

Answers to Student's Book

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1 Data representation

Answers to activities

1.1

- a 51
- b 127
- c 153
- d 116
- e 255
- f 15
- g 143
- h 179
- i 112
- j 238
- k 487
- l 1364
- m 3855
- n 1992
- o 2047
- p 31984
- q 16141
- r 49983
- s 34952
- t 32767

1.2

- a** 00101001
- b** 01000011
- c** 01010110
- d** 01100100
- e** 01101111
- f** 01111111
- g** 10010000
- h** 10111101
- i** 11001000
- j** 11111111
- k** 1000000011101000
- l** 0000001101111000
- m** 0000111111111111
- n** 0100000000010000
- o** 1111001101100011

1.3

- a** C3
- b** F7
- c** 27F
- d** 4EE
- e** 1E1
- f** 89E
- g** (0)4FE
- h** (0)E9C
- i** FF7D
- j** 67AE

1.4

- a** 0110 1100
- b** 0101 1001
- c** 1010 1010
- d** 1010 0000 0000
- e** 0100 0000 1110
- f** 1011 1010 0110
- g** 1001 1100 1100
- h** 0100 0000 1010 1010
- i** 1101 1010 0100 0111
- j** 0001 1010 1011 0000

1.5

- a** 107
- b** 156
- c** 74
- d** 255
- e** 511
- f** 2561
- g** 2996
- h** 3240
- i** 4782
- j** 44425

1.6

- a** 62
- b** E3
- c** 1EA
- d** 1FF
- e** 33A
- f** 3E8
- g** A4A
- h** E9F
- i** FA7
- j** 1388

1.7

1 Student investigation

- 2**
- a** 35, 37, 8B
 - b** C9, 7A, CC
 - c** C, 6F, 51

1.8

- a** 10000011
- b** 01100110
- c** 01111011
- d** 10110110
- e** 01101111
- f** 10110111
- g** 01111110
- h** 01110000
- i** 11111110
- j** 11011101

1.9

- a** $98 = 01100010$ and $15 = 00001111$; sum = 01110001 (= 113)
- b** $29 = 00011101$ and $88 = 01011000$; sum = 01110101 (= 117)
- c** $49 = 00110001$ and $100 = 01100100$; sum = 10010101 (= 149)
- d** $51 = 00110011$ and $171 = 10101011$; sum = 11011110 (= 222)
- e** $82 = 01010010$ and $69 = 01000101$; sum = 10010111 (= 151)
- f** $100 = 01100100$ and $140 = 10001100$; sum = 11110000 (= 240)
- g** $19 = 00010011$ and $139 = 10001011$; sum = 10011110 (= 158)
- h** $203 = 11001011$ and $30 = 00011110$; sum = 11101001 (= 233)
- i** $66 = 01000010$ and $166 = 10100110$; sum = 11101000 (= 232)
- j** $211 = 11010011$ and $35 = 00100011$; sum = 11110110 (= 246)

1.10

- 1 a** $89 = 01011001$ and $175 = 10101111$; sum = $1]00001000$ (= 8)
overflow error has occurred (9 bits)
- b** $168 = 10101000$ and $99 = 01100011$; sum = $1]00001011$ (= 11)
overflow error has occurred (9 bits)
- c** $88 = 01011000$ and $215 = 11010111$; sum = $1]00101111$ (= 47)
overflow error has occurred (9 bits)
- 2 a** 1101 1111 0010 1010 – result is correct
- b** $1]1110\ 1011\ 1110\ 0100$ – overflow error has occurred

1.11

- 1 a** denary value = $64 + 32 + 8 = 104$

$$0\ 0\ 0\ 0\ 1\ 1\ 0\ 1$$
- b** denary value is 13 ($104 \div 8$) therefore shift three places right is the same as division by 2^3 (i.e. 8)
- c** denary value = 15

$$1\ 1\ 1\ 1\ 0\ 0\ 0\ 0$$
- d** denary value is 240 (15×16) therefore shift four places left is the same as multiplication by 2^4 (i.e. 16)
- 2 a** $29 = 00011101$ and $51 = 00110011$
- b** sum = 01010000
- c** 00001010
- d** $75 = 01001011$
- e** 01010101
- f** 10101010

1.12

- 1**
- a** 00100111
 - b** 01000010
 - c** 01011000
 - d** 01100110
 - e** 01101111
 - f** 01111101
 - g** 01001101
 - h** 00010100
 - i** 00110001
 - j** 00111000

