AQA Computer Science A-Level
4.5.6 Representing images, sound and other data
Past Paper Questions

| 0 | 4 |

Figure 1 shows a message being encrypted using a Caesar cipher.

Figure 1

Plaintext: MONKEY

Ciphertext: FHGDXR
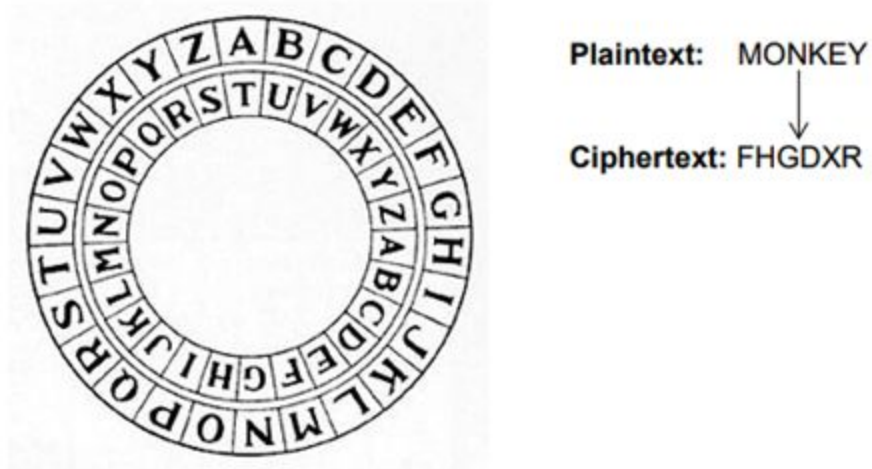
| 0 | 4 | . | 1 |

Encrypt the plaintext "COMPUTING" using the Caesar cipher with the settings shown in **Figure 1**.

[1 mark]

_____

_____

| 0 | 4 | . | 2 |

Decrypt the ciphertext "IRMAHG" using the Caesar cipher with the settings shown in **Figure 1**.

[1 mark]

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`0 4` . `3` Using the Vernam cipher method, the plaintext "SOS" is to be encrypted. "S" will be encoded using 8-bit ASCII as 01010011 and "O" as 01001111.

The key 10111001 00110101 00011010 will be used to perform the encryption.

Perform this encryption, showing how you have worked out what the ciphertext would be from the plaintext.

[3 marks]

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`0 5` A screen contains black text on a solid white background. One line of the screen might be represented as follows with W representing white pixel and B representing a black pixel.

WWWWWWWBBBWWWWWWWWWWWWWWWWBBBBBBWBBBWWWW

`0 5` . `1` Explain what the term pixel means.

[1 mark]

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A compression technique is applied to the line of data and results in the following:

6W3B12W6B1W3B4W

`0 5` . `2` State what data compression algorithm has been applied.

[1 mark]

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Another data compression technique is JPEG, which is a lossy compression algorithm.

0 5 . 3 Explain what is meant by lossy compression.

[1 mark]

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_____

A JPEG file contains data about the pixels that form the image as well as metadata.

0 5 . 4 Provide **two** examples of information that might be contained within the metadata for an image.

[2 marks]

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Additional Specimen Paper 2

1 0 **Figure 7** shows a message being encrypted using a Caesar cipher.

Figure 7

1 0 . 1 Decrypt the ciphertext "QXQBTMZF" using the Caesar cipher with the settings shown in **Figure 7**.

[1 mark]

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Using the Vernam cipher method, the plaintext "RUN" is to be encrypted. "RUN" will be encoded using 8-bit ASCII, according to the ASCII table in **Figure 8**.

