CAMBRIDGE IGCSE (0478)

Module C: Data representation

Workbooklet · 11 parts · 222 marks

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	Total	**222**

MODULE C DATA REPRESENTATION · C1

Why computers use binary

Original practice questions · 20 marks · ~25 minutes · Cambridge 0478 syllabus 1.1.1

Name _____ Date _____

Instructions. Answer all questions in the spaces provided. No calculator. The marks for each part are shown in brackets [ ]. The total for this worksheet is **20 marks**.

1

Total: 3 marks

(a) Binary is a number system. State the base of the binary number system. **[1]**

(b) Give the name of a single binary digit. **[1]**

(c) State the name of the components inside a computer that data is processed using. **[1]**

2

Total: 4 marks

(a) Tick (✓) **one** box in each row to show whether each statement is true or false. **[4]**

Statement	True	False
Sound must be converted to binary before a computer can process it		
Binary uses the digits 1 and 2		
Data being processed is stored in registers		
Only numbers are represented in binary; text is stored as letters		

3 **Total: 4 marks**

A farming co-operative installs a weather station in a field. It takes photographs of the sky, records the sound of the wind, measures the temperature and shows short text alerts on a display.

(a) Identify **three** different types of data the weather station must represent in binary. **[3]**

1

2

3

(b) State where, in the weather station's processor, data is stored while it is being processed. **[1]**

4 **Total: 4 marks**

Each extra bit doubles the number of different patterns of 1s and 0s that a group of bits can make.

(a) Complete the table to show how many different patterns each group of bits can make. **[3]**

Number of bits	Number of different patterns
1	2
4	.....
8	.....
16	.....

(b) State the name given to a group of 4 bits. **[1]**

5 **Total: 2 marks**

(a) Explain why computers use binary to represent data. **[2]**

6 **Total: 3 marks**

A hospital's IT manager writes in a staff guide: *"Computers use binary because they can only understand binary."*

(a) Explain why this statement is not a full explanation. Give a better explanation of why computers use binary to represent all forms of data. **[3]**

Total for this worksheet: 20 marks

MODULE C DATA REPRESENTATION · C2

Converting denary and binary

Original practice questions · 20 marks · ~25 minutes · Cambridge 0478 syllabus 1.1.2

Name _____ Date _____

Instructions. Answer all questions in the spaces provided. No calculator. All numbers are positive integers; binary numbers are up to 16 bits. The marks for each part are shown in brackets [ ]. The total for this worksheet is **20 marks**.

1

Total: 2 marks

(a) State the base of the binary number system. **[1]**

(b) State the base of the denary number system. **[1]**

2

Total: 3 marks

(a) Convert the 8-bit binary number **01110011** to denary. **[1]**

(b) Convert the 16-bit binary number **0000010110010110** to denary. Show your working. **[2]**

Answer: .....

3 **Total: 5 marks**

(a) Convert the denary number **181** to 8-bit binary. **[1]**

Answer: .....

(b) Convert the denary number **1000** to 16-bit binary. Show your working. **[2]**

Answer: .....

(c) Convert the denary number **40000** to 16-bit binary. Show your working. **[2]**

Answer: .....

4 **Total: 4 marks**

A warehouse robot stores values in binary registers. Some registers are 8-bit and some are 16-bit.

(a) Complete the table by filling in each empty box. **[4]**

Value	Register size	Denary	Binary
Shelf number	8-bit	52	
Parcel count	8-bit		10000001
Distance travelled	16-bit	5000	
Item code	16-bit		1000100000000001

5 **Total: 3 marks**

An engineer converts the denary number 13 to 8-bit binary and writes **10110000**.

(a) Explain the error the engineer has made and give the correct 8-bit binary number. **[3]**

Correct binary: .....

