

Name:

Class Teacher:

Date:



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# OCR J276

# GCSE Computer Science

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## *MARK SCHEME*

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### 2.6 DATA REPRESENTATION

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#### **Content in J276 GCSE Computer Science:**

- 1.1 Systems Architecture
- 1.2 Memory
- 1.3 Storage
- 1.4 Wireless and Wired Networks
- 1.5 Network Topologies, Protocols and Layers
- 1.6 System Security
- 1.7 Systems Software
- 1.8 Ethical, Legal, Cultural and Environmental Concerns
- 2.1 Algorithms
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- 2.3 Producing Robust Programs
- 2.4 Computational Logic
- 2.5 Translators and Facilities of Languages
- 2.6 Data Representation

# EXAM QUESTIONS

## QUESTION 1

Kofi uses his computer to record an audio file of himself playing his guitar. Outline what happens when the computer converts the music into a file.

1	a		<ul style="list-style-type: none"> <li>• The height of the wave is measured / sampled (at regular / set intervals)</li> <li>• Turned into / stored as binary</li> </ul>	2	1 mark for each bullet, to a maximum of 2.
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Kofi increases the sample rate his computer is using to record his guitar. Explain **two** effects this will have on Kofi's recording.

	b		<ul style="list-style-type: none"> <li>• The quality will improve ...</li> <li>• ... because the sound wave is more accurate to the original</li> <li>• The file size will increase ...</li> <li>• ... because there are more samples to store 4</li> </ul>	4	1 mark for each bullet. (1 mark for identification of the effect, one mark for an explanation)
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Kofi is emailing his recording to a record label. He uses lossy compression to produce the music file. Explain **two** reasons why using lossy compression is beneficial.

	c		<ul style="list-style-type: none"> <li>• Lossy means the decompressed file is not identical to the original...</li> <li>• ...the difference is unlikely to be noticed by humans</li> <li>• Lossy will decrease the file size ...</li> <li>• ... so it can be sent via e-mail</li> </ul>	2	1 mark for each bullet. (1 mark for identification of the effect, one mark for an explanation)
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## QUESTION 2

Order the following units from smallest to largest:

GB      bit      PB      byte      nibble      MB

2	a		bit, nibble, byte, MB, GB, PB 1	1	Correct Answer Only
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Convert the decimal number 191 into an 8-bit binary number.

	b		10111111	1	Correct Answer Only
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Convert the hexadecimal number 3E into a decimal number. You must show your working.

	c		<ul style="list-style-type: none"> <li>Working; <math>(3 * 16) + 14</math> <b>OR</b> 00111110</li> <li>62</li> </ul>	2	1 mark for correct answer, 1 for valid method of working
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There is a subroutine, HEX(), that takes a denary number between 10 and 15 and returns the corresponding hexadecimal number. E.g. HEX(10) would return "A", HEX(15) would return "F". Write an algorithm, using the subroutine HEX(), to convert any whole decimal number between 0 and 255 into a 2 digit hexadecimal number.

	d		<ul style="list-style-type: none"> <li>Taking a number as input</li> <li>Using HEX subroutine correctly</li> <li>Calculating Digit 1</li> <li>Calculating Digit 2</li> </ul> <p>INPUT decimal  digit1 = decimal DIV 16  IF digit1 &gt;= 10 THEN digit1 = HEX(digit1)  digit2 = decimal - (digit1 * 16)  IF digit2 &gt;= 10 THEN digit2 = HEX(digit2)</p>	4	<p>1 mark for each bullet.</p> <p>There are no marks associated with data types or conversions of data types.</p> <p>If used, a flowchart should represent the bulleted steps in the answer column.</p>
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Add together the following two 8-bit binary numbers. Express your response in an 8-bit binary form.

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0 1 1 0 1 0 1 0
1 0 0 1 0 1 1 0

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	e	i	0000 0000	2	Correct Answer Only 1 mark per nibble
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Identify the problem this addition has created.

		ii	overflow	1	Correct Answer Only
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### QUESTION 3

Complete a 2-place right shift on the binary number 11001011.