Figure 8

| Letter	ASCII Code	Letter	ASCII Code	Letter	ASCII Code
A	01000001	J	01001010	S	01010011
B	01000010	K	01001011	T	01010100
C	01000011	L	01001100	U	01010101
D	01000100	M	01001101	V	01010110
E	01000101	N	01001110	W	01010111
F	01000110	O	01001111	X	01011000
G	01000111	P	01010000	Y	01011001
H	01001000	Q	01010001	Z	01011010
I	01001001	R	01010010		

The key 10111001 01001101 01000001 will be used to perform the encryption.

Perform this encryption, showing how you have worked out what the ciphertext would be from the plaintext.

[3 marks]

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| 1 | 0 | . | 3 | Explain why messages encrypted using a Caesar cipher can be easily cracked, and why the Vernam cipher is, under certain conditions, considered to be perfectly secure.

[4 marks]

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| 1 | 1 |

The triangle in **Figure 9** is repesented as part of an image using vector graphics.

Figure 9

(0,0)
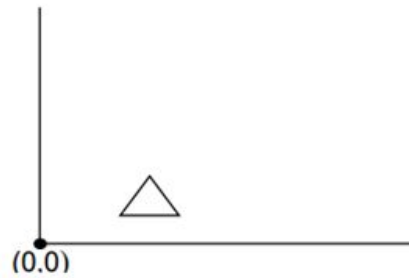
| 1 | 1 | . | 1 |

The location of the triangle on the screen is represented by storing the co-ordinates of its three corners.

State **two** distinct properties, other than the co-ordinates, that could be stored about a triangle object.

[2 marks]

Property 1 _____

Property 2 _____

| 1 | 1 | . | 2 |

Discuss the advantages and limitations of vector graphics when compared to the use of bitmap graphics.

[3 marks]

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June 2012 Comp 3

5 (a)　What is *encryption*?

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....

....

(1 mark)

5 (b)　The data that are being transmitted will be encrypted using public and private keys. A and B will each have a public key and a private key.

A will encrypt the data that it is sending using B's public key.

Explain why the data should **not** be encrypted using:

5 (b) (i)　A's public key.

....

....

....

(1 mark)

5 (b) (ii)　A's private key.

....

....

....

(1 mark)

5 (c)　The communication will be made more secure by the use of a digital signature attached to the end of the message.

- State the purpose of the digital signature.
- Explain how it will be created and used in the data transmission process from A to B.

In your answer you will be assessed on your ability to use good English, and to organise your answer clearly in complete sentences, using specialist vocabulary where appropriate.

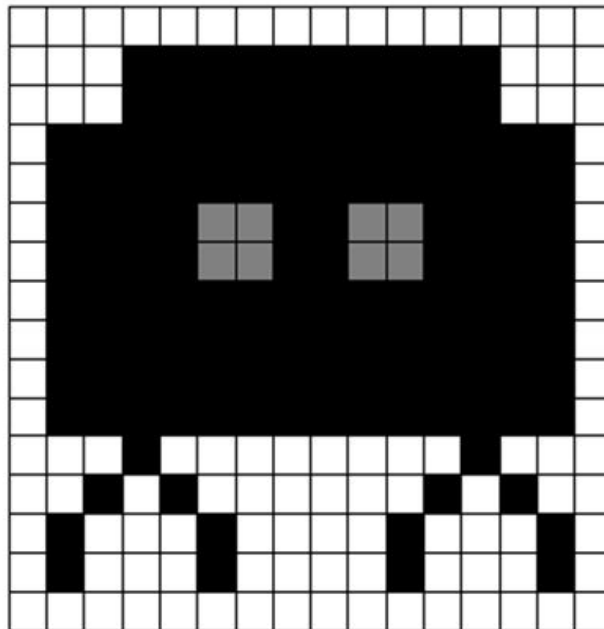...

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(6 marks)

0 6 Digital images are often represented using a bitmap. **Figure 7** shows a 16x16 bitmap image that is to be used as a character in a computer game.

Figure 7

0 6 . 1 What is the minimum file size in **bytes** of the image shown in **Figure 7** when it is represented using a bitmap?

