

Exercise walk-through

1.2

Text, sound and images

IGCSE Computer Science

Turn characters into binary

A **character set** gives each character a number. The computer stores the number in binary.

This extract from **ASCII** ASCII uses 7-bit codes:

Character	Code	Character	Code
A	65	C	67
B	66	space	32

Try it. Encode CAB followed by one space. Write all four 7-bit groups, including the space.

Then decode: 1000010 1000001 1000011.

A space is stored too

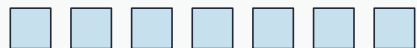
Character	ASCII code	Seven bits
C	67	1000011
A	65	1000001
B	66	1000010
space	32	0100000

Decode each group using the same mapping: 1000010 1000001 1000011 gives **BAC**.

The space is a fourth character with its own code. The sender and receiver need the same mapping to recover the intended text.

Why Unicode supports more languages

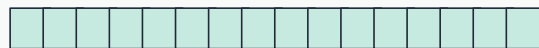
ASCII - 7 bits per character



$2^7 = 128$ characters

English letters, digits
and common symbols

Unicode - wider-code model



far **more** characters

many languages
symbols and emoji
width varies by encoding

Unicode includes a much greater range of languages, symbols and emoji.
ASCII cannot directly represent a Chinese name.

The syllabus compares 7-bit ASCII with wider Unicode codes. The wider row illustrates that comparison; it is not a fixed Unicode width.

Compare two stated storage models

Store CAB followed by one space: **four characters**.

Model A 7 bits per character

Model B 16 bits per character

Assume packed bits, with no padding or extra file information. Calculate the text data size in each model.

Explain why the larger result follows from these assumptions. The 16-bit value is given for this example, not a universal Unicode width.

Use the stated width, not a storage slogan

For fixed-width data, size equals character count times bits per character:

$$S = nb = 4 \times 7 \text{ bits} = 28 \text{ bits}$$

$$S = nb = 4 \times 16 \text{ bits} = 64 \text{ bits}$$

Model B uses more storage *in this example* because its width is larger.

Real file size also depends on the encoding. UTF-8 stores ASCII characters in the same bytes as an ASCII file, so Unicode does not *always* use more bytes.

Use the bit width stated in an exam question. Detailed UTF-8 rules are outside this comparison.

Exercises 2.1-2.3

2.1 State the difference between ASCII and Unicode.

[2]

2.2 Define sample rate.

[1]

2.3 Give one advantage and one disadvantage of Unicode compared with ASCII.

[2]

Exercises 2.1-2.3

2.1 State the difference between ASCII and Unicode. [2]

2.1

- ASCII uses 7 bits and a small set of characters (English letters, digits, punctuation)
 - Unicode uses more bits, so it can represent **many more characters and languages**
-

2.2 Define sample rate. [1]

2.2

- given: sound is sampled many times each second
 - **sample rate** is the number of samples taken **each second**
-

2.3 Give one advantage and one disadvantage of Unicode compared with ASCII. [2]

2.3

- advantage: Unicode can represent **every writing system**, not just English
- disadvantage: more bits per character, so the **same text takes more storage**

Exercises 2.4·2.5

2.4 Calculate the file size, in bytes, of a 10-second mono sound recording sampled at 8000 Hz with a resolution of 8 bits. [3]

2.5 State what happens to the file size of an image if its colour depth is increased from 8 bits to 16 bits. [1]

Exercises 2.4·2.5

2.4 Calculate the file size, in bytes, of a 10-second mono sound recording sampled at 8000 Hz with a resolution of 8 bits. [3]

2.4

- file size in bits = sample rate $\times$ resolution $\times$ time

$$\text{file size (bits)} = \text{sampling rate} \times \text{sample resolution} \times \text{seconds}$$

$$\text{file size} = 8000 \text{ Hz} \times 8 \text{ bits} \times 10 \text{ s} = 640\,000 \text{ bits}$$

- convert to bytes

$$\text{bytes} = \frac{\text{bits}}{8} = \frac{640\,000 \text{ bits}}{8 \text{ bits/byte}} = \mathbf{80\,000} \text{ bytes}$$

2.5 State what happens to the file size of an image if its colour depth is increased from 8 bits to 16 bits. [1]

2.5

- colour depth doubles from 8 bits to 16 bits, so each pixel stores twice as many bits
- the file size **doubles**

Exercise 3.1

3.1 Increasing the colour depth of an image will:

[1]

☐

A reduce the file size

B increase the file size and quality

C have no effect

D reduce the resolution

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3.1 Increasing the colour depth of an image will:

[1]

☐

A reduce the file size

B increase the file size and quality

C have no effect

D reduce the resolution

3.1 B

- more bits per pixel means more colours **and** a larger file
- A is the opposite; C ignores the extra bits; D mixes colour depth with resolution

Exercise 3.2 (a)

3.2 An image is 200×100 pixels with a colour depth of 8 bits.

(a) Calculate the file size in bits.

