MODULE C · OCR J277 1.2.3-1.2.5 · CAMBRIDGE 0478 1.1, 1.2, 1.3.3-1.3.4

Data representation

Binary, **hexadecimal**, **binary addition** and **overflow**, **shifts**, **two's complement**, **character sets**, **images**, **sound** and **compression**. Spec versions as checked in November 2026.

01 Why binary (C1)

Two states Switches (transistors) are on or off: 1 or 0.

Processing Logic gates process data; registers store it. All data is converted to binary.

Patterns n bits give 2^n values. 4 bits: 16. 8 bits: 256 (0 to 255).

Bits needed Round up to the next power of 2: 20 values need 5 bits.

02 Denary and binary (C2)

Place values 128 64 32 16 8 4 2 1. MSB on the left, LSB on the right.

To denary Add the place values with a 1: 01101011 = 107.

To binary From the left, 1 where it fits: 156 = 10011100.

OCR GCSE only Up to 8 bits (0 to 255); 1 to 8 bits accepted.

Cambridge IGCSE only Up to 16 bits (256, 512 ... 32,768).

03 Hexadecimal (C3)

Base 16 0-9 then A=10, B=11, C=12, D=13, E=14, F=15.

Hex to denary Left digit x 16 + right digit: 2F = 32 + 15 = 47.

Denary to hex ÷ 16, remainder is the right digit: 156 = 9 r 12 = 9C.

OCR GCSE only 2 digits only, 00 to FF.

Cambridge IGCSE only Up to 4 digits (4,096 256 16 1). Why: shorter than binary, easier for humans, fewer errors. Uses: MAC addresses, colour codes, error codes.

04 Binary and hex (C4)

Key fact 1 hex digit = 1 nibble (4 bits, place values 8 4 2 1).

Binary to hex Split into nibbles from the right: 1011 0110 = B6.

Hex to binary Each digit to 4 bits: 3E = 0011 1110.

Watch Keep 0 nibbles: B0 is 1011 0000, not 1011.

05 Binary addition and overflow (C5)

Rules 0+0=0; 0+1=1; 1+1=0 carry 1; 1+1+1=1 carry 1.

Method Right to left; show every carry. Do not convert to denary.

Overflow Result too big for the bits available: over 255 in 8 bits. The 9th bit is lost.

Example 10110110 + 01100111 = 1 00011101 (182 + 103 = 285): overflow.

Limit IGCSE only Cambridge wording: a device has a predefined limit (e.g. 16-bit).

06 Binary shifts (C6)

Left x 2 per place. 00010110 (22) left 2 = 01011000 (88).

Right ÷ 2 per place. 01011000 right 3 = 00001011 (11).

Gaps / ends 0s fill the gaps; bits off the end are lost.

Answer Give direction and number of places: x 8 = left 3.

Wording Cambridge says "logical" shift on positive 8-bit integers.

07 Two's complement (C7) IGCSE only

MSB Worth -128; others 64 to 1. Range -128 to +127.

Negative Positive in 8 bits, flip every bit, add 1.

-45 00101101 → 11010010 → 11010011.

Read 10110100 = -128 + 32 + 16 + 4 = -76.

OCR Not on J277: positive binary only.

08 Character sets (C8)

Character set All the characters a computer can represent, each with a binary code.

ASCII 7 bits, 128 characters (extended 8-bit: 256). English letters, digits, symbols.

Unicode More bits per character: many languages and emojis, but bigger files.

OCR GCSE only ASCII shown as 8 bits in the exam; codes are in order (B = A + 1). No memorising.

09 Images (C9)

Pixel One dot of the image; its colour is a binary code.

Colour depth Bits per pixel. 2 bits = 4 colours; 8 bits = 256.

Resolution Number of pixels (width x height).

Effect Increase either: better quality, bigger file.

Metadata GCSE only Extra data about the image: width, height, colour depth.

10 Sound (C10)

Sampling The amplitude of the analogue wave is measured at regular intervals and stored in binary.

Sample rate Samples per second, in hertz (Hz).

Bits per sample OCR: "bit depth". Cambridge: "sample resolution".

Effect Increase either: closer to the original, bigger file. Longer duration: bigger file.

11 Compression (C11)

- **Lossy**

  Permanently removes data. Much smaller files; original cannot be rebuilt; quality may drop. Photos, music, video. **IGCSE only:** methods are reducing resolution or colour depth, or sample rate or sample resolution.

- **Lossless**

  No data lost; original rebuilt exactly; less reduction. Text and program files. **IGCSE only:** run length encoding, e.g. WWWWBBBWWWWW → 4W 3B 5W.

Why compress Less storage space, less bandwidth, shorter transmission time.

OCR GCSE only No compression algorithm to carry out.

01
Why binary: say **switches / logic gates with two states**, not just "computers understand binary".

02
Add in binary and **show the carries**; overflow = result **over 255, cannot fit in 8 bits**.

03
Shifts: give the **direction and the number of places**.

04
Compression: never lossy for text; link your answer to **the file in the question**.