You may get some marks for your working even if your answer is incorrect.

[3 marks]

_____

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Answer _____

0 6 . 2 Explain why the actual file size for the image will be larger than the minimum file size calculated for your answer for **0 6 . 1**

[1 mark]

_____

_____

_____

0 6 . 3 If the number of colours used in the image in **Figure 7** were increased by two, what is the minimum number of extra bits that would be needed to represent each pixel?

[1 mark]

_____

_____

0 6 . 4 Image files are often compressed so that they take up less storage space. Describe how **run length encoding** (**RLE**) could be used to compress the image shown in **Figure 7**.

[2 marks]

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June 2017 AS Paper 2

0 3 A band is recording and digitising a song to make available as a download from their website.

0 3 . 1 The song lasts 3 minutes. The sample resolution is 16 bits and a sample rate of 44 kHz has been used.

A sample rate of 1 Hz means that one sample has been taken every second.

Calculate the minimum amount of storage space, in megabytes (MB), needed to store the song in an uncompressed format.

You **must** show your working.

[3 marks]

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Answer: _____

| 0 | 3 | . | 2 |

The song is being recorded using a microphone plugged into the sound card of the computer. The sound card contains an analogue to digital converter (ADC).

Describe the steps the ADC goes through in this process.

[3 marks]

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| 0 | 3 | . | 3 |

The band have been advised to save their song using lossless compression.

Explain why it might be appropriate for the band to save the song using lossless compression rather than using lossy compression.

[2 marks]

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0	2

Figure 2 shows a message being encrypted using a Caesar cipher.

Figure 2

Wheel settings to use
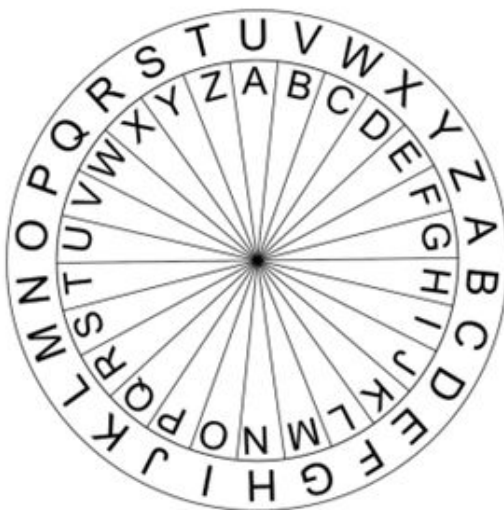
Example

Plaintext: COMPUTER
↓
Ciphertext: IUSVAZKX

0	2	.	1

Decrypt the ciphertext "QGOZRKT" using the Caesar cipher with the settings shown in **Figure 2**.

[1 mark]

_____

The Vernam cipher is a more sophisticated cipher system that, under certain circumstances, offers perfect security.

0 2 . 2   State **two** conditions that must be met for the Vernam cipher to offer perfect security.

[2 marks]

Condition 1

_____

_____

Condition 2

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_____

Both the Caesar and Vernam ciphers are symmetric ciphers, whereas a public and private key encryption system is an asymmetric cipher system.

0 2 . 3   Explain the difference between a symmetric and an asymmetric cipher system.

[1 mark]

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| 0 | 8 |

Two methods of representing and playing music on a computer are sampled sound and MIDI.

Sound is being sampled using a 16-bit sample resolution and a sample rate of 20 000 Hz.

1 Hz is one sample per second.

| 0 | 8 | . | 1 |

Calculate the amount of storage space that will be required to store 30 seconds of recorded sound. Express your answer in kilobytes.

You **must** show your working.

[2 marks]

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Answer _____

`0 8 . 2` The highest frequency component in the sound that is being sampled is 14 500 Hz. The sample rate of 20 000 Hz is not high enough to enable a faithful reproduction of the original sound from the sample.

Explain why this is the case, justifying your response.

