GCSE Computer Science

Mark Scheme Answers

Exam Practice

Topic 2: Data

This booklet contains ***all*** past questions on this topic

Topic 2: Data

Computers use binary to represent different types of data.

Students are expected to learn how different types of data are represented in a computer.

Subject content	Students should:
2.1 Binary	2.1.1 understand that computers use binary to represent data (numbers, text, sound, graphics) and program instructions and be able to determine the maximum number of states that can be represented by a binary pattern of a given length
	2.1.2 understand how computers represent and manipulate unsigned integers and two's complement signed integers
	2.1.3 be able to convert between denary and 8-bit binary numbers (0 to 255, -128 to +127)
	2.1.4 be able to add together two positive binary patterns and apply logical and arithmetic binary shifts
	2.1.5 understand the concept of overflow in relation to the number of bits available to store a value
	2.1.6 understand why hexadecimal notation is used and be able to convert between hexadecimal and binary
2.2 Data representation	2.2.1 understand how computers encode characters using 7-bit ASCII
	2.2.2 understand how bitmap images are represented in binary (pixels, resolution, colour depth)
	2.2.3 understand how analogue sound is represented in binary (amplitude, sample rate, bit depth, sample interval)
	2.2.4 understand the limitations of binary representation of data when constrained by the number of available bits
2.3 Data storage and compression	2.3.1 understand that data storage is measured in binary multiples (bit, nibble, byte, kibibyte, mebibyte, gibibyte, tebibyte) and be able to construct expressions to calculate file sizes and data capacity requirements
	2.3.2 understand the need for data compression and methods of compressing data (lossless, lossy)

2 Data

(a) The ASCII system is used to represent letters and symbols.

(i) State the number of bits used to represent each letter or symbol in ASCII.

(1)

- 7 (1)

Do not award 8, as that is Extended ASCII

(ii) The ASCII code 65 represents the letter A.

Give the letter represented by the ASCII code 68.

- D (1)

Additional Guidance
Do not award lowercase

(b) Sound waves are converted to binary using sample intervals.

Define the term 'sample interval'.

(1)

- The time/number of seconds/gap between samples/measurements (1)

Do not accept answers defining sampling frequency

(c) Give an expression to calculate the size of a bitmap image, not the size of the file that stores the image.

(2)

Award **one** mark for any of the following up to a maximum of **two** marks:

- width × height (1)
- units expressed as pixels (1)

Examples:

- width in pixels × height in pixels
- width × height pixels
- size in pixels = width × height

Additional Guidance
Allow values in any order
Allow synonyms such as length for the x/y dimension
Only award 2 marks for a fully correct expression

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

(d) Computers manipulate binary patterns.

(i) Complete the table with the result of applying the shift to the binary pattern.

(2)

Binary pattern	Shift	8-bit binary result
1010 0011	Logical shift left by 3	0001 1000 (1)
1100 1010	Arithmetic shift right by 2	1111 0010 (1)

(ii) Identify the correct statement about overflow.

(1)

- ☒ **A** Causing the program
- ☒ **B** Requiring more bits to
- ☒ **C** Switching between bi
- ☒ **D** Using an index less th

The only correct answer is B

A is not correct because all overflow errors do not cause programs to crash
C is not correct because computers don't use hexadecimal, only humans do
D is not correct because indexing outside an array bounds is a runtime error

(iii) Convert the denary value +112 to 8-bit binary representation.

(2)

Award **one** mark for each correct nibble in the correct order:

- 0111 0000

0 marks if response is not 8-bit binary

(iv) Give the 8-bit binary two's complement representation of denary –73

(2)

Award **one** mark for each correct nibble in the correct order:

1011 0111

0 marks if response is not 8-bit binary

(e) The number of bits determines the number of patterns that can be represented.

(i) Identify the number of symbols available in the hexadecimal system.

(1)

☒ **A** 2

☒ **B** 8

☒ **C** 10

☒ **D** 16

The only correct answer is D

A is not correct because the binary system has two symbols
B is not correct because the octal system has eight symbols
C is not correct because the denary system has ten symbols

(ii) The address bus of a computer is 8-bits wide.

State the number of unique addresses that can be accessed.

(1)

Award **one** mark for any of the following:

- 256 (1)
- 2^8 (1)
- 2 × 2 × 2 × 2 × 2 × 2 × 2 × 2 (1)

(f) Construct an expression to convert 40 681 930 227 712 bytes to tebibytes.