6 **Total: 3 marks**

(a) Give the largest denary number that can be stored in a 16-bit register. **[1]**

(b) Explain why the denary number 70000 cannot be stored in a 16-bit register. **[2]**

Total for this worksheet: 20 marks

MODULE C DATA REPRESENTATION · C3

Hexadecimal and why we use it

Original practice questions · 20 marks · ~25 minutes · Cambridge 0478 syllabus 1.1.2(b)(ii), 1.1.3

Name _____ Date _____

Instructions. Answer all questions in the spaces provided. No calculator. Hexadecimal numbers on this worksheet have up to **4 digits**. The marks for each part are shown in brackets [ ]. The total for this worksheet is **20 marks**.

1

Total: 2 marks

(a) State the base of the hexadecimal number system. **[1]**

(b) Tick (✓) **one** box to show which of these is a valid hexadecimal number. **[1]**

Number	Tick (✓) one
1G4	
3AF	
2.5	
H12	

2

Total: 5 marks

A warehouse robot stores the number of the shelf it is going to as a positive integer. Engineers see the shelf number in hexadecimal.

(a) Convert the denary number 92 into hexadecimal. **[1]**

Answer: .....

(b) Convert the denary number 400 into hexadecimal. Show your working. **[2]**

Working:

Answer: .....

(c) Convert the denary number 2750 into hexadecimal. Show your working. **[2]**

Working:

Answer: .....

3 **Total: 5 marks**

(a) Convert the hexadecimal number 7F into denary. **[1]**

Answer: .....

(b) Convert the hexadecimal number 1A0 into denary. Show your working. **[2]**

Working:

Answer: .....

(c) Convert the hexadecimal number 3C2D into denary. Show your working. **[2]**

Working:

Answer: .....

4 **Total: 3 marks**

A design company builds web pages. One colour is written as the code #00C8FF, which gives the red, green and blue values as two hexadecimal digits each.

(a) State the denary value of the green part of the colour, C8. **[1]**

Answer: .....

(b) Identify **two other** uses of hexadecimal in computer science. **[2]**

1

2

5 **Total: 2 marks**

A network interface card has a MAC address made of 48 bits. It is written as 12 hexadecimal digits.

(a) State how many bits are shown by **one** hexadecimal digit. **[1]**

(b) State the largest denary value that can be written using 4 hexadecimal digits. **[1]**

6 **Total: 3 marks**

(a) Explain why computer scientists use hexadecimal instead of binary to represent data. **[3]**

Total for this worksheet: 20 marks

MODULE C DATA REPRESENTATION · C4

Converting binary and hexadecimal

Original practice questions · 20 marks · ~25 minutes · Cambridge 0478 syllabus 1.1.2(b)(iii)

Name _____ Date _____

Instructions. Answer all questions in the spaces provided. No calculator. Binary numbers are up to 16 bits and hexadecimal numbers up to 4 digits. Give binary answers with the number of bits asked for. The marks for each part are shown in brackets [ ]. The total for this worksheet is **20 marks**.

1

Total: 2 marks

(a) State how many bits are represented by **one** hexadecimal digit. **[1]**

(b) State how many hexadecimal digits are needed to represent a 16-bit binary number. **[1]**

2

Total: 6 marks

A network switch stores its settings as binary values.

(a) Convert the 8-bit binary value 1100 1010 into hexadecimal. **[2]**

Answer: .....

(b) Convert the 16-bit binary value 0011 1110 1000 0101 into hexadecimal. Show your working. **[4]**

Answer: .....

3 Total: 6 marks

(a) Convert the hexadecimal value 9F into 8-bit binary. **[2]**

Answer: .....

(b) Convert the hexadecimal value 2B0D into 16-bit binary. Show your working. **[4]**

Answer: .....

4 Total: 2 marks

A technician converts the 16-bit binary value 1101 0000 1010 0011 from an error log and writes the hexadecimal value as **DA3**.

(a) Identify the mistake the technician has made. **[1]**

(b) Give the correct hexadecimal value. **[1]**

Answer: .....