[2 marks]

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0 8 . 3 MIDI is a system that can be used to enable musical devices to communicate and to represent music on a computer.

Explain how MIDI represents music **and** the advantages of using MIDI for representing music instead of using sampled sound.

[4 marks]

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June 2011 Comp 1

0 9 What is meant by the **resolution** of a bitmapped graphic image? *(2 marks)*

1 0 What is meant by the **colour depth** of a bitmapped graphic image? *(2 marks)*

1 1 An image has 10 x 10 pixels. It is stored in an image format that is limited to 16 colours.

Calculate the image size in bytes. *(2 marks)*

| 1 | 2 | Instead of using bitmapped graphics, images may be represented in a computer's main memory using vector graphics.

State **one** advantage of vector graphics compared with bitmapped graphics. *(1 mark)*

June 2012 Comp 1

Question 3

To record sound a computer needs to convert the analogue sound signal into a digital form. During this process samples of the analogue signal are taken. **Figure 1** shows part (0.02 seconds) of an analogue sound wave.

Figure 1
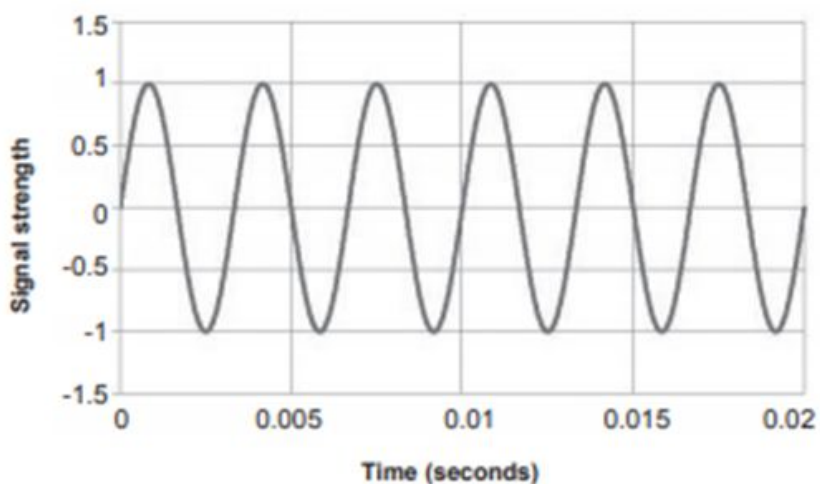
The **frequency** of an analogue sound wave is determined by how many waves of oscillation occur per second and is measured in Hertz (Hz) – the number of waves of oscillation per second.

| 0 | 5 | If the part of the analogue sound shown in **Figure 1** is the highest frequency in the entire sound to be sampled, what is the **minimum sampling rate** (in Hz) that should be used?

Use the space below for rough working - then copy the answer, and your working out, to your Electronic Answer Document. You may get some marks for your working even if your answer is incorrect if you include the working in your Electronic Answer Document.

(2 marks)

0 6 Describe clearly the steps taken by an ADC (analogue-to-digital converter) in the conversion of an analogue sound wave to an equivalent digital signal. *(3 marks)*

MIDI is an alternative method for storing sound digitally that does not use sound waves; instead, information about each musical note is stored.

0 7 State **one** advantage of using the MIDI representation for storing sound digitally. *(1 mark)*

0 8 State an item of data, other than the note itself, that might be stored about a musical note in a MIDI file. *(1 mark)*

A bitmapped image consists of pixels. **Figure 3** shows a bitmapped representation of an image of a winking, happy face consisting of red, blue, black and white pixels only.