(2)

Award **one** mark for any of the following up to a maximum of **two** marks: • Sight of 1024^4 anywhere for number of bytes in a tebibyte (1) • 40 681 930 227 712 ÷ 1024^4 (1) Examples: 40 681 930 227 712 ÷ 1024^4 40 681 930 227 712 / 1024^4 $\frac{40\,681\,930\,227\,712}{1024 \times 1024 \times 1024 \times 1024}$ $\frac{40\,681\,930\,227\,712}{2^{40}}$	Award equivalent expressions Ignore transcription errors The first mark is for knowing the conversion units. The second mark is for an accurate expression.

(Total for Question 2 = 16 marks)

5 Data

(a) Describe **one** effect of using lossy compression to reduce the size of a file.

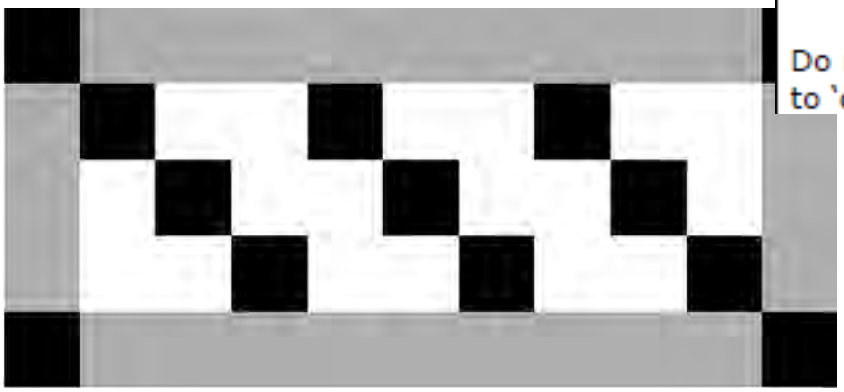
(2)

Award up to **two** marks for a linked description, such as:

- (Removed) data (1) cannot be restored / means that the original file/information cannot be fully recreated/represented (1)
- When data is removed (1) humans may perceive/interpret the image/sound/text/information differently (1)

Additional Guidance
For both marks, the expansion must associate with the statement. Award both marks for reference to loss of data and an example of the effect of that. Do not accept reference to 'quality' as an effect.

(b) Here is an original image.



There is one bit available to represent each pixel.

Explain **one** reason why the image cannot be accurately represented using one bit for each pixel.

(2)

Award up to **two** marks for a linked explanation, such as:

- One bit can only have two values (1), so can only represent black and white (1)
- The three colours in this image cannot be represented (1) because one bit can only have two values (1)
- It is not possible to represent each pixel with three colours / as greyscale / as anything other than black and white (1) because one bit can only represent two unique values (1)

Additional Guidance
For both marks, the expansion must associate with the statement.

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

(c) Shifts are performed on binary patterns.

A **logical** shift right is performed on a pattern.

An **arithmetic** shift right is performed on the same original pattern.

Describe the reason the results will be different.

(2)

Award up to **two** marks for a linked description, such as:

- An arithmetic shift fills from the left with a copy of the most-significant bit (MSB) (1), whereas a logical shift fills from the left with a 0 (1)
- An arithmetic shift keeps the most-significant bit (MSB) the same (1) whereas a logical shift always fills the MSB bit with a 0 (1)

Additional Guidance
Both statements must be provided for two marks, as an arithmetic shift will fill with 0s, if the MSB is 0. Read carefully responses that indicate what the fill character is. Allow 'sign bit' for MSB

(d) Binary, denary and hexadecimal patterns represent numbers.

(i) Convert the binary pattern 0100 0010 to denary.

(1)

- 66 (1)

(ii) Convert the binary pattern 0101 1011 to hexadecimal.

(2)

- 5B

(e) Data storage is measured in bits and bytes.

(i) State the number of unique values that can be represented with 6 bits.

(1)

- 64 (1)
- 2^6 (1)
- 2^6 (1)
- 2**6 (1)
- 2 x 2 x 2 x 2 x 2 x 2 (1)

Allow any expression that evaluates to 64

(ii) A file format uses a 100 × 600 table of 32-bit integers.

The file uses 1 kibibyte of additional data.

Construct an expression to show the number of **bytes** of storage needed to store the file.

(3)

Award **one** mark for any of the following up to a maximum of **two** marks:

- Sight of 100 x 600 (1)
- x 32 in numerator **and** 8 in the denominator (1)
- + 1024 applied to whole expression (1)

Award **three** marks for all three elements presented as a correct expression such as:

- $\frac{100 \times 600 \times 32}{8} + 1024$
- ((100 x 600 x 32) / 8) + 1024

Additional Guidance
Consider order of operations (BIDMAS) Award mental reductions, such as (100 x 600 x 4) + 1024

(f) An analogue sound is represented in digital form.

The sound is one second long and is sampled at 10 Hz.