3	a		00110010	1	Correct Answer Only
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Explain the effect of performing a 2-place right shift on the binary number 11001011.

	b		<ul style="list-style-type: none"> <li>• The number is divided by 4</li> <li>• Loss of accuracy ...</li> <li>• ... the bits on the right are removed</li> <li>• ... the bits on the right are removed</li> </ul>	2	1 mark per bullet to a maximum of 2.
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#### QUESTION 4

Explain why data is stored in computers in a binary format.

4	a		<p>e.g.</p> <ul style="list-style-type: none"> <li>• Circuit only needs to check for two states / uses switches...</li> <li>• ...electricity flowing or not flowing / on or off / 1 and 0</li> </ul> <p>...resulting in more reliable circuits.</p>	2	<p><b>Examiner's Comments</b></p> <p>A number of candidates were able to make the connection between the use of binary and the design of computer circuitry which is what was being addressed. Many other candidates made some relevant point which allowed them to gain one of the marks, but missed this crucial link.</p>
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In the ASCII character set, the character codes for the first three capital letters are given below.

Letter	ASCII character code
A	0100 0001
B	0100 0010
C	0100 0011

State how the ASCII character set is used to represent text in a computer.

	b	i	<ul style="list-style-type: none"> <li>• Each character is assigned a unique character code</li> <li>• Each letter is converted to its character code (which is a binary number)</li> </ul>	1	
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Convert the word CAB into binary using the ASCII character set.

		ii	<ul style="list-style-type: none"> <li>• 0100 0011 0100 0001 0100 0010.</li> </ul>	1	Correct answer only but spaces don't matter
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Explain why the ASCII character set is **not** suitable for representing text in all the languages of the world.

		iii	<ul style="list-style-type: none"> <li>• ASCII uses 8 bits...</li> <li>• ...and so can only represent 255 / 256 distinct characters...</li> <li>• ...many more characters are needed for coping with all languages (e.g. Unicode 16bits)</li> <li>• ASCII does contain characters used in some languages</li> </ul>	2	<p>Accept answers referring to 7 bits are equally valid</p> <p><b><u>Examiner's Comments</u></b></p> <p>This question was generally well answered, with the best answers for part (b)(iii) referring clearly to the fact that the number of bits per character imposes a limit on the number of symbols that can be represented.</p>
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## QUESTION 5

When recording a sound file on a computer, the sound needs to be sampled. Describe how sampling is used when storing sound.

5		i	<ul style="list-style-type: none"> <li>• The height / amplitude of the sound wave is measured</li> <li>• ... at regular intervals</li> <li>• ... and converted to binary.</li> </ul>	2	<p>Remember to transfer marks between (i) and (ii) if necessary... many candidates may make this point in their answer to part (ii)</p> <p><b><u>Examiner's Comments</u></b></p> <p>This question was poorly answered and it was obvious that many of the candidates had not studied this. Most candidates thought sampling was the same as compression, while others used their experience of downloading large media files to describe sampling as a "taster file" to determine whether the rest of the file is of acceptable quality.</p>
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Explain the effect of the sampling interval on the size and quality of the sound file recorded.

		ii	<ul style="list-style-type: none"> <li>• If the interval is smaller / if you sample more often you have more data to store...</li> <li>• ... so larger file</li> <li>• but the sound reproduced is closer to the original...</li> <li>• ...so better quality.</li> </ul>	3	<p>Accept the converse ie if you sample less often you have a smaller file etc... as long as the explanation is correct</p> <p><b><u>Examiner's Comments</u></b></p> <p>Some of those who were on the right track lost marks because their answers lacked precision. The question asked about the effect of the sample interval but some candidates interpreted this as the sample rate. As these are reciprocals of each other, the sample rate obviously gives the wrong answers, unless the candidate specifically stated that this is what they were referring to. Other candidates were even less precise with answers like "it increases the quality" without stating what change in the sampling interval increases the quality.</p>
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## QUESTION 6

