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CAMBRIDGE
International Education

Cambridge International AS & A Level

COMPUTER SCIENCE **9618/31**

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.

This document consists of **16** printed pages.

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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 correct data type (**Max 2**) set class / object	**2**	Do not allow record.
1(b)(i)	A user-defined data type that is used to reference a memory location	**1**	Do not allow point/pointer as the purpose.
1(b)(ii)	**One** mark per mark point (**Max 2**) MP1 `TYPE Word` MP2 `= ^STRING` Example answer: `TYPE Word = ^STRING`	**2**	

Question	Answer	Marks	Guidance
2(a)	**One** mark for an appropriate use of random file organisation (**Max 1**) Booking systems e.g. airline Operating system file management systems Video games Encryption utilities Compression utilities	**1**	Do not allow DBMS. Do not allow definitions of random file organisation.
2(b)	**One** mark per mark point (**Max 2**) MP1 Records are stored in no particular order / any available position MP2 A record key is used to determine the location where the record is to be stored MP3 … which is generated using a **hash** function on the key field MP4 New records are added in an empty location	**2**	Do not allow use of data/file instead of record Do not accept random as the description.

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Question	Answer	Marks	Guidance
2(c)	**One** mark per mark point (**Max 3**) MP1 Direct file access is used MP2 A hashing function is used on the key field to find the location in the file where the record is stored MP3 If the required record is found at the hashed location it is retrieved MP4 If the required record is not found, a collision resolution strategy is employed // Records from that point are searched linearly until the required record is found // Linear probing	**3**	Do not allow use of data/file instead of record Allow open or closed hashing / addressing for MP4.

Question	Answer	Marks	Guidance
3(a)	**One** mark per mark point (**Max 3**) MP1 correct **method** to find the binary number MP2 correct **use** of exponent MP3 correct answer in the space provided Working: –10.8125 converted to binary positive binary version of 10.8125 = 01010.1101 // two's complement version - bits flipped and 1 added = 10101.0011 // -8+2+0.5+0.25+0.0625 // -16+4+1+0.125+0.0625. Movement of binary point by 4 places **Mantissa**: 1 0 1 0 1 0 0 1 1 0 **Exponent**: 0 0 0 1 0 0	**3**	Allow other methods of working

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Question	Answer	Marks	Guidance
3(b)	**Two** marks for working (**Max 2**) • correct application of exponent seen • correct method to find the final answer Working: 10100001.11 (moving bp 7 places to right) Evaluation of two's complement −128 +32 + 1 + 0.5 + 0.25 **One** mark for correct answer (**Max 1**) Denary value: −94.25 // $-94^{1}/_{4}$	**3**	Allow other methods of working

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Question	Answer	Marks	Guidance
4	**One** mark for each correct line connecting a TCP/IP layer to its description **(Max 4)**. **TCP/IP layer** — **description** Application Transport Internet Link ensures packets arrive in sequence without errors provides remote access to files on a host server to access and manage files stored in a remote location interconnects nodes or hosts in a network, encapsulates IP packets into frames and ensures correct protocols are followed identifies the intended network and host. contains all the programs that exchange data and includes protocols: HTTP, FTP and POP3	**4**	

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Question	Answer	Marks	Guidance
5	**One** mark for each correct benefit (**Max 2**) MP1 Virtual machines can provide an instruction set architecture that is different to the actual computer. // Multiple operating system environments can be used on the same computer. // You can run an application / legacy software which is not compatible with the host computer / operating system using a guest operating system that is compatible with the application / software. MP2 Costs can be saved by not having to purchase additional hardware to test / use applications. MP3 The guest operating system can crash without affecting the host machine. // Guest operating system hosted on a virtual machine can be used without impacting anything outside the virtual machine. // When trying a piece of suspicious software, if it causes a problem, it will only infect the virtual machine. **One** mark for each correct limitation (**Max 2**) MP4 Degraded performance. // A virtual machine is less efficient than real machines because they access hardware indirectly. // The virtual machine has to request access to the hardware from the host, which slows usability. // If multiple virtual machines are running on the same host, performance may be negatively affected if the host lacks sufficient power to deal with all their requirements. MP5 A virtual machine is dependent on the features / standard of the host machine. // It may be affected by the weaknesses of the host machine // Not all hardware/software can be emulated. MP6 Managing and maintaining a virtual machine can be quite complex /specialised.	**4**	MP2 do not allow the mark for 'virtual machines can be cheaper', 'cost saving' by itself, or similar. The answer must match the phrase in the mark scheme. MP6 do not allow for just saying 'virtual machine can be expensive'. It has to have a reason e.g. expensive to maintain.

