



AS Computer Science

7516/2 - Paper 2

Mark scheme

June 2018

Version/Stage: 1.0 Final

Mark schemes are prepared by the Lead Assessment Writer and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all associates participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the students' responses to questions and that every associate understands and applies it in the same correct way. As preparation for standardisation each associate analyses a number of students' scripts. Alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, associates encounter unusual answers which have not been raised they are required to refer these to the Lead Assessment Writer.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of students' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

Further copies of this mark scheme are available from aqa.org.uk

Level of response marking instructions

Level of response mark schemes are broken down into levels, each of which has a descriptor. The descriptor for the level shows the average performance for the level. There are marks in each level.

Before you apply the mark scheme to a student's answer read through the answer and annotate it (as instructed) to show the qualities that are being looked for. You can then apply the mark scheme.

Step 1 Determine a level

Start at the lowest level of the mark scheme and use it as a ladder to see whether the answer meets the descriptor for that level. The descriptor for the level indicates the different qualities that might be seen in the student's answer for that level. If it meets the lowest level then go to the next one and decide if it meets this level, and so on, until you have a match between the level descriptor and the answer. With practice and familiarity you will find that for better answers you will be able to quickly skip through the lower levels of the mark scheme.

When assigning a level you should look at the overall quality of the answer and not look to pick holes in small and specific parts of the answer where the student has not performed quite as well as the rest. If the answer covers different aspects of different levels of the mark scheme you should use a best fit approach for defining the level and then use the variability of the response to help decide the mark within the level, ie if the response is predominantly level 3 with a small amount of level 4 material it would be placed in level 3 but be awarded a mark near the top of the level because of the level 4 content.

Step 2 Determine a mark

Once you have assigned a level you need to decide on the mark. The descriptors on how to allocate marks can help with this. The exemplar materials used during standardisation will help. There will be an answer in the standardising materials which will correspond with each level of the mark scheme. This answer will have been awarded a mark by the Lead Examiner. You can compare the student's answer with the example to determine if it is the same standard, better or worse than the example. You can then use this to allocate a mark for the answer based on the Lead Examiner's mark on the example.

You may well need to read back through the answer as you apply the mark scheme to clarify points and assure yourself that the level and the mark are appropriate.

Indicative content in the mark scheme is provided as a guide for examiners. It is not intended to be exhaustive and you must credit other valid points. Students do not have to cover all of the points mentioned in the Indicative content to reach the highest level of the mark scheme.

An answer which contains nothing of relevance to the question must be awarded no marks.

AS Computer Science

Paper 2 (7516/2)

June 2016

To Examiners:

- **When to award '0' (zero) or '-' (hyphen) when inputting marks on CMI+**

A mark of 0 should be awarded where a candidate has attempted a question but failed to write anything creditworthy.

Insert a hyphen when a candidate has not attempted a question, so that eventually the Principal Examiner will be able to distinguish between the two (not attempted / nothing creditworthy) in any statistics.

- This mark scheme contains the correct responses which we believe that candidates are most likely to give. Other valid responses are possible to some questions and should be credited. Examiners should refer responses that are not covered by the mark scheme, but which they deem creditworthy, to a **Team Leader**.

The following annotation is used in the mark scheme:

- ;** - means a single mark
- //** - means an alternative response
- /** - means an alternative word or sub-phrase
- A** - means acceptable creditworthy answer
- R** - means reject answer as not creditworthy
- NE** - means not enough
- I** - means ignore
- DPT** - means "Don't penalise twice". In some questions a specific error made by a candidate, if repeated, could result in the loss of more than one mark. The **DPT** label indicates that this mistake should only result in a candidate losing one mark, on the first occasion that the error is made. Provided that the answer remains understandable, subsequent marks should be awarded as if the error was not being repeated.

Examiners are required to assign each of the candidate's responses to the most appropriate level according to **its overall quality**, and then allocate a single mark within the level. When deciding upon a mark in a level examiners should bear in mind the relative weightings of the assessment objectives.

eg

In the following questions the marks available are as follows:

Question 7.1 (max 9 marks)

AO2 (analyse) – 9 marks

Question 7.2 (max 6 marks)

AO1 (understanding) – 6 marks

Question 8.3 (max 6 marks)

AO1 (understanding) – 4 marks

AO2 (apply) – 2 marks

Where a candidate's answer only reflects one element of the AO, the maximum mark they can receive will be restricted accordingly.