5 Total: 4 marks

(a) Complete the table by writing the missing binary or hexadecimal value in each gap. **[4]**

Binary	Hexadecimal
0110 1111	
(8 bits)	B4
0001 0010 1100 1110	
(16 bits)	8E07

Total for this worksheet: 20 marks

MODULE C DATA REPRESENTATION · C5

Binary addition and overflow

Original practice questions · 21 marks · ~25 minutes · Cambridge 0478 syllabus 1.1.4

Name _____ Date _____

Instructions. Answer all questions in the spaces provided. No calculator. All numbers are positive 8-bit binary integers. Where a question says "You must show all your working", show your carries in the grid. The marks for each part are shown in brackets [ ]. The total for this worksheet is **21 marks**.

1

Total: 4 marks

(a) State the largest denary value that can be stored in an 8-bit register. **[1]**

(b) Add the two positive 8-bit binary integers 01100111 and 00011101 using binary addition. Give your answer in binary. You must show all your working. Use the grid. The dashed column on the left is for any carry out of the 128 column. **[3]**

128	64	32	16	8	4	2	1	
0	1	1	0	0	1	1	1	
0	0	0	1	1	1	0	1	+
								Answer
								Carries

2

Total: 6 marks

A car park barrier stores the number of cars that have entered in an 8-bit register. At midday it adds the morning count to the overnight count.

(a) Add the two positive 8-bit binary integers 10111010 and 01011011 using binary addition. Give your answer in binary. You must show all your working. **[4]**

128	64	32	16	8	4	2	1	
1	0	1	1	1	0	1	0	
0	1	0	1	1	0	1	1	+
								Answer
								Carries

(b) An overflow error occurs in the addition in part (a). Explain why the overflow error occurs. **[2]**

3 Total: 4 marks

(a) Tick (✓) **one** box in each row to show whether each statement is true or false. **[4]**

Statement	True	False
An overflow error occurs if the result of an addition is greater than 255 in an 8-bit register		
Adding two 8-bit integers that both have 0 as the most significant bit can cause an overflow error		
A 16-bit register can store the value 300 without an overflow error		
When an overflow error occurs, the correct result is still stored in the 8-bit register		

4 Total: 3 marks

(a) A device uses 16-bit registers. State the largest denary value it can store in one register. **[1]**

(b) A computer or device has a predefined limit that it can represent or store. Explain what is meant by an overflow error, using this limit. **[2]**

5 Total: 4 marks

(a) Add the two positive 8-bit binary integers 01110101 and 00101011 using binary addition. Give your answer in binary. You must show all your working. **[3]**

128 64 32 16 8 4 2 1

0 1 1 1 0 1 0 1

0 0 1 0 1 0 1 1 +

Answer

Carries

(b) Convert your answer to part (a) into denary. **[1]**

Total for this worksheet: 21 marks

MODULE C DATA REPRESENTATION · C6

Logical binary shifts

Original practice questions · 19 marks · ~25 minutes · Cambridge 0478 syllabus 1.1.5

Name _____ Date _____

Instructions. Answer all questions in the spaces provided. No calculator. All binary integers are positive 8-bit integers held in an 8-bit register. The marks for each part are shown in brackets [ ]. The total for this worksheet is **19 marks**.

1

Total: 2 marks

(a) Perform a logical left shift of **three** places on the positive 8-bit binary integer **00010101**. **[1]**

	128	64	32	16	8	4	2	1
Result								

(b) Perform a logical right shift of **two** places on the positive 8-bit binary integer **11001100**. **[1]**

	128	64	32	16	8	4	2	1
Result								

2

Total: 2 marks

(a) Tick (✓) **one** box to show the effect of a logical left shift of **two** places on a positive binary integer (no 1s are lost). **[1]**

Effect	Tick (✓) one
Multiplied by 2	
Multiplied by 4	
Divided by 4	
Multiplied by 8	

(b) Tick (✓) **one** box to show the effect of a logical right shift of **four** places on a positive binary integer (no 1s are lost). **[1]**

Effect	Tick (✓) one
Divided by 4	
Divided by 8	
Divided by 16	
Multiplied by 16	

3 Total: 4 marks

(a) Complete the table by giving the result of each logical shift. **[4]**

8-bit binary integer	Logical shift	8-bit result
00101101	left 1 place	.....
01100000	right 5 places	.....
00001011	left 4 places	.....
10010110	right 1 place	.....