6	a	<p>Correct answer:</p> $  \begin{array}{r}  1\ 1\ 0\ 1\ 1\ 0\ 0\ 0 \\  +\ 0\ 1\ 1\ 0\ 0\ 0\ 0\ 0 \\  \hline  (1)\ 0\ 0\ 1\ 1\ 1\ 0\ 0\ 0  \end{array}  $ <p>Award marks for:</p> <ul style="list-style-type: none"> <li>• 1 1 1 0 0 0 for bits 5 to 0</li> <li>• 0 0 for bits 7 and 6.</li> </ul>	2	<p><b>Examiner's Comments</b></p> <p>Most candidates had no difficulty with the portion of the binary addition where there was no carry, but weaker candidates were less sure about what to do about the carry with some even using the digit 2.</p>

State the problem that will occur if a computer is to store the result as a byte.

	b	<ul style="list-style-type: none"> <li>• there is an overflow / a carry left over after the addition / does not fit into one byte.</li> </ul>	1	<p><b>Examiner's Comments</b></p> <p>It was unfortunate that a good number of candidates did not simply use the technical term ("overflow") – however, those who did not use this term were still able to get the mark by giving an accurate description of an overflow error.</p>
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## QUESTION 7

Files are often compressed before they are sent over the internet. State what is meant by compression.

7	a	<ul style="list-style-type: none"> <li>• Reduce the size of the file.</li> </ul>	1	<p>Accept other valid advantages to do with <i>sending</i> files, NOT storage</p>
		<ul style="list-style-type: none"> <li>• Transmits more quickly / uses less bandwidth</li> </ul>	1	<p><b>Examiner's Comments</b></p> <p>This question was generally answered well by most candidates.</p>

State **one** advantage of compressing files before sending them over the internet.

		<ul style="list-style-type: none"> <li>• Transmits more quickly / uses less bandwidth</li> </ul>	1	
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Two types of compression are lossy and lossless. State which type of compression is most appropriate for each of the following and explain why it is appropriate.

- Downloading the source code of a large program

	b	i	<ul style="list-style-type: none"> <li>• Lossless compression</li> <li>• The code has to be exactly as it was originally written</li> <li>• ... or else it will not work.</li> </ul>	3	<p>Explanation must follow from the type of compression given.</p> <p><b>Examiner's Comments</b></p> <p>Middle ability candidates were largely able to show their understanding of lossless and lossy compression by identifying which was to be used in the scenarios given, and stronger candidates were able to also justify why. It was pleasing to see significantly better performance on this topic than in previous sessions, suggesting that centres have heeded to the advice given in previous reports.</p>
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- Streaming a large video file

		ii	<ul style="list-style-type: none"> <li>• Lossy compression</li> <li>• Achieves higher compression / smaller file size / faster streaming than lossless</li> <li>• Video can still be viewed at lower quality (from the data compressed).</li> </ul>	3	<p><b>Examiner's Comments</b></p> <p>When candidates were justifying the use of lossy compression for the large video, most stated the fact that the loss of detail was relatively inconsequential but only the most able candidates went on to add that in addition it provides better compression ratios than lossless to give a full justification.</p>
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### QUESTION 8

Numbers can be represented in denary, binary or hexadecimal. Convert the binary number 01101001 to denary, showing your working.

8	a	i	<ul style="list-style-type: none"> <li>• <math>64 + 32 + 8 + 1</math></li> <li>• 105.</li> </ul>	2	
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Convert the denary number 154 to binary.

		ii	<p>Answer: 10011010 (one mark per nibble if partly wrong)</p>	2	<p>Allow 1 mark for 01011001</p> <p><b>Examiner's Comments</b></p> <p>Candidates usually perform well at binary conversions and continued to do so this year which is pleasing to see. The majority of candidates obtained full marks</p>
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The security code for an alarm system is a long binary number which begins

10001111100101111011 ...

