0 1 . 1 Describe the difference between analogue and digital data.

[2 marks]

Two methods of representing music digitally are as sampled sound and using MIDI.

0 1 . 2 State **two** advantages of representing music using MIDI instead of as sampled sound.

[2 marks]

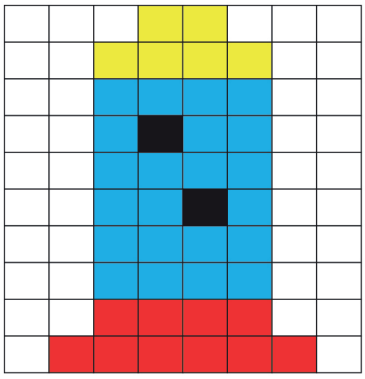
0 2 . 1 Cameras within the taxi take still images once every second for security purposes. The images are compressed using run-length encoding and stored on a flash memory card within the camera.

Describe how a digital image could be captured by a digital camera and compressed using run-length encoding.

[6 marks]

0 3 **Figure 5** shows a bitmap representation of an image consisting of white, red, blue, black and yellow pixels only.

Figure 5



0 3 . 1 Calculate the minimum size of file (excluding metadata) that could be used to store the bitmap image in **Figure 5**. Express your answer in bytes.

You **must** show your working.

[3 marks]

0 3 . 2 Shade in **one** lozenge to indicate the minimum colour depth in bits required for an image with 18 colours.

[1 mark]

3 ⬭ **4** ⬭ **5** ⬭

0 4 . 1 Sampling with an 8-bit sample resolution means that each sample can be approximated to one of 256 different levels.

If the sample resolution is increased to 10 bits, how many **more** levels are available for approximating samples?

[1 mark]

0 4 . 2 A sound lasts 3 minutes and 20 seconds. It is sampled at a 44.1kHz sample rate with a 16-bit sample resolution.

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

Calculate the minimum amount of storage space, in megabytes (MB), needed to store the sampled sound.

You should show your working.

[3 marks]

Answer:

0 5 . 1 A sound is being recorded from an analogue source using a sound card in a computer. The sound card contains an analogue to digital converter (ADC).

Describe the steps the ADC performs in this process.

[3 marks]

A sound has been recorded and takes up 34.56 megabytes (MB) of storage space.
The sound lasts 360 seconds and was recorded with a sample resolution of 16 bits.

0 5 . 2 Calculate the sample rate used for the recording.

State your answer in samples per second (Hertz).

You should show your working.

[2 marks]

Answer _____

0 5 . 3 State Nyquist's theorem.

[2 marks]

0 6 A student has attempted to calculate the minimum file size, in bytes, of a bitmapped image.

The bitmapped image is 10 pixels wide by 16 pixels high with 4 possible colours for each pixel.

The student calculates the answer to be 80 bytes by using the following method:

$$\frac{\text{number of pixels wide} \times \text{number of pixels high} \times \text{number of colours}}{\text{number of bits in a byte}}$$

Explain what the student has done wrong **and** state the correct minimum file size in bytes.

[2 marks]

What the student has done wrong _____

_____

_____

_____

Correct minimum file size _____

_____

0 7 . 1 Write an assembly language program to encrypt a single character using the Caesar cipher. The character to be encrypted is represented using a character set consisting of 26 characters with character codes 0–25. The output of the process should be the character code of the encrypted character.

The assembly language instruction set that you should use to write the program is listed in **Table 1**.

Table 2 shows the character codes and the characters they represent.

Table 2

Code	Character
0	A
1	B
2	C
3	D
4	E
5	F
6	G
7	H
8	I

Code	Character
9	J
10	K
11	L
12	M
13	N
14	O
15	P
16	Q
17	R

Code	Character
18	S
19	T
20	U
21	V
22	W
23	X
24	Y
25	Z

- Memory location 100 contains the character code to be encrypted, which is in the range 0–25
- Memory location 101 contains an integer key to be used for encryption, which is in the range 0–25
- The program should store the character code of the encrypted character in memory location 102

[4 marks]

0 7 . 2 Another method of encryption is the Vernam cipher.