4 Total: 4 marks

A register in a ticket machine's processor holds the positive 8-bit binary integer 11010010.

(a) Give the result of a logical left shift of **one** place on 11010010. **[1]**

Answer (binary): .....

(b) Give your answer to part (a) in denary. **[1]**

Answer (denary): .....

(c) 11010010 is 210 in denary. Explain why the result is **not** 420. **[2]**

5 Total: 3 marks

(a) A logical right shift of **three** places is performed on 00101111. The result is 00000101. State the bits that are lost. **[1]**

(b) 00101111 is 47 in denary, and 47 ÷ 8 = 5.875. Explain why the result of the shift is 5 and not 5.875. **[2]**

6 **Total: 4 marks**

(a) State the value of the bits that are moved in at the opposite end of the register during a logical shift. **[1]**

(b) Describe the logical shift that would divide a positive 8-bit binary integer by 32. **[2]**

(c) State what happens to the bits that are shifted off the end of the register. **[1]**

Total for this worksheet: 19 marks

MODULE C DATA REPRESENTATION · C7

Two's complement

Original practice questions · 22 marks · ~25 minutes · Cambridge 0478 syllabus 1.1.6

Name _____ Date _____

Instructions. Answer all questions in the spaces provided. No calculator. All binary numbers on this worksheet are **8-bit two's complement** integers. The marks for each part are shown in brackets [ ]. The total for this worksheet is **22 marks**.

1

Total: 3 marks

(a) State the denary place value of the most significant bit in an 8-bit two's complement integer. **[1]**

(b) State the smallest and the largest denary values that can be stored as an 8-bit two's complement integer. **[2]**

Smallest: .....

Largest: .....

2

Total: 4 marks

(a) Convert the two's complement integer **01011010** to denary. **[1]**

Answer: .....

(b) Convert the two's complement integer **10110101** to denary. Show your working. **[2]**

Working space

Answer: .....

(c) Convert the two's complement integer **11111111** to denary. **[1]**

Answer: .....

3 Total: 5 marks

(a) Convert the denary integer **77** to an 8-bit two's complement integer. **[1]**

−128	64	32	16	8	4	2	1

(b) Convert the denary integer **−77** to an 8-bit two's complement integer. **[2]**

Working space

−128	64	32	16	8	4	2	1

(c) Convert the denary integer **−19** to an 8-bit two's complement integer. Show your working. **[2]**

Working space

Answer: .....

4 Total: 4 marks

A freezer controller stores each temperature reading, in °C, as an 8-bit two's complement integer.

(a) One reading is stored as **11110110**. An engineer says the reading is 246 °C. Explain why the engineer is wrong and give the correct reading. **[2]**

(b) Explain why the controller cannot store a reading of 150 °C. **[2]**

5 Total: 3 marks

(a) Tick (✓) **one** box in each row to show whether each statement about 8-bit two's complement integers is true or false. **[3]**

Statement	True (✓)	False (✓)
Every negative integer has a 1 as its most significant bit		
10000000 represents the denary value 0		
A positive integer is stored the same way as in 8-bit binary with no sign		

6 **Total: 3 marks**

(a) Describe how a negative denary integer is converted to an 8-bit two's complement integer. **[3]**

Total for this worksheet: 22 marks

MODULE C DATA REPRESENTATION · C8

Text and character sets: ASCII and Unicode

Original practice questions · 20 marks · ~25 minutes · Cambridge 0478 syllabus 1.2.1

Name _____ Date _____

Instructions. Answer all questions in the spaces provided. No calculator. You do not need to remember any character codes: use the codes given. Write ASCII codes as 8-bit binary. The marks for each part are shown in brackets [ ]. The total for this worksheet is **20 marks**.