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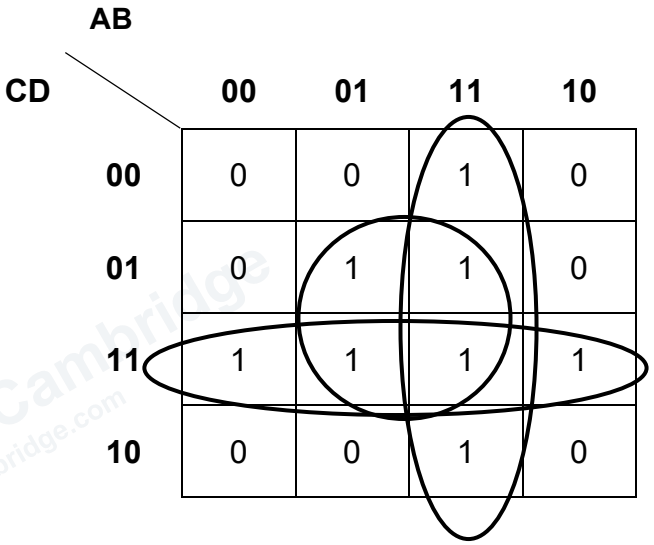
<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>6(a)</td><td>

- **One** mark for columns P, Q and R
- **One** mark for column S
- **One** mark for column Z

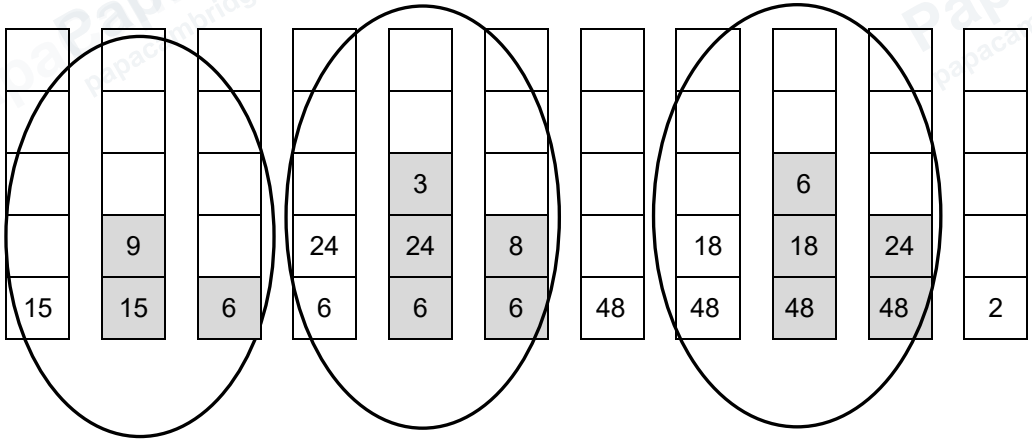
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<tr><th>A</th><th>B</th><th>C</th><th>P</th><th>Q</th><th>R</th><th>S</th><th>Z</th></tr>
<tr><td>0</td><td>0</td><td>0</td><td>1</td><td>1</td><td>1</td><td>0</td><td>0</td></tr>
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</table>

</td><td>3</td><td></td></tr>
<tr><td>6(b)</td><td>**One** mark per mark point (**Max 1**)
Solving logic expressions using a K-map makes it easier because you don’t need to use Boolean algebra. // It is **guaranteed** to give you an optimal solution. // Converts complex logic problems into simpler ones.</td><td>1</td><td>Makes it easier by itself is not enough.
Do not allow optimal sum-of-products instead of optimal solution.</td></tr>
</table>

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Question	Answer	Marks	Guidance
6(c)(i)	**One** mark for each correct loop **(Max 3)**  	**3**	Max 2 if incorrect loops seen.
6(c)(ii)	**One** mark per mark point (**Max 2**) MP1 One correct Boolean term with an OR (+) sign MP2 All three correct Boolean terms connected by OR signs and no other terms present. A.B + B.D + C.D	**2**	Terms can be in any order.

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Question	Answer	Marks	Guidance
7(a)	**One** mark per mark point (**Max 2**) MP1 `21 15 3 -` MP2 `8 + * 7 /` Final correct expression `21 15 3 - 8 + * 7 /`	**2**	
7(b)	**One** mark per mark point (**Max 3**) MP1 `(c + d)` MP2 `(a - b) * (a - c)` MP3 `/(` MP2 `)` Final correct expression `(c + d) / ((a - b) * (a - c))`	**3**	
7(c)	**One** mark per ring (**Max 3**) **One** mark for the interim total (48) **and** the final total (2). 	**4**	Do not allow operators in stacks Values in shaded areas are necessary to award the marks in the rings.