Figure 3
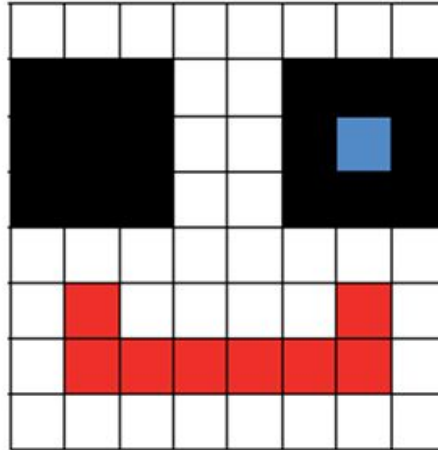
1 1   Why must at least two bits be used to represent each pixel?   *(1 mark)*

The second line of pixels (from the top) shown in **Figure 3** has been represented in a computer's memory as the bit pattern `1111 1100 0011 1111`. A black pixel is coded as `11`.

1 2   Suggest a suitable 16-bit bit pattern that could be used to represent the third line of pixels (from the top) in **Figure 3**.

Type your answer into the table provided in the Electronic Answer Document. *(2 marks)*

1 3   What, in bytes, is the minimum file size for the bitmapped image in **Figure 3**?

Use the space below for rough working - then copy the answer, and your working out, to your Electronic Answer Document. You may get some marks for your working even if your answer is incorrect if you include the working in your Electronic Answer Document.

Instead of representing the face as a bitmapped image, vector graphics could have been used.

1 4   State **three** items of data that would need to be stored about an eye object, similar to those shown in the image in **Figure 3**, if it is to be represented using vector graphics.
(3 marks)

1 5   Describe **two** advantages of using vector graphics instead of bitmaps to represent an image.   *(2 marks)*

June 2013 Comp 1

Question 3

A performance by a music band is to be recorded and distributed on CD.

Figure 3 shows three samples stored in a computer's memory that have been taken from an analogue signal as part of the recording process. A sampling rate of 44,000Hz (Hertz) has been used.

1Hz is one sample per second.

Figure 3

```
0000 0001 1000 1110
0000 0001 1000 1110
0000 0001 1000 0011
```

| 1 | 5 | What sampling resolution has been used? *(1 mark)*

| 1 | 6 | If the original analogue signal lasts 100 seconds, how many bytes of storage will be required to store all the samples taken in the recording process? *(3 marks)*

The average human can hear frequencies up to 20,000Hz (Hertz).

| 1 | 7 | Explain why a sampling rate of 44,000Hz has been chosen for the recording. *(2 marks)*

The CD recording is processed to create a version of the performance that can be downloaded from the band's website.

The sound quality of the version of the recording stored on the web server is not as good as the sound quality of the CD version.

| 1 | 8 | State **one** possible cause of this reduction in sound quality. *(1 mark)*

Specimen AS Paper 2

0 5 The OpenSSL project is a collaborative effort to develop a general purpose cryptography software library for encrypting data transmissions.

In April 2014, a bug known as the 'Heartbleed Bug' was found in the OpenSSL software library. The bug allowed anyone on the Internet to access the memory of systems protected by the vulnerable versions of this OpenSSL software.

According to web server statistics, this bug could have affected around 66% of known web servers.

0 5 . 1 What is encryption?

[2 marks]

_____

_____

_____

_____

0 5 . 3 The 'Heartbleed Bug' was introduced into the code on December 31, 2011 but was only discovered in 2014.

State **one** reason why the bug took over two years to find.

[1 mark]

_____

_____

_____

| 0 5 . 4 | Government agencies sometimes require that they are given copies of encryption keys. This allows these agencies to decrypt messages encrypted with these keys.

State **one** reason for and **one** reason against a government having the ability to decrypt any encrypted messages.

[2 marks]

Reason for: _____

_____

_____

Reason against: _____

_____

_____

| 0 8 | A flight recorder is an electronic recording device placed in an aircraft for the purpose of facilitating the investigation of aviation accidents and incidents **Figure 3** shows an example of a flight recorder. It is a requirement for every commercial aircraft to have a type of flight recorder called a cockpit voice recorder.