1

Total: 3 marks

(a) Explain why text must be converted to binary before a computer can process it. **[2]**

(b) State what is meant by a **character set**. **[1]**

2

Total: 5 marks

A factory machine displays short product codes using ASCII. The ASCII code for **A** is 65 (01000001).

(a) Give the denary ASCII code for **D**. **[1]**

Answer: .....

(b) Give the 8-bit binary ASCII code for **C**. **[1]**

Answer: .....

(c) Write the code **DAB** in 8-bit binary ASCII. **[3]**

Character	8-bit binary ASCII code
D	
A	
B	

3 **Total: 3 marks**

A weather station stores a three-letter word in ASCII. The ASCII code for lower case **a** is 97. The stored codes are:
01100100 01101001 01100111

(a) Convert each code to its character. Show your working. **[3]**

Word: .....

4 **Total: 5 marks**

An online messaging service is used in many countries. Users write in many languages and send emojis.

(a) Give **two** differences between ASCII and Unicode. **[2]**

1 .....

2 .....

(b) Explain why the service uses Unicode rather than ASCII. **[3]**

5 **Total: 4 marks**

A message contains 40 characters. ASCII uses 8 bits per character. The Unicode format used stores 32 bits per character.

(a) Calculate the number of **bytes** needed to store the message in ASCII. Show your working. **[2]**

Answer: ..... bytes

(b) Calculate the number of **bytes** needed to store the message in Unicode. **[1]**

Answer: ..... bytes

(c) State the effect on the file size of using Unicode instead of ASCII. **[1]**

Total for this worksheet: 20 marks

MODULE C DATA REPRESENTATION · C9

Representing images

Original practice questions · 20 marks · ~25 minutes · Cambridge 0478 syllabus 1.2.3

Name _____ Date _____

Instructions. Answer all questions in the spaces provided. No calculator. The marks for each part are shown in brackets [ ]. The total for this worksheet is **20 marks**.

1

Total: 3 marks

A museum takes digital images of its exhibits and stores them as bitmap images.

(a) State what is meant by a **pixel**. **[1]**

(b) State what is meant by the **resolution** of an image. **[1]**

(c) State what is meant by the **colour depth** of an image. **[1]**

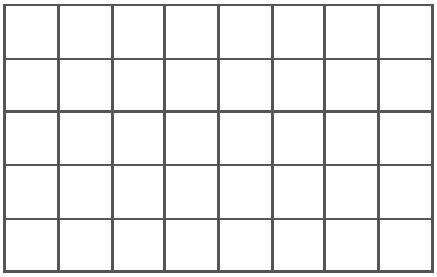
2

Total: 4 marks

(a) The museum's exit sign is a black-and-white bitmap image, 8 pixels wide and 5 pixels high. Each pixel is stored as 1 bit: 1 is black and 0 is white. The binary for each row is: **[2]**

Row 1: **`00011000`**
Row 2: **`00001100`**
Row 3: **`11111110`**
Row 4: **`00001100`**
Row 5: **`00011000`**

Shade the grid to show the image.



(b) The museum wants the sign to use 16 different colours. State the colour depth needed. **[1]**

(c) State how many different colours can be represented with a colour depth of 8 bits. **[1]**

3

Total: 4 marks

(a) Complete the table. The first row has been done for you. **[4]**

Colour depth (bits)	Number of different colours
1	2
3	
5	
	128
10	

4

Total: 1 mark

(a) An image uses 100 different colours. State the **minimum** colour depth needed. **[1]**

5 Total: 3 marks

(a) Tick (✓) **one** box in each row to show whether each statement is true or false. **[3]**

Statement	True	False
The file size of an image increases as its resolution increases		
Increasing the colour depth increases the number of pixels in an image		
An image with a higher colour depth can show more different colours		

6 Total: 5 marks

The museum scans a painting to display on its website.