The digital representation has a bit depth of 5 and is stored in two's complement.

Sound data:

00000 11111 11111 11111 11111

00000 00000 00001 00001 00001

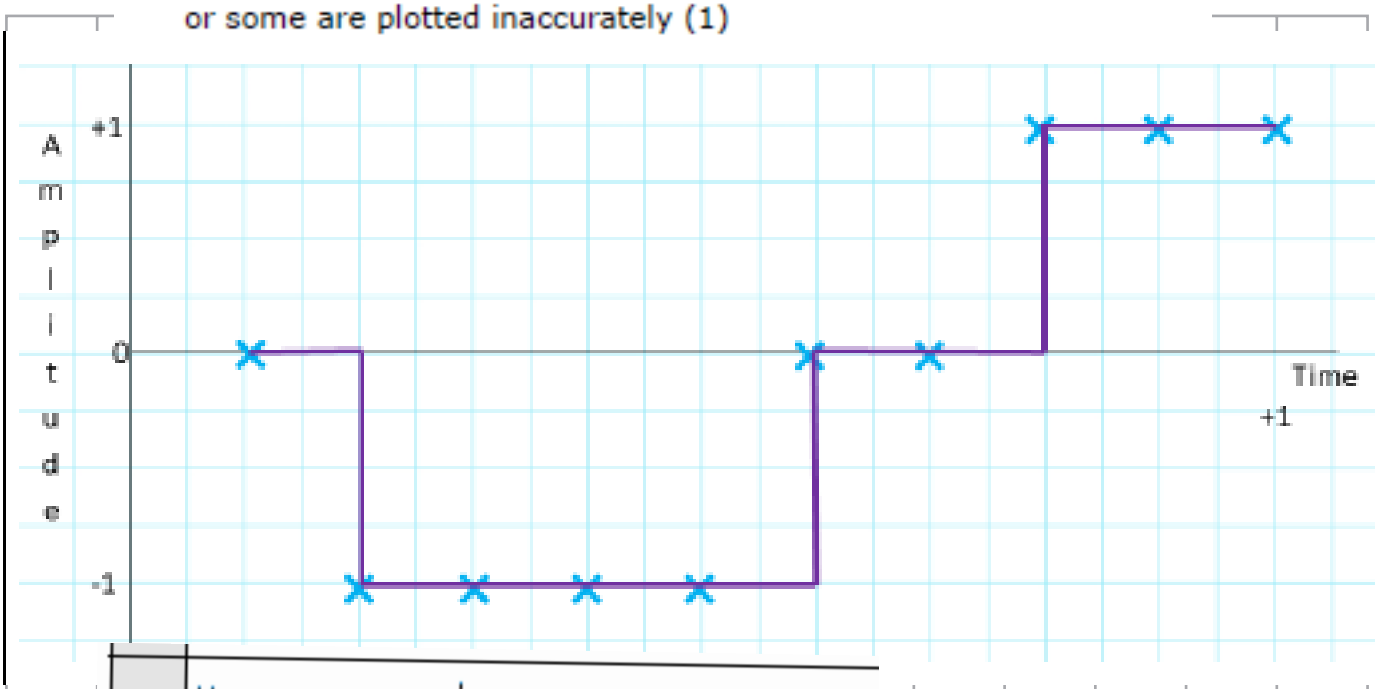
Draw a graph to represent the data sampled.

You must include:

- labels for the x and y axes
- values for the x and y axes
- each sample plotted as an ×
- samples joined up to show the digital form.

- x-axis labelled correctly as time/seconds (1)
- y-axis labelled correctly as amplitude/value/sample (1)
- value labels on x-axis as 0 and 1 (1)
- value labels y-axis as -1 and 1 (1)
- all 10 values plotted to correct points (1)
- points joined to form a square wave, even if not all points are there or some are plotted inaccurately (1)

(6)



Additional Guidance
Allow first sample at time 0
Award inverse (vertical flip) if y-axis labels also flipped, i.e. must recognise 11111 as -1.
Ignore any other values on x and y axes
Accept binary representation for value labels on y axis.

for Question 5 = 19 marks)

TOTAL FOR PAPER = 75 MARKS

3 Data

(a) Computers manipulate binary patterns. Patterns can represent signed or unsigned integers.

(i) Convert the denary number 57 to 8-bit binary.

(2)

1 mark for each nibble: 0011(1) 1001(1)

(ii) Convert the binary number 0010 1101 to hexadecimal.

(2)

1 mark for each digit in the correct location: 2D

(iii) Describe the process of converting a binary number to two's complement.