The technicians prefer to use hexadecimal to enter the security code. When the number is converted into hexadecimal, the first two digits are 8F as shown below. Complete the gaps to show the next three digits.

	b	i	Answer: 9 7 B (one mark per hex digit)	3	<b>Examiner's Comments</b> The majority of candidates obtained full marks.
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Explain why the technicians prefer to use hexadecimal.

					<b>Examiner's</b>	<b>Comments</b>
		ii	<ul style="list-style-type: none"> <li>it is 4 bits per hex digit / straightforward to convert</li> <li>shorter number to remember / quicker to enter / less susceptible to error.</li> </ul>	2		Some of the weaker candidates showed a clear lack of understanding of the importance and relevance of hex, for example by suggest that hex requires less memory to store than binary. In applying their understanding to the scenario, many candidates also gave vague answers such as stating that numbers in hex are "easier to understand" than their binary equivalent.

### QUESTION 9

Bob's computer has 512 kilobytes of ROM and 8 gigabytes of RAM. State how many bytes are in a kilobyte and a gigabyte.

9			<ul style="list-style-type: none"> <li>1 kilobyte = 1024 bytes / ?1000 bytes</li> <li>1 gigabyte = 1024 × 1024 × 1024 bytes / ?1000000000 bytes.</li> </ul>	2	<p>1024 × 1024 × 1024 = 1073741824.</p> <p><b>Examiner's Comments??</b></p> <p>Most candidates were able to say that 1024 or 1000 bytes in a kilobyte but many struggled with giving the number of bytes in a gigabyte. Some of these simply failed to read the question carefully and give the number of megabytes in a gigabyte. In other cases the difficulty was due in part to attempting to calculate the answer using pencil and paper methods. Centres should note that we are primarily concerned with the difference in order of magnitude between different units, not mathematical skills, so answers such as 1024x1024x1024 are acceptable.</p>
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## QUESTION 10

The number 62 could be a denary number or a hex number. If 62 is a hex number, calculate its value as a denary number. You **must** show your working.

10		i	<ul style="list-style-type: none"><li>• <math>6 \times 16 + 2 = 0110\ 0010</math></li><li>• 98</li></ul>	2	<p>Accept working where candidates write the least significant bit first in their binary representation (i.e. 01111100) as long as this is clear (e.g. by showing the place values).</p> <p><b>Examiner's Comments</b></p> <p>Most candidates who attempted this part correctly converted between denary and hex, and vice versa. The most common error was the use of the hex digit "D" for the denary number 14. Some candidates omitted this question, although their performance in other questions suggested that they should have been able to make a reasonable attempt.</p>
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If 62 is a denary number, calculate its value as a hex number. You **must** show your working.

		ii	<ul style="list-style-type: none"><li>• <math>62 \div 16 = 3\ r\ 14 / 62 = 0011\ 1110</math></li><li>• 3E</li></ul>	2	<p>Accept working where candidates write the least significant bit first in their binary representation (i.e. 01000110) as long as this is clear (e.g. by showing the place values)</p>
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## QUESTION 11

11	a		<p>Answer: 1 1 1 0 1 1 1 1</p> <p>One mark per nibble</p>	2	<p><b>Examiner's Comments</b></p> <p>This part posed no difficulty for most candidates.</p>
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An overflow error can occur when adding two 8-bit binary numbers. Describe what is meant by an overflow error.

		b	<ul style="list-style-type: none"><li>• There is an extra carry / bit</li><li>• As number cannot fit into 8 bits</li><li>• Result is greater than 255 / 11111111</li></ul>	2	<p><b>Examiner's Comments</b></p> <p>In this part, while most candidates showed some understanding of what an overflow error is, fewer were able to give a detailed description for full marks. Using the context provided by the question (that we were dealing specifically with the addition of 2 8-bit numbers) might have helped some of these candidates to achieve the second mark. Candidates continue to confuse the terms "number" and "digit". In most cases, this did not affect the candidates' mark as their meaning was clear in the context of their answer, but in some cases it can be so ambiguous that the examiner is unable to determine the candidate's level of understanding.</p>
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## QUESTION 12

The website of a school allows visitors to download JPG, MP3, MPEG and PDF files. The video clip is compressed using lossy compression. Explain why lossy compression is suitable for a video clip, but not suitable for a text document.

