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7 A computer stores binary data.

(a) Tick (✓) **one** box only to identify the **largest** file size.

☐	3300 kibibytes
☐	0.3 megabytes
☐	3 mebibytes
☐	3300 kilobytes

[1]

(b) Subtract the denary number 10 from the denary number 100 using binary subtraction.

Show your working.

Working ....

....

....

....

....

....

Answer ....

[3]

(c) Convert the hexadecimal number C0F into denary.

Show your working.

Working ....

....

....

Answer ....

[2]

Question	Answer	Marks
7(a)	**1 mark** for: 3300 kibibytes	1
7(b)	**1 mark** each: • Converting 100 to binary **0110 0100 and** 10 to binary **0000 1010** • Subtraction method - converting 10 to – 10 and adding // direct subtraction … • … correct answer **0101 1010** Method 1: Converting to -10 and adding: Binary for +10 is 0000 1010 Binary for –10 is 1111 0110 Binary for 100 is 0110 0100 100 + (-10): 0 1 1 0 0 1 0 0 +1 1 1 1 0 1 1 0 (1) 0 1 0 1 1 0 1 0 Carries: 1 1 0 0 1 0 0 0 Method 2: Direct Subtraction Borrows: 0 0 0 1 1 0 1 0 0 1 1 0 0 1 0 0 – 0 0 0 0 1 0 1 0 0 1 0 1 1 0 1 0	3
7(c)	**1 mark** for working: 1100 0000 1111 // 2048 + 1024 + 8 + 4 + 2 + 1 // $(12 * 16^2) + 15$ // (12 * 16 * 16) + 15 // 3072 + 15 **1 mark** for correct answer: 3087	2

(d) The computer can transmit a video made from bitmap images and vector graphic animations to the VR headset.

(i) Describe how the data for a bitmapped image is encoded.

....

....

....

....

....

.... [3]

(ii) Describe the contents of a vector graphic drawing list.

....

....

....

.... [2]

(iii) The bitmap video is **not** compressed before transmission to the VR headset.

Give **two** reasons why the video does **not** need to be compressed.

1 ....

....

2 ....

....

[2]

2(d)(i)	**1 mark** each:	3
	• Image is made of pixels and each pixel has one colour • Each colour has a **unique** binary code • **Code for the colour** of each pixel is stored in **sequence**	
2(d)(ii)	**1 mark** each to **max 2**:	2
	• List of objects in the drawing • A list that stores the command/description/equation required to draw each object • Properties of each object e.g. the fill colour, line weight/colour	
2(d)(iii)	**1 mark** each to **max 2**:	2
	• Dedicated connection to the headset // not sharing bandwidth • Already fast connection that can transmit the data without slowing • Video may already be a small file size and does not need further reduction • Video is not saved so storage is not an issue in the headset	

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3   (a)   State **one** difference between a kibibyte and a megabyte.

....

.... [1]

(b)   (i)   Convert the denary value into a 12-bit two's complement binary integer.

−196

Answer .... [1]

(ii)   Convert the Binary Coded Decimal (BCD) into denary.

100001100101

Answer .... [1]

(iii)   Convert the unsigned binary integer into denary.

000111010110

Answer .... [1]

(c)   Identify **one** practical application of BCD **and** justify why BCD is used in this application.

Application ....

....

Justification ....

....

....

.... [2]

Question	Answer	Marks
3(a)	**1 mark** for: Either • kibibyte = 1,024 bytes // 2^{10} bytes **and** megabyte = 1000 kilobytes //1 000 000 bytes // 10^3 kilobytes // 10^6 bytes Or • kibi is binary prefix **and** mega is denary prefix	1
3(b)(i)	1111 0011 1100	1
3(b)(ii)	865	1
3(b)(iii)	470	1
3(c)	**1 mark** for a correct application **1 mark** for a corresponding justification • An application that performs financial / banking calculations • ... because it is difficult to represent decimal values exactly in normal binary and financial transactions use only two decimal places and must be accurate, no accumulating errors Or • Electronic displays, e.g. calculators, digital clocks • ... because visual displays only need to show individual digits • ... because conversion between denary and BCD is easier Or • The storage of the date and time in the BIOS of a PC • ... because conversion with denary is easier	2

6 **(a)** A real-time video of a music concert needs to be streamed to subscribers.

Tick (✓) **one** box to identify the most appropriate type of compression **and** justify your answer.

Lossy	Lossless

Justification ....

....

....

....

....

.... [3]

(b) Explain the impact of changing the sampling resolution on the accuracy of a sound recording.

....

....

....

....

....

.... [3]

(c) A bitmap image has a resolution of 2048 pixels wide and 1024 pixels high.

The image has a bit depth of 10 bits per pixel.

Estimate the file size of the bitmap image in mebibytes. Show your working.

