

Exercise walk-through

1.2

Data representation

International Baccalaureate · IB Diploma · Computer Science · HL

Computing Systems · executable trace

- Trace the state changes and boundary guard.
- Run the boundary case and compare the printed output.

```
size_MB, rate_Mbps = 20, 10
bits = size_MB * 1_000_000 * 8
if rate_Mbps <= 0:
    raise ValueError("Rate must be positive")
seconds = bits / (rate_Mbps * 1_000_000)
print(seconds)
print(0 / (rate_Mbps * 1_000_000))
```

Exercises 2.1·2.3

2.1 Convert to denary: (i) 01101001; (ii) 3C.

[2]

2.2 Convert 154 to (i) 8-bit binary; (ii) hexadecimal.

[2]

2.3 Write -25 in 8-bit two's complement.

[2]

Exercises 2.1-2.3

2.1 Convert to denary: (i) 01101001; (ii) 3C.

[2]

2.1

- (i) $64 + 32 + 8 + 1 = \mathbf{105}$
- (ii) $3 \times 16 + 12 = \mathbf{60}$

2.2 Convert 154 to (i) 8-bit binary; (ii) hexadecimal.

[2]

2.2

- (i) $154 = 128 + 16 + 8 + 2$: **10011010**
- (ii) 1001 1010: **9A**

2.3 Write -25 in 8-bit two's complement.

[2]

2.3

- $25 = 00011001$, flipped 11100110
- add 1: **11100111**

Exercises 2.4·3.1

2.4 State the largest and smallest values in 8-bit two's complement. [1]

3.1 How many different values can 10 bits represent? [1]

☐

A 10

B 100

C 512

D 1024

Exercises 2.4·3.1

2.4 State the largest and smallest values in 8-bit two's complement. [1]

2.4

- **127** and **−128**

3.1 How many different values can 10 bits represent? [1]

☐

A 10

B 100

C 512

D 1024

3.1 D

- $2^{10} = 1024$

Exercises 3.2-3.3

3.2 What is 1111 0000 in hexadecimal?

[1]

☐

A F0

B 0F

C FF

D E0

3.3 Why does a Chinese text app use Unicode rather than ASCII?

[1]

☐

A Unicode files are always smaller

B ASCII has only 128 characters, too few for Chinese

C ASCII cannot store numbers

D Unicode needs no bits

Exercises 3.2-3.3

3.2 What is 1111 0000 in hexadecimal?

[1]

- ☐ A F0
☐ B 0F
☐ C FF
☐ D E0

3.2 A

- 1111 = F, 0000 = 0

3.3 Why does a Chinese text app use Unicode rather than ASCII?

[1]

- ☐ A Unicode files are always smaller
☐ B ASCII has only 128 characters, too few for Chinese
☐ C ASCII cannot store numbers
☐ D Unicode needs no bits

3.3 B

- Chinese needs thousands of characters

Exercise 3.4 (a)

3.4 A school records a 3-minute stereo announcement and takes a photo for its website.

(a) The recording uses a sample rate of 22 050 Hz and a bit depth of 16. Calculate its size in bytes. [3]

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(a)

- $\text{size} = \text{sample rate} \times \text{bit depth} \times \text{channels} \times \text{time}$
- $22\,050 \times 16 \times 2 \times 180 = 127\,008\,000 \text{ bits}$
- $\div 8 = \mathbf{15\,876\,000 \text{ bytes}}$

Exercise 3.4 (b)

3.4 A school records a 3-minute stereo announcement and takes a photo for its website.

(b) State **two** ways to make the recording file smaller, and the effect of each on quality. [2]

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(b)

- lower the sample rate: less accurate sound, high notes lost
- lower the bit depth, or record in mono: less detail or no stereo

Exercise 3.4 (c)

3.4 A school records a 3-minute stereo announcement and takes a photo for its website.

(c) The photo is 1200×800 pixels with a colour depth of 24 bits. Calculate its size in megabytes ($1 \text{ MB} = 10^6$ bytes). [3]

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(c)

- $\text{size} = \text{width} \times \text{height} \times \text{colour depth}$
- $1200 \times 800 \times 24 = 23\,040\,000 \text{ bits} = 2\,880\,000 \text{ bytes}$
- **2.88 MB**

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- 24 bits give 2^{24} , about 16.7 million colours
- 8 bits give only $2^8 = 256$ colours, so smooth shades look banded