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Question	Answer	Marks	Guidance
8(a)(i)	Text **encrypted** from plain text using an encryption algorithm // The result of putting plain text through an **encryption algorithm**.	**1**	
8(a)(ii)	A cryptographic/encryption key that can be obtained/used by anyone to send encrypted messages. // A key that is part of a matched pair // An encryption key known to all users // A decryption key obtained/used by anyone to decrypt sender's digital signature	**1**	
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 individual MP3 The individual uses the public key to encrypt their message MP4 … and sends this message to the organisation MP5 The organisation decrypts the message using their private key **Alternative answer** **One** mark per mark point (**Max 4**) MP6 The individual generates a matched pair of encryption keys MP7 The individual sends their public key to the organisation MP8 The individual uses their private key to encrypt their message MP9 … and sends this message to the organisation MP10 The organisation decrypts the message using the individual's public key	**4**	The correct sequence of steps that is important.

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<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>9(a)</td><td>One mark per mark point (Max 4)
MP1 Supervised learning makes use of labelled training data
MP2 … to predict future events based on past outcomes
MP3 Unsupervised learning makes use of unlabelled training data / training data without instructions on what to do with it / does not use training data with the correct/expected outcomes
MP4 … to search for hidden patterns/relationships/structures/similarities/ outliers within the data
MP5 … to therefore get closer to the desired outcome as the training progresses.</td><td>4</td><td></td></tr>
<tr><td>9(b)</td><td>One mark per mark point - working (Max 3)
May be seen on diagram or in working section

MP1 Initialisation – setting Begin 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)
Two marks for all six correct values
One mark for four or five correct values.

<table><tr><th>P</th><th>Q</th><th>R</th><th>S</th><th>T</th><th>U</th></tr><tr><td>8</td><td>13</td><td>6</td><td>14</td><td>17</td><td>20</td></tr></table></td><td>5</td><td>MP1 a 0 on the Begin node in the diagram or clearly labelled in working
MP2 requires an ∞ symbol on EVERY node except Begin in the diagram or clearly labelled in working
MP3 evidence of correct numbers being written on the diagram at the nodes to represent ‘distance’ for a particular route
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>
</table>

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Question	Answer	Marks	Guidance

10(a)	**One** mark per mark point (**Max 5**)
	MP1 Correct outer loop iterating through entire array starting at second element
	MP2 Temporary variables both initialised to current value of arrays
	MP3 Insertion variable initialised
	MP4 Correct inner loop criteria
	MP5 Elements of both arrays inserted as appropriate
	MP6 Insertion variable decremented
	MP7 Temporary values replaced in correct place in arrays
	
	Sample algorithm
	
	`FOR Count ← 1 to 499`
	`  Temp1 ← MemberID[Count]`
	`  Temp2 ← Names[Count]`
	`  Insert ← Count - 1`
	`  WHILE Insert >= 0 AND MemberID[Insert] > Temp1`
	`  MemberID[Insert + 1] ← MemberID[Insert]`
	`  Names[Insert + 1] ← Names[Insert]`
	`  Insert ← Insert - 1`
	`  ENDWHILE`
	`  MemberID[Insert + 1] ← Temp1`
	`  Names[Insert + 1] ← Temp2`
	`NEXT Count`
		5	MP2 must be `Temp1` and `Temp2`
			MP3 must be `Insert`
			
			Do not accept bubble sort answers

10(b)	**One** mark per mark point (**Max 3**) MP1 Array size // Number of elements in the array MP2 … time efficiency will improve if the number of elements to be sorted are fewer MP3 Initial order MP4 … if the array is partially sorted the insertion sort works better	**3**	Allow the opposite for MP2 (worse/more). Allow the opposite for MP4 (reversed/slower).
10(c)	$O(n^2)$ // $O(N^2)$	**1**	Must be completely correct (including brackets).

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Question	Answer	Marks	Guidance

11(a)	**One** mark for each correctly completed clause (**Max 3**)
	
	`(25) customer(betty).`
	`(26) owns(large_tv, betty).`
	`(27) wants(bluray_player, betty).`
		3	Accept facts in any order.
			The device names have been given in clauses `02` and `04`. Responses must match these.

11(b)	`(Owner =) petrov, susan, sammy`	**1**	Can be in any order

11(c)	**One** mark per mark point (**Max 4**)
	MP1 `device(D)`
	MP2 `customer(A)`
	MP3 `owns(D, A).`
	MP4 All logic conditions / punctuation correct (accept , for `AND`)
	
	Example answers
	
	`may_buy_device(D, A)`
	`  IF device(D) AND customer(A) AND NOT owns(D, A).`
	
	`may_buy_device(D, A)`
	`  IF device(D), customer(A), NOT owns(D, A).`
		4	Allow MP1, MP2 and MP3 in any order.
			
			Accept \+ for NOT operator as Swish Prolog.

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