Qu		Marks													
01	1	<p>Marks are for AO1 (knowledge)</p> <p>A;</p> <p>R. More than one lozenge shaded</p>	1												
01	2	<p>Marks are for AO1 (knowledge)</p> <p>C;</p> <p>R. More than one lozenge shaded</p>	1												
02	1	<p>Marks are for AO1 (understanding)</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>Quantity</th> <th>Position</th> </tr> </thead> <tbody> <tr> <td>3 kilobytes</td> <td>3</td> </tr> <tr> <td>2 mebibytes</td> <td>5</td> </tr> <tr> <td>2 bytes</td> <td>1</td> </tr> <tr> <td>2 megabytes</td> <td>4</td> </tr> <tr> <td>20 bits</td> <td>2</td> </tr> </tbody> </table> <p>Mark as follows: 1 mark for bits, bytes and kilobytes in correct positions 1 mark for mebibytes and megabytes in correct positions</p>	Quantity	Position	3 kilobytes	3	2 mebibytes	5	2 bytes	1	2 megabytes	4	20 bits	2	2
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2 megabytes	4														
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02	2	<p>Marks are for AO2 (apply)</p> <p>1 mark for correct conversions between representations, allowing follow through for final answer.</p> <p style="text-align: center;"> $27_{16} = 0010\ 0111_2$ $C9_{16} = 1100\ 1001_2$ Final answer: $F0_{16}$ </p> <p>1 mark for binary addition 11110000_2 allowing follow through if conversion was incorrect.</p>	2												
02	3	<p>Mark is for AO2 (apply)</p> <p>-2048;</p>	1												

03	1	<p>Marks are for AO1 (understanding)</p> <p>1 mark for identifying that analogue is <u>continuous</u> data 1 mark for identifying that digital has <u>discrete</u> values / stored as <u>binary</u> values A. consists of 1s and 0s.</p>	2
03	2	<p>Marks are for AO1 (understanding)</p> <p>More compact representation; Easy to modify / edit notes // easy to change values eg octave for entire score; Easy to change instruments; Simple method to compose algorithmically; Musical score can be generated directly from a MIDI file; No data lost about musical notes // no data lost through sampling; A. “better quality” but only if it there is some explanation of this eg “no error introduced during sampling”, “no background noise recorded” The MIDI file can be directly output to control a device; MIDI records the musician’s inputs rather than the sound produced; Max 2</p>	2
04	1	<p>Mark is for AO1 (knowledge)</p> <p>(Using an algorithm) to convert a message into a form that is not understandable (without the key to decrypt it); (Using an algorithm) to convert a message into a form that is only understandable by the intended parties // can only be read with the correct key; (Using an algorithm) to convert a message into cipher text;</p> <p>N.E. Scrambling unless further explanation is provided N.E. Coding A. “Unreadable” for “understandable” A. “Data” for “a message” R. Responses that do not make clear that encryption is a process</p> <p>Max 1</p>	1
04	2	<p>Marks are for AO1 (understanding)</p> <p>Vernam cipher (if implemented correctly) is unbreakable / harder to crack / Caesar cipher can be easily cracked; Frequency / statistical analysis of ciphertext reveals nothing about plaintext; More possible keys; Vernam cipher does not always translate a ciphertext character to the same plaintext character (removing repeated patterns);</p> <p>A. Points made in reverse, ie as disadvantages of the Caesar cipher</p> <p>Max 2</p>	2

04	3	<p>Marks are for AO2 (apply)</p> <p>1 mark for identifying 1001000 1001111 1000111 as the binary representation of 'HOG'</p> <p>1 mark for final result being 21 bits long;</p> <p>R. if result is the same as HOG (1001000 1001111 1000111) or SON (1010011 1001111 1001110)</p> <p>1 mark for correct application of XOR; 0011011 0000000 0001001</p> <p>A. follow through mistakes</p>	3
05	1	<p>Mark is for AO1 (knowledge)</p> <p>System Software;</p> <p>R. More than one lozenge shaded</p>	1
05	2	<p>Mark is for AO1 (knowledge)</p> <p>Mark as follows:</p> <p>Processors A. CPU; Memory / Memories A. RAM; I/O devices (among competing processes) A. examples;</p> <p>A. Hardware</p> <p>Max 1</p>	1
05	3	<p>Mark is for AO1 (knowledge)</p> <p>The role of the operating system is to hide the complexities of the hardware from the user;</p> <p>A. other reasonable answers that are not resource management.</p>	1
06	1	<p>Marks are for AO1 (knowledge)</p> <p>Instructions are stored in (main) memory; Instructions are fetched, (decoded) and executed (serially) by the processor; Programs can be moved in and out of main memory;</p> <p>Max 2</p>	2