- 2**
- a** 85
 - b** 51
 - c** 76
 - d** 126
 - e** 15
 - f** 125
 - g** 65
 - h** 30
 - i** 113
 - j** 120

1.13

- a** 11101110
- b** 11100001
- c** 11010001
- d** 11000001
- e** 10101000
- f** 10100100
- g** 10011100
- h** 11111111
- i** 11110000
- j** 10000001

1.14

- a** -51
- b** -66
- c** -17
- d** -121
- e** -96
- f** -7
- g** -81
- h** -1
- i** -127
- j** -10

1.15

- 1 i** The number of possible colours of a group of pixels (usually three or four) based on the bit depth.
- ii** The coding system for all the characters on a standard keyboard and control codes; extended ASCII, gives another 128 codes to allow for characters in non-English alphabets and for some graphical characters to be included.
- iii** The coding system which represents all the languages of the world (the first 128 characters are the same as ASCII code).
- iv** The number of sound samples taken per second.
- v** Images which are made up of pixels.
- 2 i, ii, iii** each colour is $2^8 = 256$
- iv** $256 \times 256 \times 256 = 16\,777\,216$ possible colours
- 3** They both increase the size of the sound file.

1.16

- 1** $1920 \times 1536 = 2\,949\,120$ pixels
 colour depth = 16 $\Rightarrow 16 \times 2\,949\,120 = 47\,185\,920$ bits
 bits ($\div 8$) $\Rightarrow 5\,898\,240$ bytes
 ($\div (1024 \times 1024)$) $\Rightarrow 5.625$ MiB
- 2** $1024 \times 1536 = 1\,572\,864$ pixels
 colour depth = 24 $\Rightarrow 24 \times 1\,572\,864 = 37\,748\,736$ bits
 bits ($\div 8$) $\Rightarrow 4\,718\,592$ bytes
 16 GiB = 17 179 869 bytes
 $\Rightarrow$ number of photos = $(17\,179\,869)/(4\,718\,592) = 3640$ photos
- 3 a** sample size = $44\,100 \times 8 \times 2$ (two tracks) = 705 600 bits
- b** file size = $44\,100 \times 8 \times 30 \times 2$ (two tracks) = 21 168 000 bits
 bytes ($\div 8$) $\Rightarrow 2\,646\,000$ bytes = 2.5 MiB

- 4** sample size = $44\,100 \times 16 \times 210 \times 2$ (two songs) = 296 352 000 bits
 bytes ($\div 8$) $\Rightarrow$ 37 044 000 bytes $\Rightarrow$ 35.33 MiB
 $\Rightarrow$ 740 MiB CD can store $740/35.33 = 20.94 \Rightarrow$ 20 full songs

Answers to exam-style questions

Answers to questions 6 and 7 in this section are example answers for past paper questions. The details of the relevant past paper can be found with the corresponding exam-style question in the Student's Book.

- 1 a i** The number of bits used to represent sound amplitude.
ii Better sound quality
 Less sound distortion
- b i** The number of pixels that make up an image; for example, an image could contain 4096×3192 pixels (i.e. 12 738 656 pixels in total).
ii 4 bits 16 colours
iii $16\,384 \times 512 = 8\,388\,608$ pixels
 Colour depth = 256 (8 bits per pixel)
 $\Rightarrow 8\,388\,608 \times 8 = 67\,108\,864$ bits
 $\Rightarrow (67\,108\,864 / (1024 \times 1024 \times 1024)) = 0.0625$ GiB
iv The developer may wish to use lossy compression and use the JPEG format to save space on their camera and/or computer.
- 2 a** The editor decides how many bits to represent the sound amplitude. Increasing the number of bits to represent sound amplitude increases accuracy; this is sampling resolution.
 The editor also decides how many samples per second should be taken; this is the sampling rate – the higher the number of sound samples per second, the better the quality of the sound recording.
- b** The editor will use lossy format, for example, MP3 format, which uses perceptual music shaping, which removes sounds the ear cannot hear properly, therefore the sound quality is essentially retained.
 Lossless files would be larger than lossy files for little improvement in sound quality.
- c i** RLE is a form of lossless compression. It reduces the size of a string of adjacent, identical data, for example, repeated colours of an image. The repeating string is encoded into two values; one value represents the number of identical items and the second value represents the code of the data item (ASCII code).
ii 3G 2W 4G 9W 4G 2W 1G 2W 2G 2W 1G (W = 1 and G = 0)
 $\Rightarrow$ 30 21 40 91 40 21 10 21 20 21 10
 8×4 grid = 32 bytes
 RLE code = $11 \times 2 = 22$ bytes
 $\Rightarrow$ RLE saves 10 bytes of memory/storage