12			<ul style="list-style-type: none"><li>• When the file is compressed some detail / data / quality / resolution is lost...</li><li>• ... which is not noticeable in the video file / video still viewable with lower quality</li><li>• ... but would make the text file unreadable / lose meaning or comprehension</li></ul>	3	<p><i>The first bullet is for the idea that something is lost in the compression process.</i></p> <p><i>The second bullet is for the idea that the video file is still usable with this loss.</i></p> <p><i>The third bullet is for the idea that the text file is not usable.</i></p>
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## QUESTION 13

Convert the decimal number 191 into 8-bit binary.

13	a		10111111	1	<p><b>Examiner's Comments</b></p> <p>This question was answered well, with the majority of candidates getting this correct.</p>
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Perform the following binary addition.

$$\begin{array}{r} 01101011 \\ + 01011011 \\ \hline \end{array}$$

	b		1 mark per nibble 1100 0110	2	<p><b>Examiner's Comments</b></p> <p>Many candidates were able to answer this correctly.</p>
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## QUESTION 14

Alex is producing images and sound effects for a website. Part of a bitmap image is shown in Figure 2 below.

W	W	R	R	R	B	B
W	W	R	Y	R	B	B
B	B	R	R	R	B	B
B	B	B	LG	B	DG	B
B	DG	DG	LG	DG	B	B
B	B	DG	LG	B	B	B
B	B	B	LG	B	B	B

The letters represent a colour, as shown in Figure 3.

Letter	Colour
W	White
B	Blue
R	Red
Y	Yellow
DG	Dark Green
LG	Light Green

Using the example in Fig 2, explain how a bitmap image is stored on a computer.

14	3	<p>max 2 for explanation max 1 for example / use of Figure 2 or 3</p> <ul style="list-style-type: none"> <li>• An image is made up of / consists of pixels</li> <li>• A pixel can be one colour</li> <li>• Each colour has a unique / corresponding binary number</li> <li>• Each pixel / square is given the binary number of its colour</li> <li>• The binary numbers are stored in order in the file</li> <li>• E.g. White = 000, Red = 010, Blue = 110, top line would be 000000010010010110110</li> </ul>	<p>Accept answers that are annotated on Figures 1 and 2, or that use these to explain the storage of the image, that meet each bullet</p> <p>The example must be more than describing what the diagram shows, e.g. 'the squares with W in are white' is not enough.</p> <p><b>Examiner's Comments</b></p> <p>Very few candidates used the example in the figure as part of their response, there was the opportunity to annotate the diagram here, or to use it throughout their explanation, but this was very rarely done. The better candidates were able to use the correct terminology, whilst many wrote everything they knew about bitmap images, including how they are displayed on screen as opposed to how it is stored.</p>
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## QUESTION 15

Explain how reducing the number of colours in an image can reduce its file size.

15	a	<p>2 from</p> <ul style="list-style-type: none"> <li>• Fewer bits are needed per colour</li> <li>• which means fewer bits per pixel</li> <li>• Any example from diagram</li> </ul>	<p>2</p> <p>"fewer bits" with no reason or application is 0</p> <p><b>Examiner's Comments</b></p> <p>This question was not answered well. Most candidates repeated the question by saying there was less data. Candidates needed to explain how the reduction in colours reduces the file size. Another common error was that there were less pixels because there were less colours. The better candidates were able to clearly explain that there were less bits needed per colour, and therefore less bits needed to represent each pixel.</p>
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The final image file may contain metadata. Describe, using an example, what is meant by metadata.