(2)

A linked description such as: • Flip all the bits (1) and add one (1) • Copy/keep all the 0s from the right/LSB, up to and including the first 1 (1), then flip the remaining bits (1) • Flip all the bits from the left/MSB (1) up to, but not including, the 1 nearest the right/LSB (1)

(iv) Explain what has happened as a result of adding these two 8-bit binary numbers.

	1	0	1	1	0	0	0	1
	1	0	1	0	1	1	0	0 +
1	0	1	0	1	1	1	0	1

(2)

A linked explanation such as:
- There are not enough bits (1) to store the result (1)
- An overflow occurs (1) because 1 + 1 = 0 with a 1 carry / because the result is more than 255 (1)

(b) After applying compression to a file, the original contents cannot be reconstructed fully.

State the type of compression used on the file.

(1)

Lossy

(c) Data can be encoded using ASCII.

Describe ASCII.

(2)

A description to include **two** from:
- A standard
- For representing text/characters
- Allows data to be interchangeable between computers (from different manufacturers)
- Each character is mapped to a unique number/binary equivalent
- ASCII (encoding) uses 7/8 bits
- There are 128 unique characters (allow 256 for 128)

Additional Guidance
Award a mark for an example of an ASCII character equivalence e.g. A = 65 as this can be awarded from mark point 4. (A = 01000001 could similarly be awarded.)

(d) A pixel is the smallest element in a bitmap image.

(i) Two images are displayed on the same screen.

One image is 1280 × 720 pixels. The second image is 1920 × 1080 pixels. The second image has a higher resolution.

State **one** reason why the second image will be displayed in more detail.

(1)

Any **one** from:
- The number of pixels **per** (square) **inch** is higher
- The density of pixels is higher

(ii) A 10-colour bitmap image uses 15-bit colour depth. The image is 1028 pixels wide and 640 pixels high.

Complete the expression to show the minimum file size for the image in MiB.

You do not have to do the calculation.

(4)

$$\frac{1028 \times 640 \times 15}{1024 \times 1024 \times 8}$$

- 15 in numerator (1)
- 1028 x 640 in numerator (1)
- 1024×1024 in denominator (1)
- 8 in denominator (1)

Additional Guidance
Award equivalent representations of 1024 (2^{10})

(Total for Question 3 = 16 marks)

4 Data

(a) Identify the result of a single logical shift left on the 8-bit binary pattern 0101 0101.

- ☒ **A** Addition
- ☒ **B** Division
- ☒ **C** Multiplication
- ☒ **D** Subtraction

C Multiplication

A is not correct because addition does not result from a sir shift left
B is not correct because division does not result from a sin shift left
D is not correct because subtraction does not result from a logical shift left

(b) Convert the denary number –33 to 8-bit binary using two's complement.

(2)

1 mark for each nibble
1101 1111

(c) Complete the table to show the result of 1001 0110 + 0101 0001

(2)

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

1 mark for each nibble
1110 0111

(d) Convert the hexadecimal number 2A to 8-bit binary.

(2)

1 mark for each nibble
0010 1010

(e) Images can be represented as bitmaps.

(i) Define the term 'pixel'.

Question Number	Answer	Additional Guidance	Mark
4(e)i	The smallest single point of colour in an image / picture element / the smallest element of a bit-mapped image		**1**

(ii) Describe **one** way that changing the number of bits allocated to the colour depth determines how an image is represented.

(2)

4(e)ii	A description to include **two** from: Increasing the number of bits used for each pixel (1) allows more colours to be represented in each pixel (1) OR increasing the number of bits allows more pixels to be used (1) providing a greater level of resolution (1) OR Decreasing the number of bits used for each pixel (1) allows fewer colours to be represented in each pixel (1) OR Decreasing the number of bits allows fewer pixels to be used (1) providing a reduced level of resolution (1)

(i) State the name for the height of a sound wave.

(1)

4(f)i	Amplitude

(ii) State **one** benefit and **one** drawback of increasing the bit depth of audio.

(2)

Benefit .....

.....

Drawback .....

4(f)ii	One mark for the benefit: • Increases the accuracy of the representation (1) One mark for a drawback from: • Increases the amount of storage required (1) • Increases the time it takes to download the audio file (1)	Do not accept increases the quality

(g) A company is designing promotional products for a band. Products include CDs, toys, greeting cards and digital downloads. All the products use sound.

Discuss the choice of lossless or lossy compression for sound in these products.

Your answer should consider:

- the types of product
- lossless compression
- lossy compression.