06	2	<p>Marks are for AO1 (understanding) and AO2 (analyse)</p> <p>Mark as follows:</p> <p>AO2 (analyse) – 1 mark: The different processors have different instruction sets;</p> <p>A. Examples such as different numbers of general purpose registers / different architecture.</p> <p>AO1 (understanding) – 1 mark: The program is in machine code / platform dependent / makes use of those instructions;</p> <p>A. The program has been compiled NE. Not portable</p>	2
06	3	<p>Marks are for AO1 (understanding) and AO2 (analyse)</p> <p>Mark as follows:</p> <p>AO2 (analyse) – 1 mark: A processor with a clock speed of 3.2GHz may be able to execute (sequential) instructions more quickly than a processor with a clock speed of 2.8GHz;</p> <p>AO1 (understanding) – 1 mark: Where parallel processing is not possible / sequential processing is needed this may enable the 3.2GHz processor to complete the task sooner than the 2.8GHz processor;</p> <p>A. ‘Josephine’s computer’ for 3.2GHz processor and ‘Ella’s computer’ for 2.8GHz processor</p>	2

07	1	<p>Marks are for AO2 (analyse)</p> <p>Level of response question</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: center;">Level</th> <th style="text-align: center;">Description</th> <th style="text-align: center;">Mark Range</th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">3</td> <td>A line of reasoning has been followed to produce a coherent, relevant and substantiated and logically structured response. The response covers at least three of moral, ethical, legal and cultural issues. In these areas there is sufficient detail to show that the student has a good level of understanding of the issues faced by the programmers. A good level of understanding would be indicated by at least seven substantiated points being made.</td> <td style="text-align: center;">7-9</td> </tr> <tr> <td style="text-align: center;">2</td> <td>A line of reasoning has been followed to produce a mostly coherent, relevant, substantiated and logically structured response that covers at least two of moral, ethical, legal and cultural issues. At least four valid points must have been made showing reasonable understanding of the issues faced by the programmers.</td> <td style="text-align: center;">4-6</td> </tr> <tr> <td style="text-align: center;">1</td> <td>A few relevant points have been made but there is no evidence that a line of reasoning has been followed. At least one of moral, ethical, legal and cultural issues must be covered. Links to the programmer may be tenuous.</td> <td style="text-align: center;">1-3</td> </tr> </tbody> </table> <p>Note: The following notes are indicative content only and should not be used as a checklist.</p> <p>Moral:</p> <ul style="list-style-type: none"> - The developers may have to take on board the responsibility should an accident occur. - The developers may need to develop systems that cause the vehicle to make moral decisions in times of crisis e.g. if a crash is inevitable, what does the vehicle choose to crash in to. - The developer will have to accept that they are perpetuating or increasing use of vehicles which may have a negative impact on the environment. - The ability to keep them protected from hackers who might want to take over their controls while someone is on-board. <p>Ethical:</p> <ul style="list-style-type: none"> - The developer may be putting taxi drivers out of business. - By developing self-driving taxis, other similar businesses may follow suit causing further ethical considerations. - Customers may not realise the taxi is computer-controlled until they enter the vehicle leaving them in a dilemma. - If a customer is taken ill the taxi may not be able to deal with the situation. 	Level	Description	Mark Range	3	A line of reasoning has been followed to produce a coherent, relevant and substantiated and logically structured response. The response covers at least three of moral, ethical, legal and cultural issues. In these areas there is sufficient detail to show that the student has a good level of understanding of the issues faced by the programmers. A good level of understanding would be indicated by at least seven substantiated points being made.	7-9	2	A line of reasoning has been followed to produce a mostly coherent, relevant, substantiated and logically structured response that covers at least two of moral, ethical, legal and cultural issues. At least four valid points must have been made showing reasonable understanding of the issues faced by the programmers.	4-6	1	A few relevant points have been made but there is no evidence that a line of reasoning has been followed. At least one of moral, ethical, legal and cultural issues must be covered. Links to the programmer may be tenuous.	1-3	9