[2]

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3.2 An image is 200×100 pixels with a colour depth of 8 bits.

(a) Calculate the file size in bits.

[2]

(a)

- $\text{bits} = \text{width} \times \text{height} \times \text{colour depth}$

$$200 \times 100 \times 8 = \mathbf{160\,000} \text{ bits}$$

Exercise 3.2 (b)

3.2 An image is 200×100 pixels with a colour depth of 8 bits.

(b) Convert your answer to bytes.

[1]

Exercise 3.2 (b)

3.2 An image is 200×100 pixels with a colour depth of 8 bits.

(b) Convert your answer to bytes.

[1]

(b)

- divide bits by 8

$$\text{bytes} = \frac{\text{bits}}{8} = \frac{160\,000 \text{ bits}}{8 \text{ bits/byte}} = \mathbf{20\,000} \text{ bytes}$$

Exercise 3.3

3.3 A sound is recorded for 20 seconds at a sample rate of 10 000 Hz with a sample resolution of 8 bits. Calculate the file size in bits. [2]

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3.3

- $\text{bits} = \text{sample rate} \times \text{resolution} \times \text{time}$

$\text{file size (bits)} = \text{sampling rate} \times \text{sample resolution} \times \text{seconds}$

$$\text{file size} = 10\,000 \text{ Hz} \times 8 \text{ bits} \times 20 \text{ s} = \mathbf{1\,600\,000} \text{ bits}$$

Exercise 3.4 (a)

3.4 A student records a podcast and takes a photograph for its cover.

(a) Explain what is meant by sampling rate and by sample resolution.

[2]

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(a)

- **sampling rate:** number of samples taken each second
- **sample resolution:** number of bits used to store each sample

Exercise 3.4 (b)

3.4 A student records a podcast and takes a photograph for its cover.

(b) The recording lasts 60 seconds, is mono, is sampled at 22 050 Hz and uses a resolution of 16 bits. Calculate the file size in mebibytes. [4]

Exercise 3.4 (b)

3.4 A student records a podcast and takes a photograph for its cover.

(b) The recording lasts 60 seconds, is mono, is sampled at 22 050 Hz and uses a resolution of 16 bits. Calculate the file size in mebibytes. [4]

(b)

- $\text{bits} = 22\,050 \times 16 \times 60$

file size (bits) = sampling rate $\times$ sample resolution $\times$ seconds

$$\text{file size} = 22\,050 \text{ Hz} \times 16 \text{ bits} \times 60 \text{ s} = 21\,168\,000 \text{ bits}$$

- bytes

$$\text{bytes} = \frac{\text{bits}}{8} = \frac{21\,168\,000 \text{ bits}}{8 \text{ bits/byte}} = 2\,646\,000 \text{ bytes}$$

- mebibytes: divide by 1024 twice

$$\frac{2\,646\,000}{1024 \times 1024} = \mathbf{2.52 \text{ MiB}}$$

Exercise 3.4 (c)

3.4 A student records a podcast and takes a photograph for its cover.

(c) The student halves the sampling rate. State the effect on the file size and on the sound quality. [2]

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(c)

- file size **halves**
- quality **falls**, because the samples follow the original wave less closely

Exercise 3.4 (d)

3.4 A student records a podcast and takes a photograph for its cover.

(d) The cover photograph is 1200×900 pixels with a colour depth of 24 bits. Calculate its file size in mebibytes. [3]

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(d) The cover photograph is 1200×900 pixels with a colour depth of 24 bits. Calculate its file size in mebibytes. [3]

(d)

- bits = $1200 \times 900 \times 24$

$$1200 \times 900 \times 24 = 25\,920\,000 \text{ bits}$$

- bytes

$$\text{bytes} = \frac{\text{bits}}{8} = \frac{25\,920\,000 \text{ bits}}{8 \text{ bits/byte}} = 3\,240\,000 \text{ bytes}$$

$$\frac{3\,240\,000}{1024 \times 1024} = \mathbf{3.09 \text{ MiB}}$$

Exercise 3.4 (e)

3.4 A student records a podcast and takes a photograph for its cover.

(e) Explain why a colour depth of 24 bits allows over 16 million different colours. [2]

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(e)

- each of the 24 bits has two possible values, 0 or 1
- number of colours = $2^{24} = \mathbf{16\,777\,216}$

Exercise 3.4 (f)

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(f) The student's text file of show notes contains Chinese characters. Explain why it must use Unicode rather than ASCII. [2]

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(f) The student's text file of show notes contains Chinese characters. Explain why it must use Unicode rather than ASCII. [2]

(f)

- ASCII has only 128 codes, covering English letters, digits and punctuation – **no Chinese**
- Unicode uses more bits per character, so it has enough codes for **every writing system, including Chinese**