

## 1.4 DATA TYPES &amp; STRUCTURES · 1.4.1 A-LEVEL

# Bitwise manipulation & masks

Shifts to multiply/divide, and AND/OR/XOR masks. Spec 1.4.1(i).

## 01 Shifts

**Left**  $\ll$   $\times 2$  per place (adds 0 on right).

**Right**  $\gg$   $\div 2$  per place (adds 0 on left).

**n places**  $\times 2^n$  or  $\div 2^n$ .

**Example**  $00010110$  (22)  $\ll 1 = 00101100$  (44)

**Lost bits** Bits off the end are discarded ( $\div$  rounds down).

**$\times \text{non-}2^n$**  Combine shifts + add ( $\times 7 = \ll 2 + \ll 1 + \times 1$ ).

## 02 Masks — pick the operator

**AND** **Clear / check.** mask 0  $\rightarrow$  0; mask 1  $\rightarrow$  keep.

**OR** **Set.** mask 1  $\rightarrow$  1; mask 0  $\rightarrow$  keep.

**XOR** **Toggle.** mask 1  $\rightarrow$  flip; mask 0  $\rightarrow$  keep.

**Check bit** AND with single 1  $\rightarrow$  non-zero means set.

## 03 Worked masks (data 11001010)

**AND**  $11001010$  AND  $00001111 = 00001010$  (clears top 4)

**OR**  $01000001$  ('A') OR  $00100000 = 01100001$  ('a') (sets bit  $\rightarrow$  lower-case)

**XOR**  $11001010$  XOR  $11110000 = 00111010$  (toggles top 4)

## FINAL PASS BEFORE THE EXAM

## Rapid exam tips

Six slips on bitwise questions.

### 01

Left shift = **x2** per place; right shift = **+2** per place.

### 02

**AND** clears/checks, **OR** sets, **XOR** toggles. Learn the trio.

### 03

AND keeps where mask = **1**; OR/XOR keep where mask = **0**.

### 04

To **test** a bit, AND with a single-1 mask → non-zero means it was set.

### 05

Right-shifting an odd number **loses** the bit that falls off (rounds down).

### 06

Two XORs with the **same** mask return the original value.