- 3 a** $32 + 16 + 4 + 2 = 54$ (base 10)
- b i** 0 0 0 1 1 0 1 1
- ii** $16 + 8 + 2 + 1 = 27$ (base 10)
- c i** 1 1 0 1 1 0 0 0
- ii** $128 + 64 + 16 + 8 = 216$ (base 10)
- Therefore two places shift to the left = multiply by 4 (2^2)
- 4 a** Parts **i** to **iii**
- | | | | | | | | |
|---|---|---|---|---|---|---|---|
| 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 |
| 0 | 0 | 1 | 1 | 0 | 1 | 1 | 1 |
| 1 | 0 | 1 | 1 | 0 | 1 | 0 | 0 |
- b i** $123 + 55 = 0\ 1\ 1\ 1\ 1\ 0\ 1\ 1 + 0\ 0\ 1\ 1\ 0\ 1\ 1\ 1 = 1\ 0\ 1\ 1\ 0\ 0\ 1\ 0$ (178)
- ii** $123 + 180 = 0\ 1\ 1\ 1\ 1\ 0\ 1\ 1 + 1\ 0\ 1\ 1\ 0\ 1\ 0\ 0 = 1\ 0\ 0\ 1\ 0\ 1\ 1\ 1\ 1$ (47), which is incorrect; overflow has occurred
- c i** 0 1 1 1 0 1 0 0
- two's complement gives: 1 0 0 0 1 1 0 0 (-116)
- ii** $-112 = 1\ 0\ 0\ 1\ 0\ 0\ 0\ 0$
- iii** $1\ 0\ 1\ 1\ 1\ 0\ 0\ 1 = -128 + (32 + 16 + 8 + 1) = -128 + 57 = -71$
- d i** 0 1 1 0 1 0 0 0
- ii** 1 0 0 1 1 0 0 0
- 5 a** A picture element is the smallest element used to make up an image; each pixel is represented by a minimum of 8 bits and 3 pixels are needed to make up the RGB colours.
- b** The number of possible colours of a group of pixels (usually three or four) based on the bit depth.
- c** $1140 \times 1080 = 1\ 231\ 200$ pixels
- $\Rightarrow 1\ 231\ 200 \times 24 = 29\ 548\ 800$ bits
- $\Rightarrow (29\ 548\ 800)/8 = 3\ 693\ 600$ bytes
- Memory card is $32 \times (1024 \times 1024 \times 1024)$ bytes
- $\Rightarrow$ number of photos $= (32 \times 1024 \times 1024 \times 1024)/(3\ 693\ 600) = 9302$ photos
- d** Use file compression (e.g. JPEG) which reduces the size of the files/images being stored. Therefore more files/images can be stored on a memory stick.

- 6 a**
- image converted from analogue to digital
 - image turned into pixels
 - each pixel is given a binary value
 - pixels form a grid/pattern
 - each pixel has associated colour
 - pixels are stored in sequence
 - meta data stored (dimensions, colour depth, etc.)
 - for example, JPEG, raw, TIFF, PSD, PNG

b Lossy:

- lossy would reduce file size more than lossless
- unnecessary data removed from the file
- images can be of similar quality/won't notice any difference
- no requirement for files to be the same as the original
- can send photos faster/faster to upload

7 a

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

- b**
- 0 0 0 0 0 1 0 1 = 5
- 0 0 0 1 1 0 1 0 = 26
- 0 0 1 1 0 1 1 1 = 55

Time shown as:

05 : 26 : 55

- 8 a** $64 \text{ GiB} = 64 \times 1024 \times 1024 \text{ KiB}$
 $\Rightarrow (64 \times 1024 \times 1024)/10 = 6\,710\,886 \text{ photos}$

b i Use JPEG lossy file compression

- ii**
- saves storage space
 - faster to send photos by email
 - quicker to download/upload photos

iii loss of quality

c i Each primary colour intensity needs to be stored as a byte to allow for sufficient different colour variations.

ii $2^8 \times 2^8 \times 2^8 = 256 \times 256 \times 256 = 16\,777\,216$

9

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