Working ....

....

....

....

....

....

Estimated file size in mebibytes ....

[2]

Question	Answer	Marks
6(a)	**1 mark** for each bullet point (**max 3**) Lossy compression (ticked) • Loss of quality will not be noticed • Needs to be viewed in real time so less bandwidth needed if file size smaller • Smaller file sizes will reduce buffering so the video will play more smoothly • Viewers may watch on different devices, so may not need high quality resolution Lossless compression (ticked) • Original recording may not have been made in high resolution • Could be streaming to high bandwidth devices • The reduction in the file size is sufficient for the receiving device • Viewers do not want any loss of quality	3

Question	Answer	Marks
6(b)	**1 mark** for each bullet point (**max 3**) Increase sampling resolution • … the number of bits used for each sample is increased • … there will be more values available to represent each sample // more amplitudes can be represented • … each binary amplitude/note in the digital recording is closer to the analogue amplitude/note • … quantisation errors are reduced • … the digital soundwave is closer to the original analogue soundwave Decrease sampling resolution • … the number of bits used for each sample is decreased • … there will be fewer values available to represent each sample // fewer amplitudes can be stored • … each binary amplitude/note in the digital recording is further from the analogue amplitude/note • … quantisation errors are increased • … the digital soundwave is less like the original analogue soundwave	3
6(c)	**1 mark** for answer, **1 mark** for working Answer: 2.5 mebibytes Working: $(2048 \times 1024 \times 10) / (8 \times 1024 \times 1024)$	2

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4   Data in a computer is stored in binary form.

(a) State the number of unique binary values that can be represented in 16 bits.

.... [1]

(b) Give the 8-bit one's complement representation of the denary number −120.

Show your working.

Working ....

....

....

....

Answer ....

[2]

(c) Convert the hexadecimal number A04 into denary.

Show your working.

Working ....

....

....

....

Answer ....

[2]

(d) Show the result of a 2-place left logical shift on the binary number:

01001111

.... [1]

Question	Answer	Marks
4(a)	2^{16} // 65536	1
4(b)	**1 mark** for working; **1 mark** for answer • Working: +120 = 0111 1000 • Answer: 1000 0111	2

4(c)	**1 mark** for working; **1 mark** for answer
	
	• Working: A04 = (10 * 16^2) + 4
	  // A04 = (10 * 256) + 4
	  // A04 = 1010 0000 0100
	
	• Answer: 2564
		2

4(d)	0011 1100	1

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2   (a)   (i)   Convert the two's complement binary integer into denary.

10010110

Answer ....   [1]

(ii)   Convert the unsigned binary integer into hexadecimal.

10010110

Answer ....   [1]

(iii)   Convert the unsigned binary integer into Binary Coded Decimal (BCD). Show your working.

10010101

Working ....

....

....

Answer ....

[2]

(b)   Perform the following binary addition.

```
    1  0  0  0  1  1  0  0
+   0  1  0  0  0  1  1  0
   ─────────────────────────
```

[1]

Question	Answer	Marks
2(a)(i)	−106	1
2(a)(ii)	96	1
2(a)(iii)	**1 mark** for each bullet point: • 149 decimal • 0001 0100 1001	2
2(b)	1101 0010	1

8   The following bitmap image has a resolution of 4096 × 4096 pixels and a colour depth of 24 bits per pixel.
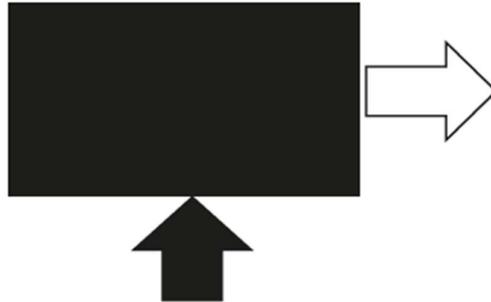
The image is displayed on a monitor that has a screen resolution of 1920 × 1080 pixels.

(a)   Tick (✓) **one** box in each row to identify the effect of each action on the image file size.

Action	Increases the file size	Decreases the file size	No change to the file size
Change the colour depth of the image file to 16 bits per pixel.			
Change the screen resolution to 1366 × 768 pixels.			
Change the colour of the rectangle from black to red.			

[2]

(b)   State **two** benefits of creating a vector graphic instead of a bitmap image.

1 ....

....

2 ....

....

[2]

Question	Answer	Marks
8(a)	**1 mark** one or two correct row(s). **2 marks** for all three correct rows.	2

Action	Increases the file size	Decreases the file size	No change to the file size
Change the colour depth of the image file to 16 bits per pixel.		✓	
Change the screen resolution to 1366 × 768 pixels.			✓
Change the colour of the rectangle from black to red.			✓

Question	Answer	Marks
8(b)	**1 mark** for each bullet point (**max 2**). For example: • can be enlarged without pixelation / loss of quality • individual components of the image can be edited • generally a smaller **file** size	2

(c) A second bitmap image is stored using a colour depth of 8 bits per pixel.

