T1

Data representation

CHAPTER ASSIGNMENT · 83 MARKS

Name _____ Class _____ No. _____ Date _____

Answer every question in the space given. Show your working. You may use the chapter page to help you.

Questions from *Cambridge IGCSE and O Level Computer Science*, 2nd edition, David Watson and Helen Williams (Hodder Education), for classroom use.

Activities from the chapter

1.1 Convert the following binary numbers into denary:

(a) 00110011

(b) 01111111

(c) 10011001

(d) 01110100

(e) 11111111

(f) 00001111

(g) 10001111

(h) 10110011

(i) 01110000

(j) 11101110

(k) 0001 1110 0111

(l) 0101 0101 0100

(m) 1111 0000 1111

(n) 0111 1100 1000

(o) 0111 1111 1111

(p) 0111 1100 1111 0000

(q) 0011 1111 0000 1101

(r) 1100 0011 0011 1111

(s) 1000 1000 1000 1000

(t) 0111 1111 1111 1111

1.2 Convert the following denary numbers into binary (using both methods):

(a) 41

(b) 67

(c) 86

(d) 100

(e) 111

(f) 127

(g) 144

(h) 189

(i) 200

(j) 255

(k) 33000

(l) 888

(m) 4095

(n) 16400

(o) 62307

1.3 Convert the following binary numbers into hexadecimal:

(a) 11000011

(b) 11110111

(c) 1001111111

(d) 10011101110

(e) 000111100001

(f) 100010011110

(g) 0010011111110

(h) 0111010011100

(i) 1111111101111101

(j) 00110011110101110

1.4 Convert the following hexadecimal numbers into binary:

(a) 6C

(b) 59

(c) AA

(d) A00

(e) 40E

(f) BA6

(g) 9CC

(h) 40AA

(i) DA47

(j) 1AB0

1.5 Convert the following hexadecimal numbers into denary:

(a) 6B

(b) 9C

(c) 4A

(d) FF

(e) 1FF

(f) A01

(g) BB4

(h) CA8

(i) 12AE

(j) AD89

1.6 Convert the following denary numbers into hexadecimal:

(a) 98

(b) 227

(c) 490

(d) 511

(e) 826

(f) 1000

(g) 2634

(h) 3743

(i) 4007

(j) 5000

1.7

(1) Using software on your computer (for example, text colour option in *Word*), find out what colours would be represented by the following RGB denary value combinations:

(a) Red 53 Green 55 Blue 139

(b) Red 201 Green 122 Blue 204

(c) Red 12 Green 111 Blue 81

(2) Convert each of the above denary numbers into hexadecimal.

1.8 Carry out the following binary additions:

(a) 00011101 + 01100110

(b) 00100111 + 00111111

(c) 00101110 + 01001101

(d) 01110111 + 00111111

(e) 00111100 + 00110011

(f) 00111100 + 01111011

(g) 00111111 + 00111111

(h) 00110001 + 00111111

(i) 01111111 + 01111111

(j) 10100010 + 00111011

1.9 Convert the following denary numbers into binary and then carry out the binary addition of the two numbers and check your answer against the equivalent denary sum:

(a) 98 + 15

(b) 29 + 88

(c) 49 + 100

(d) 51 + 171

(e) 82 + 69

(f) 100 + 140

(g) 19 + 139

(h) 203 + 30

(i) 66 + 166

(j) 211 + 35

1.10

(1) Convert the following pairs of denary numbers to 8-bit binary numbers and then add the binary numbers. Comment on your answers in each case:

(a) 89 + 175

(b) 168 + 99

(c) 88 + 215

(2) Carry out the following 16-bit binary additions and comment on your answers:

(a) 0111 1111 1111 0001 + 0101 1111 0011 1001

(b) 1110 1110 0000 1011 + 1111 1101 1101 1001

1.11

(1) Write down the denary value of the following binary number.

(a)

0	1	1	0	1	0	0	0

(b) Shift the binary number three places to the right and comment on your result.

(c) Write down the denary value of the following binary number.

0	0	0	0	1	1	1	1

(d) Shift the binary number four places to the left and comment on your result.

(2) Convert 29 and 51 to 8-bit binary numbers.

(a)

(b) Add the two binary numbers in part **a**.

(c) Shift the result in part **b** three places to the right.

(d) Convert 75 to an 8-bit binary number.

(e) Add the two binary numbers from parts **c** and **d**.

(f) Shift your result from part **e** one place to the left.