(6)

- Compression reduces data used to represent the original sound
- Both types require encoding and decoding
- Lossy compression reduces the accuracy of the representation
- (Lossless - Reverse)
- Lossy compression increases the reduction in file size.
- (Lossless - Reverse)
- Lossy better for online transmission of sound, e.g. streaming technologies as it takes less time to download / can facilitate access by users with low-speed connections.
- Lossy better for cases where limited storage available, e.g. embedded systems (toys/cards)
- Lossless better for physical media (CDs), since it supports high quality audio.
- Lossy audio removes data representing frequencies that humans cannot hear (or are masked) so they cannot tell the difference
- Lossy compression can be variable so that different amounts of compression can be offered depending on a user's bandwidth.

Level	Mark	Descriptor
	0	No rewardable content.
Level 1	1–2	Basic, independent points are made, showing elements of understanding of key concepts/principles of computer science. (AO1) The discussion will contain basic information with little linkage between points made or application to the context. (AO2)
Level 2	3–4	Demonstrates adequate understanding of key concepts/principles of computer science. (AO1) The discussion shows some linkages and lines of reasoning with some structure and application to the context. (AO2)
Level 3	5–6	Demonstrates comprehensive understanding of key concepts/principles of computer science to support the discussion being presented. (AO1) The discussion is well developed, with sustained lines of reasoning that are coherent and logically structured, and which clearly apply to the context. (AO2)

(Total for Question 4 = 19 marks)

3 Data

(a) Complete the table.

(2)

Base	Number of values per digit
Binary	2
Hexadecimal	16

(b) Identify the reason why data capacity should be expressed in gibibytes rather than gigabytes.

(1)

☒ **A** Gibibytes are consistent with the units used for data transmission

☒ **B** Gibibytes represent binary multiples

☒ **C** More data can be represented in gibibytes

☒ **D** Processors have to carry out fewer operations when using gibibytes

B Gibibytes represent binary multiples *A is not correct because Gigabits are consistent with the units used for data transmission* *C is not correct because more data cannot be represented in gibibytes* *D is not correct because processors do not have to carry out fewer operations when using gibibytes*

(c) Convert the denary number 82 to 8-bit binary.

(2)

Answer
1 mark for each nibble 0101 0010

(d) A sound is recorded with these settings:

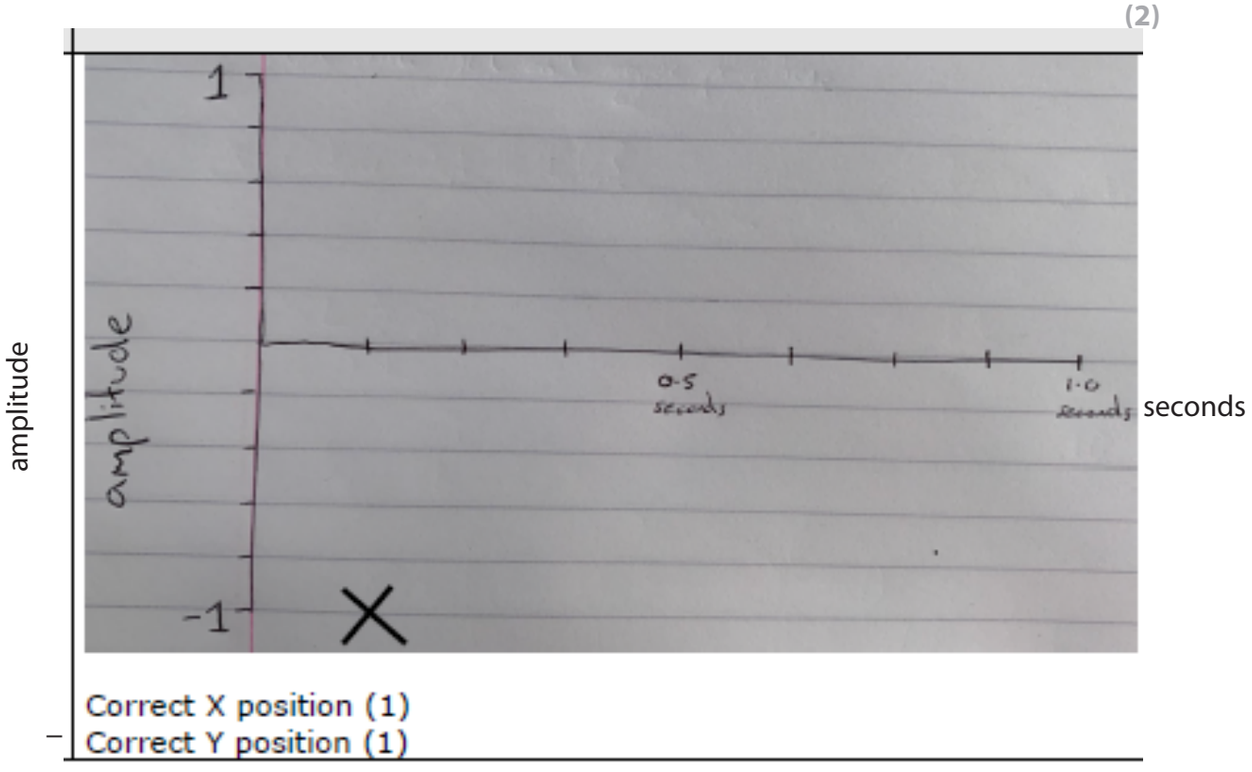
- sample rate: 24 kHz
- bit depth: 4-bit.

