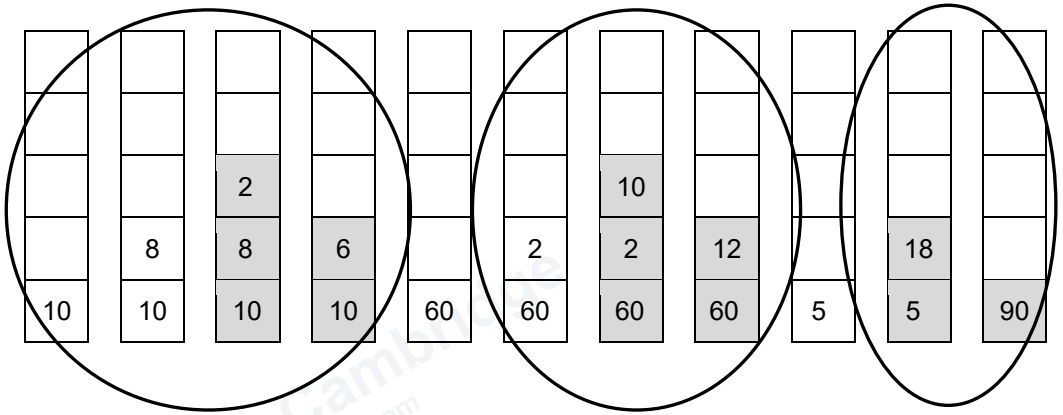
Question	Answer	Marks	Guidance
6(a)	**One** mark per mark point (**Max 2**) MP1 `16 9 7 –` MP2 `18 6 + / +` Final correct expression `16 9 7 – 18 6 + / +`	**2**	
6(b)	**One** mark per mark point (**Max 3**) MP1 `(6 + 15)` // `6 + 15` MP2 `– (20 – 3)` MP3 `/ (27 * 9)` **and** the pair of brackets around the whole numerator Final correct expression `((6 + 15) – (20 – 3)) / (27 * 9)` // `(6 + 15 – (20 – 3)) / (27 * 9)`	**3**	
6(c)	**One** mark per ring (**Max 3**) **One** mark for the interim totals (60) **and** (5). 	**4**	Do not allow operators in stacks Do not allow letters in stacks Values in shaded areas are necessary to award the marks in the rings.

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Question	Answer	Marks	Guidance
7(a)(i)	**Two** marks if no errors present **One** mark if one error present **AB** / **CD** **00**: 0 1 1 0 **01**: 1 1 1 1 **11**: 0 1 1 0 **10**: 0 1 1 0	**2**	0's must be present
7(a)(ii)	**One** mark for each correct loop **(Max 2)** **AB** / **CD** **00**: 0 1 1 0 **01**: 1 1 1 1 **11**: 0 1 1 0 **10**: 0 1 1 0	**2**	Max 1 if incorrect loops present.
7(a)(iii)	B + $\overline{C}$.D // $\overline{C}$.D + B	**1**	Allow products with or without dots e.g. C.D or CD.

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Question	Answer	Marks	Guidance
7(b)	**One** mark for correct answer **(Max 2)** for correct working from points shown $\mathbf{X = \overline{\overline{A}.B.C.\overline{D}} + \overline{\overline{A}.D}}$ De Morgan's laws $\mathbf{(X =) \overline{\overline{A}} + \overline{B} + \overline{C} + \overline{\overline{D}} + \overline{\overline{A}} . \overline{\overline{D}}}$ // $\mathbf{(X =) \overline{\overline{A}} + \overline{B} + \overline{C} + \overline{\overline{D}} + A.D}$ Double negation law $\mathbf{(X =) A + \overline{B} + \overline{C} + D + A.D}$ Absorption law Correct answer $\mathbf{(X =) A + \overline{B} + \overline{C} + D}$	**3**	One mark for correct answer and up to two marks to show correct use of different laws in the solution, which could be in the same line. The top line, shaded grey, is given in the question. Other solutions are possible. If distributive law is seen, that is also worth 1 working mark. Mark correct working lines where you see them.