1.12

(1) Convert the following positive denary numbers into 8-bit binary numbers in the two's complement format:

(a) 39

(b) 66

(c) 88

(d) 102

(e) 111

(f) 125

(g) 77

(h) 20

(i) 49

(j) 56

(2) Convert the following binary numbers (written in two's complement format) into positive denary numbers:

	−128	64	32	16	8	4	2	1
a	0	1	0	1	0	1	0	1
b	0	0	1	1	0	0	1	1
c	0	1	0	0	1	1	0	0
d	0	1	1	1	1	1	1	0
e	0	0	0	0	1	1	1	1
f	0	1	1	1	1	1	0	1
g	0	1	0	0	0	0	0	1
h	0	0	0	1	1	1	1	0
i	0	1	1	1	0	0	0	1
j	0	1	1	1	1	0	0	0

1.13 Convert the following negative denary numbers into binary numbers using the two's complement format:

(a) −18

(b) −31

(c) −47

(d) −63

(e) −88

(f) −92

(g) −100

(h) −1

(i) −16

(j) −127

1.14 Convert the following negative binary numbers (written in two's complement format) into negative denary numbers:

a	1	1	0	0	1	1	0	1
b	1	0	1	1	1	1	1	0
c	1	1	1	0	1	1	1	1
d	1	0	0	0	0	1	1	1
e	1	0	1	0	0	0	0	0
f	1	1	1	1	1	0	0	1
g	1	0	1	0	1	1	1	1
h	1	1	1	1	1	1	1	1
i	1	0	0	0	0	0	0	1
j	1	1	1	1	0	1	1	0

1.15

(1) Explain each of the following terms:

(i) colour depth

(ii) ASCII code and Extended ASCII code

(iii) Unicode

(iv) sampling rate

(v) bitmap image

(2) A colour image is made up of red, green and blue colour combinations. 8 bits are used to represent each of the colour components.

(i) How many possible variations of red are there?

(ii) How many possible variations of green are there?

(iii) How many possible variations of blue are there?

(iv) How many different colours can be made by varying the red, green and blue values?

(3) Describe the effect of increasing resolution and sampling rate on the size of a file being stored in a computer.

1.16

(1) A camera detector has an array of 1920 by 1536 pixels. A colour depth of 16 bits is used. Calculate the size of a photograph taken by this camera, giving your answer in MiB.

(2) Photographs have been taken by a smartphone which uses a detector with a 1024 × 1536 pixel array. The software uses a colour depth of 24 bits. How many photographs could be stored on a 16 GiB memory card?

(3) Audio is being sampled at the rate of 44.1 kHz using 8 bits. Two channels are being used. Calculate:

(a) the size of a one second sample, in bits

(b) the size of a 30-second audio recording in MiB.

(4) The typical song stored on a music CD is 3 minutes and 30 seconds. Assuming each song is sampled at 44.1 kHz (44 100 samples per second) and 16 bits are used per sample. Each song utilises two channels. Calculate how many typical songs could be stored on a 740 MiB CD.

Exam-style questions

1 A software developer is using a microphone to collect various sounds for his new game. He is also using a sound editing app. When collecting sounds, the software developer can decide on the sampling resolution he wishes to use.

(a) What is meant by **sampling resolution**? [1]

(i)

(ii) Describe how sampling resolution will affect how accurate the stored digitised sound will be. [3]

(b) The software developer will include images in his new game.

(i) Explain the term **image resolution**. [1]

(ii) The software developer is using 16-colour bitmap images. How many bits would be used to encode data for **one** pixel of his image? [1]

(iii) One of his images is 16 384 pixels wide and 512 pixels high. He decides to save it as a 256-colour bitmap image. Calculate the size of the image file in gibibytes. [3]

(iv) Describe any file compression techniques the developer may use. [3]

2 The editor of a movie is finalising the music score. He will send the final version of his score to the movie producer by email attachment.

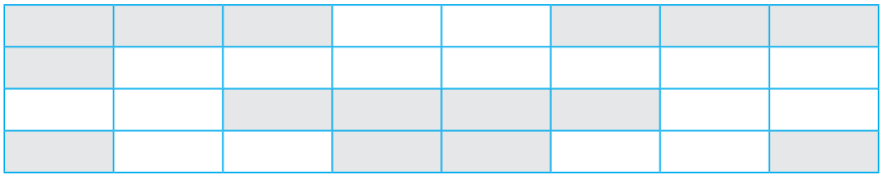
(a) Describe how **sampling** is used to record the music sound clips. [3]

(b) The music sound clips need to undergo some form of data compression before the music editor can send them via email. Which type of compression, **lossy** or **lossless**, should he use? Give a justification for your answer. [3]

(c) One method of data compression is known as **run length encoding (RLE)**.

(i) What is meant by RLE? [3]

(ii) The following image is being developed: [4]



Show how RLE would be used to produce a compressed file for the above image. Write down the data you would expect to see in the RLE compressed format (you may assume that the grey squares have a code value of 0 and the white squares have a code value of 1).