Two's complement is used to represent sample values.

The 3000th sample of the sound is represented in binary as 1111

(i) Draw an X on the graph to plot the value of the 3000th sample.

(2)



Correct X position (1)
Correct Y position (1)

(ii) State the reason why decreasing the sample interval improves the digital representation of a sound wave.

(1)

Answer
There will be more samples in each second (1)

(e) Convert the binary number 0100 1010 to hexadecimal.

(2)

Answer
1 mark for each digit in the correct location: 4A

(f) A 5-colour bitmap image uses 6-bit colour depth.

The image is 96 pixels wide and 128 pixels high.

(i) Complete the expression to show the minimum file size for the image in KiB.

You do not have to do the calculation.

(3)

$$\frac{96 \times 128 \times 6}{1024 \times 8}$$

- 6 in numerator (1)
- 1024 in either box in denominator (1)
- 8 in either box in denominator (1)

(ii) The file size can be optimised by changing the colour depth.

Give the minimum number of bits that can store 5 colours.

(1)

3 bits

Explanation: because you need to count up to 5. 3 bits counts up to 8, but 2 bits only counts to 3, which is not enough.

(g) Complete the table to show the result of the 8-bit binary addition.

(2)

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

One mark for each nibble

1010 0111

(h) Here is a sequence of text.

The quick brown fox jumps over the lazy dog 素早い茶色の狐が怠惰な犬を飛び越えます

Explain why 7-bit ASCII could not be used to represent this text.

(2)

.....

.....

.....

.....

(Total for Question 3 = 18 marks)

Answer
An explanation to include: ASCII only represents English characters / Kana/hiragana cannot be represented in ASCII (1) because there are not enough bits (1) With just 7 bits, only 128 unique codes (1) can be generated, which is not enough (1) to represent all the characters used in the written languages of the world The text has foreign characters (1) and there are not enough bits (1) in ASCII to represent them

5 Data

(a) Describe **one** reason that lossless compression is preferred to lossy compression for transmitting word-processed documents over a network.

(2)

A lossless compression will allow the exact contents of the word-processed document to be reconstructed (1) whereas a lossy compression will permanently remove data from the file (1)

(b) In arithmetic, subtraction can be done by adding a negative number.

Calculate 18 – 8, using 8-bit binary and two's complement.

Convert the result back to denary.

Show all your working.

(4)

- 18 converted to 8-bit binary 0001 0010 (1)
- -8 converted to two's complement 8-bit binary 1111 1000 (1)
- Addition performed correctly (1 mark for each nibble)
  - 8-bit binary result of 0000 (1) 1010 (1)

- Penalise use of fewer/more than 8 bits only once.
- Allow follow through errors on addition, as long as there is at least one carry.

(c) Explain the reason why at least nine bits are needed to store 300 different binary patterns.

(2)

One from

- 2^9 gives 512 (1) patterns whereas 2^8 gives 256 patterns (1)
- 2^8 (1) does not give enough patterns whereas 2^9 (1) gives more than enough patterns

(d) Construct an expression to calculate the file size, in mebibytes, of a CD quality (44.1 KHz, bit depth of 16), two-channel stereo soundtrack that is 4 minutes long.

You do **not** need to carry out the calculation.

(4)

One mark for each:

- Sample rate and bit depth = 44.1 × 1000 × 16 (1)
- Channels and time = 2 × 4 × 60 (1)
- Unit conversions = 8 × 1024 × 1024 (1)
- Numerator and denominator the right way around (1)

Example of an expression that gains full marks:
((44.1 × 1000 × 16) × (2 × 4 × 60)) ÷ (8 × 1024 × 1024)

(e) Information about a bitmap image is described in two tables.

Complete the two tables and use the information, along with the image data, to show the image in the grid.

(6)

Image data:

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

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

Image descriptors

	Denary	Binary
Width	8 denary	1000
Height	5 denary	0101
Colour depth	rted to 2	0010

Colour table

	Denary	Binary
Black	0	d to 00 bi
Red	1	t 01 binar
Green	2	d to 10 bi
White	3	d to 11 bi

Use B for black, R for red, G for green, and W for white.