Explain why, under the correct conditions, the Vernam cipher is perfectly secure.

[1 mark]

0 8 . 1 State **one** reason why a user might choose to compress an image file.

[1 mark]

0 8 . 2 Describe **one** advantage of lossless compression over lossy compression.

[1 mark]

0 8 . 3 Explain how data can be compressed using dictionary-based compression.

[3 marks]

0 9 . 1 Describe the difference between analogue and digital data.

[2 marks]

0 9 . 2 Describe the steps that an analogue to digital converter (ADC) carries out when converting a sound signal.

[3 marks]

1 0 An international technology company produces a smart speaker for use in homes. The smart speaker can be controlled by a user providing voice commands, which means the device must always be listening for audio input. The company stores audio recordings of each user to analyse when improving its voice recognition algorithms. The audio recordings are compressed using lossy compression and then sent over the Internet to be stored at the company's headquarters.

Discuss a range of ethical, legal and cultural issues that are raised by the company storing the audio captured by its smart speakers **and** justify why the company might use lossy compression.

You will be assessed on your ability to follow a line of reasoning to produce a coherent, relevant and structured response.

[12 marks]

1 1 . 1 Describe how to calculate the minimum storage requirements, excluding metadata, of a bitmapped image.

[1 mark]

One way of representing sound digitally is by using sampling.

1 1 . 2 What is meant by the term **sampling rate**?

[1 mark]

1 1 . 3 What is meant by the term **sample resolution**?

[1 mark]

1 1 . 4 A sampled sound could be compressed using lossy compression.

Describe a problem that may occur if lossy compression is used and how the compression method has caused this.

[2 marks]

1 1 . 5 An alternative to using sampled sound is MIDI.

State **two** advantages of using MIDI instead of sampled sound.

[2 marks]

1 2 A clothing company has developed an application that allows a user to take a photograph of themself on their mobile phone and upload it to their account on the company servers. The application will then use artificial intelligence to recommend new clothes that it computes will suit the user based on their preferences and the application's own interpretation of the way they look. It will then generate images of the user wearing the recommended clothes.

The user can preview the images and either buy the clothes from the company or use the generated images by linking to them from social media accounts.

Describe how a digital camera would work when capturing a photograph of the user for the application **and** discuss the moral, ethical, legal and cultural issues that developers of the application may have had to consider while developing it.

[9 marks]

1 3 . 1 State the name of the component on a sound card that transforms the continuous signal received from a microphone to a form that can be stored by a computer.

[1 mark]

1 3 . 2 A bitmap image is 52 pixels in height and 26 pixels in width. The bitmap representation of the image requires 845 bytes.

Calculate the maximum number of colours that could be used in the bitmap image.

You should show all your working.

[2 marks]

1 3 . 3 When a bitmap image is stored in a file, additional information is stored as well as the colours of the pixels. For example, the bitmap file might contain information on the date of creation, image width and height.

State the name given to this additional information when storing a bitmap image.

[1 mark]

1 3 . 4 A sound is recorded with a sample rate of 96 000 Hz and a sample resolution of 24 bits. The file size of the recording is 12 096 kilobytes.

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

Calculate the duration of the sound recording.

You should show all your working.

[3 marks]

1 3 . 5 A sample resolution of 16 bits is commonly used in audio recordings.

Explain why increasing the sample resolution from 16 bits to 24 bits can improve the quality of an audio recording.

[1 mark]

1 3 . 6 MIDI does not use sampling to represent music.

Describe how music is represented using MIDI.

[2 marks]

1 3 . 7 Explain **one** advantage of using MIDI instead of sampled sound to represent music.

[1 mark]

1 4 . 1 A message is encrypted using a Caesar cipher that operates with a shift value of four. For example, the letter A in plaintext would be represented by E in ciphertext.

The ciphertext for the message is `WSSDI`.

What is the plaintext for the message?

[1 mark]

1 4 . 2 Explain **two** reasons why Caesar ciphers are vulnerable to being cracked.

[2 marks]