3 An 8-bit binary register contains the value:

0	0	1	1	0	1	1	0

(a) Write down the denary value of this register. [1]

(b) The contents of this register undergo a logical shift **one place** to the right.

(i) Show the result of this right shift.

(ii) Write down the denary value following this right shift. [2]

(c) The contents of this register, at the start of the question, now undergo a logical shift **two places** to the left.

(i) Show the contents of the register after this left shift operation. [1]

(ii) State, with reasons, the effect of this shift on the denary value in **part a**. [2]

4

(a) Convert the following denary numbers into 8-bit binary numbers:

(i) 123

(ii) 55

(iii) 180 [3]

(b) Carry out the following additions using your binary values from **part a**:

(i) 123 + 55

(ii) 123 + 180 [4]

(c) Write down the two's complement value of: 0 1 1 1 0 1 0 0 [2]

(i)

(ii) Write down the binary value of −112 using two's complement notation. [1]

(iii) Write down the denary value of the following binary number, which is using two's complement notation: [1]

1	0	1	1	1	0	0	1

(d) **(i)** Convert the following denary number into an 8-bit binary number using two's complement notation: 104.

(ii) Use two's complement notation to find the 8-bit binary value of −104. [2]

5 A bitmap image has the following resolution: 1140 × 1080 pixels. The image uses a colour depth of 24 bits.

(a) Explain the term **pixel**. [1]

(b) Explain the term **colour depth**. [1]

(c) Calculate how many of these images could be stored on a 32-GiB memory stick. [3]

(d) Describe how it would be possible to increase the number of these images which could be stored on this memory stick. [3]

6

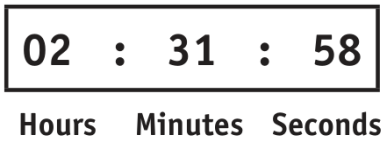
(a) Nancy has captured images of her holiday with her camera. The captured images are stored as digital photo files on her camera. Explain how the captured images are converted to digital photo files. [4]

(b) Nancy wants to email photos to Nadia. Many of the photos are very large files, so Nancy needs to reduce their file size as much as possible. Identify which type of file compression would be most suitable for Nancy to use. Explain your choice. [4]

Cambridge IGCSE Computer Science 0478, Paper 12 Q2, May/June 2018

7 A stopwatch uses six digits to store hours, minutes and seconds.

The stopwatch stopped at:



An 8-bit register is used to store each pair of digits.

(a) Write the 8-bit binary numbers that are currently stored for the **Hours, Minutes** and **Seconds**. [3]

Hours								
Minutes								
Seconds								

(b) The stopwatch is started again and then stopped. When the watch is stopped, the 8-bit binary registers show: [3]

Hours:	0	0	0	0	0	1	0	1
Minutes:	0	0	0	1	1	0	1	0
Seconds:	0	0	1	1	0	1	1	1

Write the denary values that will now be shown on the stopwatch.



Cambridge IGCSE Computer Science 0478, Paper 12 Q3, May/June 2018

8 A memory stick is advertised as having a capacity of 64 GiB.

(a) How many photographs of size 10 KiB could be stored on this memory stick? [2]

(b) John wants to store 400 photographs in a folder on his solid state drive (SSD). Each photograph is 10 KiB in size.

(i) Name **one** way of reducing the size of this file. [1]

(ii) Give **two** advantages of reducing the size of his photography files. [2]

(iii) Give **one** disadvantage of reducing files using the method named in **part b i**. [1]

(c) The original photographs were stored as bitmap images.

(i) Explain why 3 bytes of data would be needed to store each pixel in the bitmap image. [2]

(ii) Calculate how many different pixel colours could be formed if one of the bytes gives the intensity of the red colour, one of the bytes gives the intensity of the green colour and one of the bytes gives the intensity of the blue colour. [3]

9 Six calculations are shown on the left and eleven denary values are shown on the right. By drawing arrows, connect each calculation to its correct denary value. [6]

An 8-bit register uses two's complement notation. What is the denary value of: 0 0 1 0 1 1 0 1 ?	10
Convert the following into GiB: 59 055 800 320 bytes	16
If 2^x = 1 048 576 bytes What is the value of x?	20
Give the denary equivalent of the following hexadecimal number: 3F	28
What is the denary result of the following binary addition: 0 0 0 1 0 0 1 1 + 0 0 0 1 1 0 1 1	45
Find the hexadecimal value of the following denary number: 40	46
	55
	57
	60
	63
	80

End of assignment · Check your answers against the chapter at gurujazzy.com/subjects/computer-science/o-level/data-representation/