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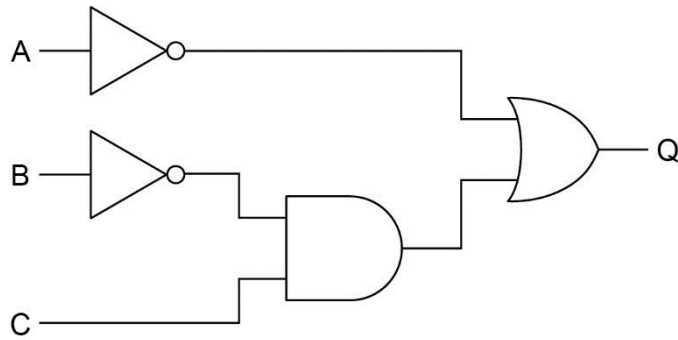
	<p>Legal</p> <ul style="list-style-type: none"> - Legal responsibility for accidents may be called into question. - If videos/images are taken during driving these may infringe the privacy of the occupants. - Passengers may find it easier to defraud or not pay the taxi company. <p>Cultural:</p> <ul style="list-style-type: none"> - Some cultures may dislike the assignation of human virtues on machines. - The culture of the ‘cabbie’ may be damaged. - As most accidents are caused by driver error and so the use of driverless cars, in theory, would improve safety. How can the public be persuaded of this? - Driverless cars would, in theory, reduce congestion and so how can this be communicated to improve uptake? 													
07	<p>2 Marks are for AO1 (understanding)</p> <p>Level of response question</p> <table border="1" data-bbox="240 882 1369 1339"> <thead> <tr> <th>Level</th> <th>Description</th> <th>Mark Range</th> </tr> </thead> <tbody> <tr> <td>3</td> <td>At least five points have been made that shows a very good understanding of both how an image is captured and how run-length encoding is applied.</td> <td>5-6</td> </tr> <tr> <td>2</td> <td>At least three points have been made that show a good understanding of at least one of how an image is captured and how run-length encoding is applied.</td> <td>3-4</td> </tr> <tr> <td>1</td> <td>At least one point has been made that shows some understanding of either image-capture or run-length encoding.</td> <td>1-2</td> </tr> </tbody> </table> <p>Guidance – Indicative Response</p> <p>Image Capture</p> <ul style="list-style-type: none"> - Light enters through/is focussed by the <u>lens</u>; on to (an array of sensors on) the sensor chip A. light sensors capture/record light (intensity) A. CCD as sensor; - Each sensor produces an electrical current/signal; - The signal represents a pixel; - An (ADC) converts measurement of light intensity into binary/digital data; - (Colour) filter is applied to generate separate data values for red, green and blue colour components; - The pixels are recorded as a group / array; <p>Run-Length Encoding</p> <ul style="list-style-type: none"> - The image is analysed to identify runs/sequences of the same colour/value NE. patterns; - The colours/values and counts of pixels/values/run-lengths are represented/identified/stored A. example; 	Level	Description	Mark Range	3	At least five points have been made that shows a very good understanding of both how an image is captured and how run-length encoding is applied.	5-6	2	At least three points have been made that show a good understanding of at least one of how an image is captured and how run-length encoding is applied.	3-4	1	At least one point has been made that shows some understanding of either image-capture or run-length encoding.	1-2	6
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08	1	<p>Marks are for AO1 (understanding)</p> <p>Physical: The (physical) <u>layout/arrangement/architecture</u> of the cabling/wiring/connections (between the devices/computers on the network); A. The (physical) <u>layout/arrangement/architecture</u> of the devices/computers/network NE. How the devices/computers are connected to each other NE. “Setup” for layout NE. List of topologies eg bus, star</p> <p>Logical: How the data/packets flow around a network // architecture of the communication mechanism in a network; A. Conceptual way that data moves around a network A. The type of protocol used (must be related to logical topology) NE. How a network operates/behaves</p>	2
08	2	<p>Marks are for AO1 (understanding)</p> <p>Every device is (directly) connected to a central node/switch/hub; Every device sends data via the central node/switch/hub; The switch sends packets of data to the intended recipient only // The hub sends every packet of data to every device;</p> <p>R. Computer Max 2</p>	2