Figure 3

0 8 . 2 Audio from the cockpit is sampled at a rate of 8000 Hz and 16 bits are allocated to each sample.

How many kilobytes would be needed to store 360 seconds of audio?
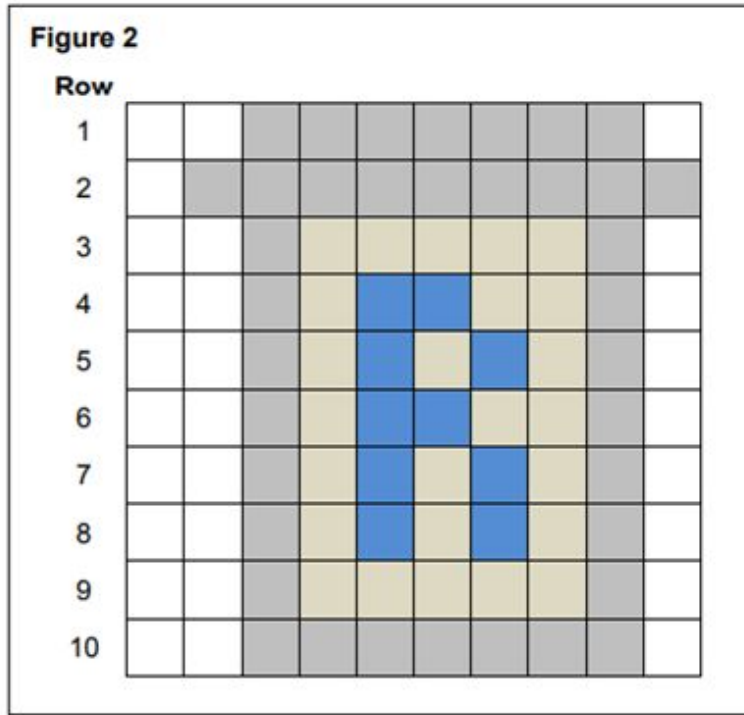Show your working.

[3 marks]

_____

_____

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_____

_____

Answer: _____

0 8 . 3 Explain why the highest audio frequency in the sampled audio from the cockpit cannot be greater than 4000 Hz.

[2 marks]

_____

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Specimen Paper 2

The icon in **Figure 2** is represented in a computer's memory as a bitmap image.

Figure 2

Four different colours have been used in the icon.

Row 1 of the icon is represented in the computer's memory as the bit pattern:

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

0 5 . 1 What are the bit patterns that have been used to represent a grey pixel and a white pixel?

[1 mark]

Grey pixel: _____   White pixel: _____

0 5 . 2 State **one** possible 20-bit representation for **Row 4** of the icon in **Figure 2**.

[1 mark]

0 5 . 3 Calculate the number of bytes required to represent all the pixel data in the icon as a bitmap.

Show your working.

[2 marks]

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Answer: _____

0 5 . 4 When the bitmap is saved as a file, the file size is bigger than the answer to **0 5 . 3** . This is because metadata is saved in the file with the pixel data

State **one** item of metadata that would be stored in a bitmap file.

[1 mark]

_____

_____

Run-length encoding (RLE) is an example of a compression method that could be used to reduce the amount of memory required to store the icon in **Figure 2**.

0 5 . 5 Describe the principle used by RLE to compress a file and explain why RLE is an appropriate compression method for compressing images such as icons.

[3 marks]

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| 1 | 0 | | Two computers, **A** and **B**, are involved in a secure communication that uses asymmetric encryption. **A** is sending a message to **B**.

Each computer has a public key and a private key.

| 1 | 0 |.| 1 | Complete the missing words in the following paragraph.

[2 marks]

> **A** will encrypt the message using _____ key. The message
>
> will be decrypted by **B** using _____ key.

The security of the communication could be improved by the addition of a digital signature.

| 1 | 0 |.| 2 | State **two** benefits of including a digital signature.

[2 marks]

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