You may not need all the squares in the grid.

B	B	B	B	B	B	B	B				
B	R	R	R	R	R	R	R				
B	G	G	G	G	G	G	G				
B	G	G	G	G	G	G	G				
B	W	W	W	W	W	W	W				

Sequence of cells any two colours labelled correctly to a maximum of 2

- L-shaped Black
- Single row Red
- Double row Green
- Single row White

(Total for Question 5 = 18 marks)

TOTAL FOR PAPER = 75 MARKS

2 Data

(a) Computers manipulate binary patterns to store numeric values and characters.

(i) Name the format used to represent signed integers in binary.

(1)

Award **one** mark for any of the following:	Allow spelling errors
• Two's complement • 2s complement	

(ii) Convert the hexadecimal value 5C to 8-bit binary.

(2)

Award **one** mark for each nibble:
• 0101 1100

(iii) In ASCII representation, the letter Q has a denary value of 81.

Give the denary ASCII representation for the letter V.

(1)

• 86

(iv) Convert the denary value 22 to 8-bit binary.

(2)

Award **one** mark for each nibble:
• 0001 0110

(v) Identify the term that means a binary digit.

(1)

- ☒ **A** Bit
- ☒ **B** Boolean
- ☒ **C** Byte
- ☒ **D** Integer

The only correct answer is **A** *B is not correct because a Boolean value is either true or false. It is not a unit of measure.* *C is not correct because a byte is made up of eight individual bits.* *D is not correct because an integer is a data type that holds whole numbers.*

(vi) Describe an overflow error.

(2)

Award up to **two** marks for a linked description, such as: The result of a calculation/addition/operation (1) needs more bits to store it than the computer has/is too big for the computer to store/cannot fit into the number of bits available. (1)	For both marks, the expansion must associate with the statement.

(b) Binary is used to represent image and audio files for processing by a computer.

(i) Define the term 'colour depth'.

(2)

Award **one** mark for any of the following up to a maximum of **two** marks:

- The number of bits (1)
- Used to represent each colour/pixel (1)

(ii) Lossy and lossless compression both make a file smaller.

Explain **one** reason lossless compression is used to transmit program source code.

Award up to **two** marks for a linked explanation such as:

- The original file can be reproduced exactly (1) because all the data is kept/encoded / no data is lost/discarded (1)
- The program can be executed/translated on receipt (1), because the original source code can be uncompressed in its entirety (1)

(iii) An audio file is 35 819 360 bits in length.

Complete the expression to show the file size in mebibytes.

(3)

35 819 360

_____

.....	×	.....	×	.....	

- 8 for bytes (1)
- 1024 for kibibytes (1)
- 1024 for mebibytes (1)

(Total for Question 2 = 16 marks)

Additional Guidance
Award any equivalent expression, even if all boxes not filled in Do not award marks for 4.27 mebibytes Do not accept 1000 for 1024

Answer ALL questions. Write your answers in the spaces provided.

Some questions must be answered with a cross in a box ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

1 Data

(a) Identify the smallest unit of measurement.

(1)

- ☒ **A** bit
- ☒ **B** byte
- ☒ **C** kibibyt
- ☒ **D** nibble

A bit

***B** is not correct because a bit is smaller than a byte*

***C** is not correct because a bit is smaller than a kibibyte*

***D** is not correct because a bit is smaller than a nibble*

(b) Identify the maximum number of values that can be represented with 5 bits.

- ☒ **A** 5
- ☒ **B** 16
- ☒ **C** 25
- ☒ **D** 32

D 32

***A** is not correct because 5 bits can represent 32 values*

***B** is not correct because 5 bits can represent 32 values*

***C** is not correct because 5 bits can represent 32 values*

(c) A car park uses a number-plate recognition system.

(i) Identify the reason why an unsigned integer should be used to record the number of cars entering the car park, rather than a signed integer.

- ☒ **A** Unsigned integers ar
- ☒ **B** Unsigned integers ca
- ☒ **C** Unsigned integers st
- ☒ **D** Unsigned integers do not use a parity bit

C Unsigned integers store more positive values

***A** is not correct because unsigned integers are not more accurate*

***B** is not correct because overflow errors can still occur with unsigned integers*

***D** is not correct because the use of a parity bit is not relevant to the scenario*

(ii) The system stores images of car number plates.

Construct an expression to show how many bytes there are in 6 tebibytes.

You do not need to carry out the calculation.

(3)

6×1024^4

Award **1** mark for sight of 1024

Award **1** mark for sight of ^{4} (applied only to 1024)

Award **1** mark for sight of x6

Award **all** marks if the result of the calculation is given: 6,597,069,766,656 (bytes).
N.B. This is not needed or expected.