Question	Answer	Marks	Guidance
8(a)	**One** mark per mark point (**Max 3**) MP1 Symmetric key encryption uses only one key but asymmetric encryption uses two keys // Asymmetric public and private keys are a mathematically linked pair, whereas symmetric uses the same key. MP2 Asymmetric key encryption uses one key to encrypt and the other key to decrypt, whereas symmetric key encryption uses the same key for both. MP3 Symmetric key encryption suffers from the key distribution problem, which the matched pair of keys for asymmetric has resolved. MP4 Asymmetric keys must be much larger/longer to achieve the same level of security as symmetric key encryption. MP5 Asymmetric key encryption allows verification of the sender, which symmetric key encryption does not.	**3**	Candidates are asked to describe the difference, so both key types need to be included for each mark, where applicable.

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Question	Answer	Marks	Guidance
8(b)	**One** mark per mark point (**Max 4**) MP1 The organisation generates a matched pair of encryption keys MP2 The organisation makes its public key available to the group of people / via its website MP3 The organisation encrypts its message using its private key MP4 … and sends it to the group of people MP5 Anyone receiving the message can decrypt it using the organisation's public key MP6 Therefore, verifying the **sender** // Providing non-repudiation.	**4**	The correct sequence of steps that is important.

Question	Answer	Marks	Guidance
9(a)	**One** mark per correct machine learning type (**Max 1**) Deep learning	**1**	Machine learning is NE because not all machine learning uses ANNs.
9(b)(i)	**One** mark per mark point (**Max 3**) MP1 The A* algorithm tries to find the shortest path using heuristics / intelligent guesses MP2 The A* algorithm doesn't necessarily pass through all nodes/paths MP3 Dijkstra's algorithm finds the shortest path to **all nodes** // Dijkstra's algorithm simply checks **each vertex** looking for the shortest path MP4 Dijkstra's algorithm **always** finds the shortest path MP5 The A* algorithm may not find the shortest path if the heuristics are inaccurate.	**3**	Do not award MP3 for searching through all **routes/paths** – it is looking at the shortest path to all **nodes**

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<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>9(b)(ii)</td><td>
One mark per mark point - working (Max 3)
May be seen on diagram or in working section

MP1 Initialisation – setting Home to 0
MP2 … and the rest of the nodes to ∞
MP3 Evidence to show values at nodes being updated
MP4 Evidence to show ‘visited node(s)’
MP5 Evidence to show a correct calculation of at least one route
MP6 Evidence to show more than one route has been calculated for at least one node

Correct Answers (Max 2) - allow these marks if totals clearly identified in working
Two marks for all six correct values
One mark for four or five correct values

<table>
<tr><th>A</th><th>B</th><th>C</th><th>D</th><th>E</th><th>F</th></tr>
<tr><td>6</td><td>13</td><td>9</td><td>20</td><td>17</td><td>14</td></tr>
</table>
</td><td>5</td><td>
MP1 a 0 on the home node in the diagram or clearly labelled in working

MP2 requires an ∞ symbol on EVERY node except Home in the diagram or clearly labelled in working

MP3 evidence of correct numbers being written and amended on the diagram at the nodes to represent ‘distance’ for a particular route, or in the working

MP4 any evidence of nodes being ‘visited’ in a route on the diagram OR listing of nodes by letter in the working

MP5 numbers on the diagram or in working that show a route being calculated from the component distances between nodes

MP6 numbers on the diagram or in working to show distances calculated to a node via different routes.
</td></tr>
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Question	Answer	Marks	Guidance
10(a)	**One** mark per mark point (**Max 3**) MP1 The time it takes to execute a linear search will increase linearly as the number of search items increases linearly MP2 Linear search worst case Big O notation is O(n) MP3 The time it takes to execute a binary search will increase logarithmically as the number of search items increases linearly // The time it takes to execute a binary search will increase linearly as the number of search items increases exponentially MP4 Binary search worst case Big O notation is O(log n) / O($\log_2$ n).	**3**	

