

1.4 DATA TYPES & STRUCTURES · 1.4.1

Binary arithmetic & two's complement

Add, subtract, store negatives, spot overflow. Spec 1.4.1(c)(d).

01 Addition & overflow

Rules $1+1=10$ (carry); $1+1+1=11$.

Method Column by column, right $\rightarrow$ left, carry the 1.

Overflow Result needs **more bits than available** (e.g. a 9th bit) $\rightarrow$ error.

02 Sign & magnitude

MSB Sign flag: 0 = +, 1 = -.

Example $+3 = 00000011$, $-9 = 10001001$

Problems **Two zeros**; normal addition fails $\rightarrow$ not used.

03 Two's complement

Top bit Place value **-128** (8-bit).

Make -X Flip all bits, then +1.

Example $-101 = 10011011$ ($-128+16+8+2+1$)

Why best **One zero**; normal addition works.

04 Subtraction

Trick $A - B = A + (\text{two's complement of } B)$.

124-101 $01111100 + 10011011 = 00010111 = 23$

Carry **Discard** the carry off the top bit.

FINAL PASS BEFORE THE EXAM

Rapid exam tips

Six slips on arithmetic questions.

01

Two's complement = flip the bits **and add 1** — don't forget the +1.

02

Subtraction → convert B to its negative, then **add**.

03

A carry **off the top bit** in two's complement is **discarded** — that's fine.

04

Always **show working** — method marks are awarded even with a slip.

05

If the answer needs a 9th bit, say **overflow**.

06

Check two's complement with place values (top bit = -128).