

Solutions

Each answer shows the steps, then the **result**.

2.1

- the **mantissa** holds the **significant digits**
- the **exponent** is the **power of 2** to multiply by

2.2

- $0.1000000 = 0.5$; exponent = 3
- $0.5 \times 2^3 = 4$

2.3

- the first significant bit is **immediately after the binary point** (0.1... for a positive number) – no wasted leading zeros, so precision is maximised

2.4

- some denary fractions (e.g. 0.1) are **repeating/infinite** in binary, so they must be **truncated** to fit the mantissa

3.1

- sign bit 0 $\rightarrow$ positive
- $.1010000 = \frac{1}{2} + \frac{1}{8} = 0.625$, exponent = 2
- $0.625 \times 2^2 = 2.5$

3.2

- $6 = 110.0_2$
- normalise to 0.110×2^3
- mantissa 01100000
- exponent 00000011

3.3

- $00011000 = 0.0011 \times 2^5$; shift mantissa **left 2**, exponent $5 - 2 = 3$
- new mantissa 01100000
- new exponent 00000011

3.4

- 0.1 and 0.2 cannot be stored **exactly** in binary (they are repeating fractions)
- the small stored errors **add up**, so the result is very close to but **not exactly** 0.3

3.5

- sign bit 1 $\rightarrow$ negative
- $1.0110000 = -1 + \frac{1}{4} + \frac{1}{8} = -0.625$, exponent = 2
- $-0.625 \times 2^2 = -2.5$

3.6

(a)

- move the point **right 5**: 0.1011011×2^{-5} ; mantissa 010110110000
- exponent -5 : $+5 = 0101$, invert 1010, add 1: 1011

(b)

- $19.625 = 10011.101$
- 0.10011101×2^5 : exponent 0101
- positive mantissa 010011101000; two's complement: invert 101100010111, add 1
- mantissa 101100011000, exponent 0101

3.7

(a)

- exponent 000100 = +4
- move the point right 4: 1.010110000 becomes 10101.10000
- $-16 + 4 + 1 + 0.5 = -10.5$

(b)

- $38.75 = 100110.11$
- 0.10011011×2^6 : mantissa 0100110110
- exponent 6 = 000110