The file is compressed using run-length encoding (RLE).

(i) The table shows the compressed and uncompressed values for parts of the image file.

Each colour of the pixel in the image is represented by a hexadecimal value.

Complete the table. The first row has been completed for you.

Uncompressed image	RLE compressed image
EA F1 F1 F2 F2 F2 EA	1EA 2F1 3F2 1EA
	2AB 2FF 11D 167
32 32 80 81 81	

[2]

(ii) RLE is an example of lossless compression.

Explain why lossless compression is more appropriate than lossy compression for a text file.

....

....

....

....

.... [2]

Question	Answer	Marks
8(c)(i)	**1 mark** for each correct underlined part:	2
8(c)(ii)	**1 mark** for each bullet point: • all the data is required // no data can be lost • ... otherwise text file will be corrupted / not make sense	2

For 8(c)(i):

Uncompressed sound	RLE compressed sound
EA F1 F1 F2 F2 F2 EA	1EA 2F1 3F2 1EA
AB AB FF FF 1D 67	2AB 2FF 11D 167
32 32 80 81 81	232 180 281

(b) The student records a sound file.

    (i) Explain the effect of increasing the sampling rate on the accuracy of the sound recording.

       ....

       ....

       ....

       .... [2]

    (ii) Explain the effect of decreasing the sampling resolution on the file size of the sound recording.

       ....

       ....

       ....

       .... [2]

6(b)(i)	**1 mark** for each bullet point **(max 2)**: • **improves** the accuracy of the sound file • ... because (digital) waveform more closely resembles the **analogue waveform** • quantization errors are reduced • increases the amount of detail stored	2
6(b)(ii)	**1 mark** for each bullet point: • decreases the file size of the sound file • ... because fewer bits are used to store **each sample**	2

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1   (a)   Draw **one** line from each image representation term to its correct definition.

Term		Definition
Pixel		The number of pixels wide by the number of pixels high
Bit depth		The smallest identifiable component of an image
Image resolution		Stores data about the image file, e.g. file format, number of bits per pixel, file size
File header		The number of bits used to represent each colour

[3]

(b)   The following section of a bitmap image is 10 pixels wide and 5 pixels high. In this example, each colour is represented by a letter, e.g. B is blue.

B	B	B	B	B	B	B	B	B	B
Y	Y	P	Y	Y	Y	P	Y	Y	Y
R	R	M	R	P	K	T	T	R	R
B	O	P	Y	Y	Y	P	G	P	P
R	O	R	P	P	P	R	R	R	R

The complete image can have up to 256 colours.

(i)   Identify the smallest number of bits that can be used to represent each colour in the complete bitmap image.

.... [1]

(13)

(ii) Calculate an estimate for the file size of the section of the bitmap image shown, giving your answer in bytes. Use your answer from **part (b)(i)**.

Show your working.

Working ....

....

....

....

Answer .... bytes

[2]

(c) Describe how changing the colour depth of an image affects its file size.

....

....

....

.... [2]

(d) The first row of pixels in the image from **part (b)** is shown:

B	B	B	B	B	B	B	B	B	B

Explain how this row of pixels can be compressed using lossless compression.

....

....

....

.... [2]

Question	Answer	Marks
1(a)	**1 mark** for 1 correct line **2 marks** for 2 or 3 correct lines **3 marks** for all 4 correct lines **Term** **Definition** Pixel → The smallest identifiable component of an image Bit depth → The number of bits used to represent each colour Image resolution → The number of pixels wide by the number of pixels high File header → Stores data about the image file, e.g. file format, number of bits per pixel, file size	3
1(b)(i)	8	1
1(b)(ii)	**1 mark** for working • **10 * 5 * 8** (bits) / **8** // = **50** (pixels) * **8** (bits) / **8** **1 mark** for answer • 50 (bytes)	2
1(c)	**1 mark** per point • Increasing the colour depth results in increased <u>file</u> size // Decreasing the colour depth results in smaller <u>file</u> size • Increasing the colour depth means more **bits per pixel** and hence more data stored // Decreasing the colour depth means fewer **bits per pixel** and hence less data stored	2
1(d)	**1 mark** per point • Use run-length encoding // RLE • Record the colour <u>Blue</u>, and the number of times it occurs <u>10</u>	2

(c) Convert the following positive binary integer into hexadecimal.

0 1 1 1 1 1 1 0

(e) Convert the denary numbers 127 and 12 to 8-bit binary and then perform the subtraction 12 − 127 in binary.

Show your working.

127 in binary ....

12 in binary ....

12 − 127 in binary ....