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08	3	4 Marks are for AO1 (understanding) and 2 Marks are for AO2 (analyse)	6																		
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Note: Points in analysis column are not worth a mark of their own. Allow AO2 analysis marks in higher mark bands when combined with expansion points.																					
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Max 2 if circuit not fully correct.

09 4 Marks are for AO2 (apply) 4

Marking guidance for examiners

- Award marks for working out until an incorrect step has been made.
- If, in any one step, a candidate is simplifying different parts of an expression simultaneously award all relevant marks for this multiple stage but don't award any further marks for working in any parts simplified incorrectly. Example, if the expression $P.P.(P+Q) + P.P.1$ was changed to $P.(P+Q)+P.0$, the candidate would get one mark for simplifying the first part to $P.(P+Q)$ and could get further marks for correctly simplifying this part of the expression further but should not be awarded marks for simplifying the incorrectly changed part $P.0$ (ie to 0)

Mark as follows

MAX 3 marks for working

Award one mark each for applying the techniques below:

- a successful application of De Morgan's Law (and any associated cancellation of NOTs) that produces a simpler expression.
- successfully expanding brackets.

Award one mark for each application of a Boolean identity **MAX 2**.

Note: A simpler expression is one that is logically equivalent to the original expression but uses fewer logical operators.

Example working (1)

$$\overline{\overline{A \cdot \overline{B}} \cdot \overline{\overline{A}} \cdot (B + B)}$$

[use of $\overline{\overline{B}} + 0 = \overline{B}$]
 $\overline{\overline{A \cdot \overline{B}} \cdot \overline{\overline{A}} \cdot B}$ [use of $B + B = B$]
 $A \cdot \overline{B} + \overline{\overline{A}} \cdot B$ [application of De Morgan's Law]

Example working (2)

$$A \cdot (\overline{B} + 0) + \overline{\overline{A}} \cdot (B + B)$$

[use of De Morgan's Law]
 $A \cdot \overline{B} + \overline{\overline{A}} \cdot 0 + \overline{\overline{A}} \cdot B + \overline{\overline{A}} \cdot B$ [expansion of brackets]

	$A \cdot \bar{B} + \bar{A} \cdot B + \bar{A} \cdot B$ $A \cdot \bar{B} + \bar{A} \cdot B$ <p>Example working (3)</p> $A \cdot (\bar{B} + 0) + \bar{A} \cdot (B + B)$ $A \cdot \bar{B} + \bar{A} \cdot B$	<p>[use of $\bar{A} \cdot 0 = 0$ and removal] [application of $\bar{A} \cdot B + \bar{A} \cdot B = \bar{A} \cdot B$]</p> <p>[use of De Morgan's Law] [$\bar{B} + 0 = \bar{B}$ and $B+B=B$ means two marks for identities within brackets]</p> <p>1 mark for final answer A XOR B // A Exclusive OR B // A EOR B // A EXOR B // $A \oplus B$</p>	
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10	1	<p>Marks are for AO3 (design) and AO3 (program)</p> <p>Mark as follows:</p> <p>AO3 (design) – 1 mark 1 mark for identifying the need for two branch commands</p> <p>AO3 (program) – 3 marks For the AO3 (program) marks, the syntax used must be correct for the language as described on the question paper.</p> <p>1 mark: Subtracting 10 from R1 and storing the result in R1</p> <p>1 mark: Adding 1 to R3 and storing the result in R3</p> <p>1 mark: Having two branches with the correct condition(s)</p> <p>Max 2 marks for programming if any syntax incorrect or program does not work correctly under all circumstances</p> <p>DPT incorrect use of commas, colons, semi-colons, etc. Note this does not apply to #.</p> <p>Refer alternative answers to team leaders</p> <ul style="list-style-type: none"> - BLT end - SUB R1, R1, #10 - ADD R3, R3, #1 - B loopstart 	4
10	2	<p>Mark is for AO1 (understanding)</p> <p>64 // 2^6;</p>	1
10	3	<p>Mark is for AO1 (understanding)</p> <p>1024 // 2^{10};</p>	1
11	1	<p>Mark is for AO1 (understanding)</p> <p>The code may need to run on multiple platforms // target platform may not be known // may need to be platform independent;</p> <p>A. Portable with some explanation A. (May lead to) smaller file sizes</p>	1

11	2	<p>Marks are for AO1 (understanding)</p> <p>A virtual machine; performs just in time compilation // translation; to convert the bytecode to object code and execute it;</p> <p>//</p> <p>A virtual machine; interprets bytecode an instruction at a time; and runs the necessary code/subroutine to carry out the command in the hardware’s instruction set;</p> <p>Max 2</p> <p>Max 1 if no concept of translation shown.</p> <p>R. Suggestion that anything other than the virtual machine carries out translation</p>	2
11	3	<p>Marks are for AO1 (knowledge)</p> <p>Instructions are executed in a programmer-defined order // Imperative programs define sequences of commands for the computer to perform; Imperative languages describe how to solve a problem (in terms of sequences of actions to be taken);</p> <p>Max 1</p> <p>High level language instructions use English-like keywords // constructs; High level languages support structured statements (A. by example); High level languages support use of <u>local</u> variables / parameters / named constants / indentation;</p> <p>R. Closer to natural language / almost written in English R. Machine independent / problem-oriented / top-down</p> <p>Max 1</p>	2
12	1	<p>Marks are for AO2 (apply)</p> <p>1 mark for calculating number of pixels (8x10 // 80)</p> <p>1 mark for multiplying number of pixels by correct colour depth (80 x 3)</p> <p>1 mark for correctly converting to bytes (240 / 8 // 30 bytes)</p> <p>A. Follow through errors</p>	3
12	2	<p>Mark is for AO1 (understanding)</p> <p>5;</p> <p>R. More than one lozenge shaded</p>	1