DO NOT WRITE IN THIS AREA DO NOT WRITE IN THIS AREA DO NOT WRITE IN THIS AREA DO NOT WRITE IN THIS AREA

(d) Identify the 4-bit binary addition that will result in an overflow error.

(1)

- ☒ **A** 1001+1000
- ☒ **B** 0011+1001
- ☒ **C** 1000+0110
- ☒ **D** 0111+1000

A 1001+1000

***B** is not correct because it will result in 1100*

***C** is not correct because it will result in 1110*

***D** is not correct because it will result in 1111*

(e) Give the 8-bit binary representation of the denary number 82.

(2)

0101 0010

Award 1 mark for each nibble in the correct location.

(f) (i) Convert the binary number 0011 1101 to hexadecimal.

(2)

3D

Award 1 mark for each nibble in the correct location.

(ii) Explain why hexadecimal notation is used.

(2)

Award **1** mark for the identification of the reason (1) with a linked justification/exemplification (1), up to a maximum of **2** marks.

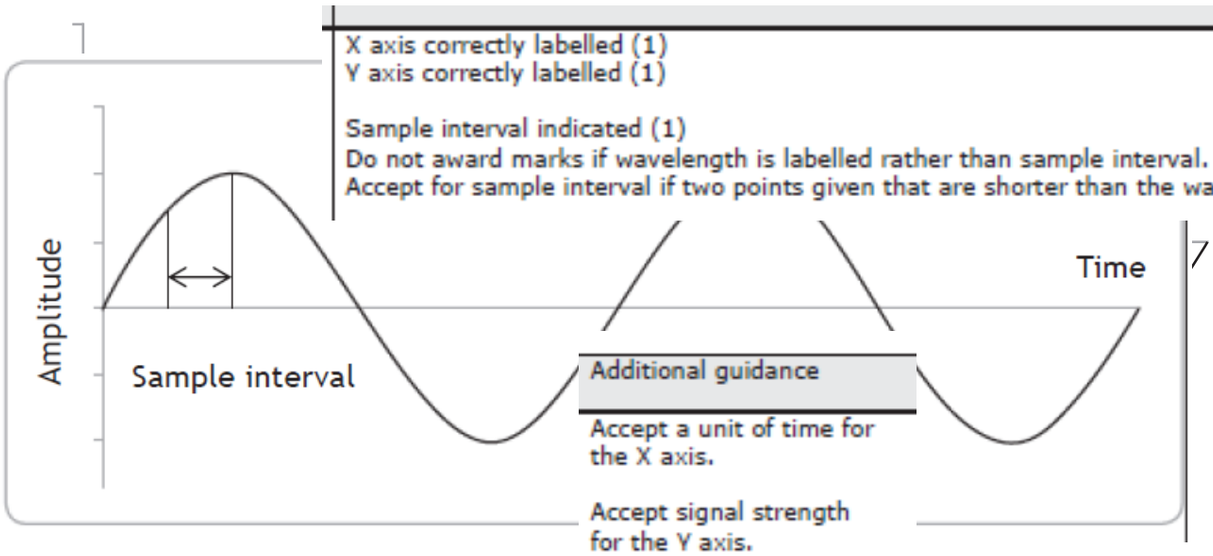
Hexadecimal is used as shorthand for binary / uses fewer digits/characters (1), so **humans** make fewer mistakes / find it easier to read/understand/remember/manipulate (1).

Do not accept answers suggesting that fewer digits save storage/memory.

(g) An analogue to digital converter is used to change the sounds received by a microphone into a form that can be processed by a computer.

Complete the diagram to show a sample interval and label both axes.

(3)



X axis correctly labelled (1)
Y axis correctly labelled (1)

Sample interval indicated (1)
Do not award marks if wavelength is labelled rather than sample interval.
Accept for sample interval if two points given that are shorter than the wavelength.

Additional guidance

Accept a unit of time for the X axis.

Accept signal strength for the Y axis.

(h) An image uses a 12-bit colour depth. It is 64 pixels wide and 48 pixels high.

Construct an expression to calculate the file size of the image in MiB.

You do not have to do the calculation.

(4)

Award **1** mark for:
Sight of: 64 × 48 × 12

Award **1** mark for:
Sight of: 1024 × 8

Award **1** mark for:
Sight of: (1024) × (1024) **OR** $(1024)^2$

Award **1** mark for correct numerator/denominator orientation.

Examples of expressions that gains full marks:

$$\frac{64 \times 48 \times 12}{1024 \times 1024 \times 8}$$

(Total for Question 1 = 20 marks)