(a) Explain the effect of **increasing the resolution** of the scan. **[2]**

(b) The museum reduces the colour depth of the scans from 24 bits to 8 bits so they load faster on its website. Explain the effects of this change. **[3]**

Total for this worksheet: 20 marks

MODULE C DATA REPRESENTATION · C10

Representing sound

Original practice questions · 20 marks · ~25 minutes · Cambridge 0478 syllabus 1.2.2

Name _____ Date _____

Instructions. Answer all questions in the spaces provided. No calculator. The marks for each part are shown in brackets [ ]. The total for this worksheet is **20 marks**.

1

Total: 2 marks

(a) Define the term **sample rate**. **[1]**

(b) Define the term **sample resolution**. **[1]**

2

Total: 4 marks

(a) Tick (✓) **one** box in each row to show whether each statement is true or false. **[4]**

Statement	True	False
A sound wave must be sampled to be converted to binary.		
The sample rate is the number of bits used for each sample.		
Increasing the sample resolution makes the recording more accurate.		
Decreasing the sample rate increases the file size.		

3

Total: 2 marks

(a) A recording uses a sample resolution of 5 bits. State how many different values each sample can have. **[1]**

(b) Give **one** reason why a sample resolution of 16 bits gives a more accurate recording than 5 bits. **[1]**

4 Total: 4 marks

(a) A recording is changed in four different ways. For each change, tick (✓) **one** box for accuracy **and one** box for file size. Everything else stays the same. **[4]**

Change	More accurate	Less accurate	File size increases	File size decreases
Sample rate increased				
Sample resolution decreased				
Sample resolution increased				
Sample rate decreased				

5 Total: 5 marks

(a) Explain how a computer represents sound. Include the effects of sample rate and sample resolution in your answer. **[5]**

6 **Total: 3 marks**

A company stores spoken tour tracks on small handheld audio guides for a museum. The guides are running out of storage.

(a) Identify **one** change the company could make to the settings to reduce the file sizes. **[1]**

(b) State **one** drawback of the change you identified in part (a). **[1]**

(c) The file size of each track also depends on one other factor. State this factor. **[1]**

Total for this worksheet: 20 marks

MODULE C DATA REPRESENTATION · C11

Compression, lossy and lossless

Original practice questions · 20 marks · ~25 minutes · Cambridge 0478 syllabus 1.3.3, 1.3.4

Name _____ Date _____

Instructions. Answer all questions in the spaces provided. No calculator. In run length encoding (RLE), each run is written as a count followed by a colour, e.g. 5W means five white pixels. The marks for each part are shown in brackets [ ]. The total for this worksheet is **20 marks**.

1

Total: 3 marks

A surveying company sends large files from its office to engineers working on site.

(a) Explain why the company compresses the files before sending them. **[3]**

2

Total: 2 marks

(a) Describe the difference between lossy and lossless compression. **[2]**

3 **Total: 7 marks**

A row of 16 pixels in an image is:
W W W W W W B B B W W W W G G G
(W = white, B = black, G = grey)

(a) Write this row using run length encoding (RLE). **[2]**

RLE: .....

(b) State how many values are stored in your answer to (a). Count each count and each colour as one value. **[1]**

Values: .....

(c) Another row is stored as **4R 2W 1R 5W** (R = red). Write out the original row of pixels. **[2]**

(d) A row of 8 pixels alternates: B W B W B W B W. Explain why RLE would **not** reduce the size of this row. **[2]**

4 **Total: 3 marks**

(a) Describe **two** ways lossy compression can reduce the file size of an image. **[2]**

1

2

(b) Identify **one** way lossy compression can reduce the file size of a sound file. **[1]**

5 **Total: 3 marks**

(a) A law firm compresses a text file containing a contract before emailing it. Explain why the firm should use lossless compression and not lossy compression. **[3]**

6 **Total: 2 marks**

(a) A travel website shows photographs of hotels. Identify the most suitable type of compression for the photographs and give **one** reason for your choice. **[2]**

Type: .....

Reason:

Total for this worksheet: 20 marks