....

....

....

....

[3]

Question	Answer	Marks
3(c)	7E	1
3(e)	**1 mark** per point • Correct conversion to binary 01111111 (127) and 00001100 (12) • Working e.g. turning 01111111 into two's complement 10000001 • Answer: 1000 1101	3

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4   A register stores the following binary number:

1	1	0	0	1	1	0	1

(a) The binary value in the register represents an unsigned binary integer.

Convert the unsigned binary integer into denary.

.... [1]

(b) The binary value in the register represents a two's complement binary integer.

Convert the two's complement binary integer into denary.

.... [1]

(c) The binary value in the register represents a hexadecimal number.

Convert the binary number into hexadecimal.

.... [1]

(d) State why the value in the register cannot be interpreted as a Binary Coded Decimal (BCD).

....

.... [1]

(e) The binary contents of **two** registers are:

Register 1	0	0	1	1	1	1	0	1
Register 2	0	0	1	0	1	1	0	1

(i)   Add the contents of **Register 1** and **Register 2**. Show your working.

Answer ....

[2]

(ii) Subtract the contents of **Register 2** from the contents of **Register 1**. Show your working.

Answer ....

[2]

Question	Answer	Marks
4(a)	205	1
4(b)	−51	1
4(c)	CD	1
4(d)	**1 mark for:** The denary value in each group of 4 bits is greater than 9 // the denary value in each nibble is greater than 9	1

4(e)(i)	**1 mark** for working, **1 mark** for answer
	
	` 0011 1101`
	`+0010 1101`
	`─────────`
	` 0110 1010`
	`  111 1 1`
		2

4(e)(ii)	**1 mark** for working, **1 mark** for answer
	
	` 0011 1101`
	`+1101 0011` (two's complement)
	`─────────`
	` 0001 0000`
	` 1111 111`
		2

5   Riya has created the following logo as a vector graphic.

(a)   Complete the table by writing a description of each vector graphic term **and** give an example for this logo.

Term	Description	Example from logo
Property		
Drawing list		

[4]

(b)   Riya takes a photograph using a digital camera. The photograph is stored as a bitmap image.

(i)   Describe **two** differences between a vector graphic and a bitmap image.

1 ....

....

....

....

2 ....

....

....

....

[4]

(ii)   Riya needs to email the photograph. She compresses the photograph before sending it using an email.

Describe **two** lossy methods that Riya can use to compress the image.

Method 1 ....

....

....

....

Method 2 ....

....

....

....

[4]

Question	Answer	Marks
5(a)	**1 mark** for each description,**1 mark** for each valid example	4

Term	Description	Example from logo
Property	data about the shapes // defines one aspect of the appearance of the drawing object	e.g. black line // white fill // black fill //solid (line) // font of letter // colour of triangle
Drawing list	the list of shapes involved in an image // a list that stores the command/description required to draw each object	e.g. triangle // capital letter R // rectangle // line

Question	Answer	Marks
5(b)(i)	**1 mark** for each bullet point to **max 2** for each difference • Bitmap made up of pixels // bitmap is made of colours stored for individual pixels • Vector graphic store a set of instructions about how to draw the shape • When bitmap is enlarged the pixels get bigger and it pixelates • When vector is enlarged it is recalculated and does not pixelate • Bitmap files are usually bigger than vector graphics files because of the need to store data about each pixel • Vector graphics have smaller file size because they contain just the instructions to create the shapes • Bitmap images can be compressed with significant reduction in file size • Vector graphic images do not compress well because of little redundant data	4
5(b)(ii)	**1 mark** for each bullet point to **max 2** for each method • Reduce bit depth • … reduces the number of bits per colour / pixel which means each pixel has fewer bits • Reduce colour palette // reduce number of colours • … fewer colours mean fewer bits needed to store each colour • Reduce image resolution • … fewer pixels per unit measurement means less binary to store	4

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6   A computer uses the ASCII character set.

(a) State the number of characters that can be represented by the ASCII character set and the extended ASCII character set.

ASCII ....

Extended ASCII ....

[2]

(b) Explain how a word such as 'HOUSE' is represented by the ASCII character set.

....

....

....

.... [2]

(c) Unicode is a different character set.

The Unicode value for the character '1' is denary value 49.

(i)   Write the hexadecimal value for the Unicode character '1'.

.... [1]

(ii) Write the denary value for the Unicode character '5'.

.... [1]

Question	Answer	Marks
6(a)	1 mark for each correct answer ASCII = 128 // 2^7 Extended ASCII = 256 // 2^8	2
6(b)	**1 mark** per bullet point to **max 2** • Each character has its own **unique** code • Each character in the word is **replaced** by its code • The codes are stored **in the order in the word**	2
6(c)(i)	31	1
6(c)(ii)	53	1