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Question	Answer	Marks	Guidance

10(b)	**One** mark per mark point (**Max 6**)
	MP1 Correct completion of `FUNCTION` header
	MP2 Correct `OPENFILE` statement
	MP3 Correct use of `SEEK`
	MP4 Correct use of `GETRECORD`
	MP5 Correct complete selection statement(s) structure `IF` … `THEN` …. `ELSE` … `ENDIF` **OR** multiple `IF` … `THEN` … `ENDIF`
	MP6 Correct application of logic between condition and action to produce / return appropriate messages
	MP7 Correct use of `CLOSEFILE` – must be after `GETRECORD` but do **NOT** award this mark if `RETURN` statements(s) come before this line
	MP8 Correct `RETURN` statement(s) - allow use of other variables in this statement as the question does not specifically ask for `Response` to be used.
	
	Completed algorithm
	
	`FUNCTION TempCheck(Position : INTEGER) RETURNS STRING`
	`  DECLARE Temperature : REAL`
	`  DECLARE Response : STRING`
	`  OPENFILE "Temperatures.dat" FOR RANDOM`
	`  SEEK "Temperatures.dat", Position`
	`  GETRECORD "Temperatures.dat", Temperature`
	`  IF Temperature > 0 THEN`
	`  Response ← "Not freezing"`
	`  ELSE`
	`  Response ← "Freezing"`
	`  ENDIF`
	`  CLOSEFILE "Temperatures.dat"`
	`  RETURN Response`
	`ENDFUNCTION`
		6	`Temperatures.dat` given in question and all variables needed are declared at the top of the algorithm, so these must be used.
			
			The parameter can be anything, but it needs to be the same as the variable used in the `SEEK` line to award MP3.
			
			MP5 and MP8 may be given together if the `RETURN` statement is included in the selection statement.
			
			Be careful to check that `RETURN` and `RETURNS` are correct.
			
			Grey shaded areas given in question.

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Question	Answer	Marks	Guidance

11(a)	**One** mark per mark point (**Max 5**)
	MP1 Correct `CLASS Node` and `ENDCLASS` statements
	MP2 Correct attribute declaration section before the constructor
	MP3 Correct statement to begin and end the constructor as `PUBLIC PROCEDURE NEW` … `ENDPROCEDURE`
	MP4 Two parameters identified in the constructor with appropriate names and data types.
	MP5 Values passed using the constructer are assigned correctly – allow use of setters.
	
	Example algorithm
	
	`CLASS Node`
	`  PRIVATE Content : STRING`
	`  PRIVATE Pointer : INTEGER`
	
	`  PUBLIC PROCEDURE NEW(NewContent : STRING,`
	`  NewPointer : INTEGER)`
	`  Content ← NewContent`
	`  Pointer ← NewPointer`
	`  ENDPROCEDURE`
	`ENDCLASS`
		5	MP1 `Node` is given in the question, so must be used.
			MP2 must use `Content` and `Pointer` as `STRING` and `INTEGER`, respectively.
			MP4 any names can be used except `Content` and `Pointer`.
			MP5 the candidate's parameters from MP4 must be assigned to the attributes from MP2.

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<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>11(b)</td><td>One mark per correct answer (Max 4)

<table>
<tr><th>OOP Term</th><th>Description</th></tr>
<tr><td>setter</td><td>A method used to change values in private attributes in a class.</td></tr>
<tr><td>instance(s) // object(s)</td><td>An occurrence of a class during the execution of a program.</td></tr>
<tr><td>aggregation</td><td>One class/object contains another
// Hierarchy of nested classes/objects
// Process by which one class can contain other classes
// Represents a “has a” relationship between classes.</td></tr>
<tr><td>inheritance</td><td>Deriving new classes/objects on existing classes/objects
// Process in which the methods and data from one class, a superclass or base class, are copied to another class, a derived class
// Represents a hierarchy of derived classes
// Represents an “is a” relationship between classes.</td></tr>
</table>
</td><td>4</td><td></td></tr>
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