	b	<p>Max 1 for description, 1 for example</p> <ul style="list-style-type: none"> <li>• To store data / information about the image / data</li> <li>• E.g. Dimensions / height / width / No. of bits per pixel / Colours used / location / date / file type</li> </ul>	<p>2</p> <p>0 marks for filename as example 'tells you something about the image' = TV 0 marks for definition referring to how the image is 'displayed'</p> <p><b>Examiner's Comments</b></p> <p>This question was answered well by many candidates, who were able to give a reasonable example of metadata. Fewer candidates could define metadata, but, again, a significant number of candidates could do this.</p>
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Alex needs to create an audio recording of himself playing his guitar. Explain how sampling is used to make the recording.

	c	i	<ul style="list-style-type: none"> <li>• The amplitude / height of the wave is measured</li> <li>• At set / regular intervals / by reasonable example</li> <li>• And stored as a binary number</li> <li>• The samples form an approximated sound wave</li> </ul>	<p>3</p> <p>NOT frequency / pitch</p> <p>NB For the second bullet, this must relate to set intervals / the same interval. A set number of times per second does not suggest the same intervals.</p> <p><b>Examiner's Comments</b></p> <p>Where candidates knew how sound was stored, they were able to give a clear description, and those better candidates did well with this question. Some candidates did not understand the terminology of sampling, and often guessed at the meaning of the word.</p>
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State the effects of increasing the sample rate of the recording.

		ii	<ul style="list-style-type: none"> <li>File size increases</li> <li>So the sound is truer / better quality / more accurate compared to the original / analogue</li> </ul>	2	<p><b>Examiner's</b></p> <p>Many candidates were able to correctly identify that the file size increased. Fewer candidates could express that the quality was improved because it was closer to the original that was being recorded.</p> <p><b>Comments</b></p>
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### QUESTION 16

The character é is part of a computer's character set. Describe what is meant by a character set.

16	a	<ul style="list-style-type: none"> <li>The characters / symbols a computer uses / understands / displays</li> </ul>	1	<p>This has to explain what the set is, not how they are stored.</p> <p>0 marks for:</p> <ul style="list-style-type: none"> <li>The characters for coding / programming</li> <li>the amount / number of / quantity of characters</li> </ul> <p><b>Examiner's Comments</b></p> <p>Most candidates made a good attempt at defining a character set, but they needed to be explicit that it referred to the characters in a computer. A common error was that it was the characters that people use, or those that are on a keyboard, the latter of which is not accurate enough because a character set often has many more characters than those a keyboard displays.</p>
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When sending text messages using a mobile phone, people can choose from hundreds of characters, called emoji, to insert in their message. An example of an emoji is 🤖. The Unicode character code for the emoji 🤖 in hexadecimal is 1F64A. Convert the hexadecimal number 1F64A to binary. The first three hexadecimal digits have been done for you.

			1 mark each								<p>Allow 100 for 4</p> <p><b>Examiner's Comments</b></p> <p>2 This question was answered well, candidates were able to correctly convert the numbers into hexadecimal. Those candidates who could not convert to hexadecimal were still often able to get the conversion of 4 correct.</p>
b	i			Hex:	1	F	6	4	A		
				Binary:	0001	1111	0110	<b>0100</b>	<b>1010</b>		

Explain why mobile phones that can send emoji would use Unicode instead of ASCII as their character set.

		ii	<ul style="list-style-type: none"> <li>Unicode has more characters / space (to store the emoji)</li> <li>Unicode is 16 bit / 1-4bytes compared to ASCII's 7/8 bits</li> </ul>	2	<p>Allow the opposite for bullet 1 i.e. ASCII does not have enough space</p> <p>Allow any acceptable format for Unicode e.g. 1, 2, 3 or 4 bytes long Allow numeric quantities in place of bits / bytes for bullet 2</p> <p><b>Examiner's Comments</b></p> <p>Many candidates had a good understanding of the differences between the two languages, the most common response being that Unicode could have more characters. Fewer candidates went into further detail to explain why this was the case. Some candidates got these the wrong way, and stated that Unicode was used because it would take up less space.</p>
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