

$$0.01100 \times 0011$$

$$1.11101 \times 0100$$

$$Q0.5 \times Q3.0$$

$$Q5 \times 3$$

$$0.11000 \times 0010 \quad \checkmark$$

$$1.01000 \times 0001 \quad \checkmark$$

$$1.11101 \times 0001$$

$$= 1.01000 \times 1110$$

$$\begin{array}{r} \cancel{0001} \\ - 0011 \\ \hline 1110 \end{array}$$

(carry)
(no overflow)

$$1.1111 \times 01000 \quad Q5 \times 4$$

$$= 1.00000 \times 00011$$

$$\begin{array}{r} \cancel{01000} \\ - 00101 \\ \hline 00011 \end{array}$$

Justification

$$0.1101 \times 0010$$

$$0.1101 \times 0011$$

Justification is the alignment of two numbers such that the exponents are equal.

Justify on largest exponent.

$$0.0110 \times 0011 \quad (\text{lost LSB})$$

$$0.1101 \times 0011$$

$$1.1101 \times 0001 \quad \leftarrow \text{smallest exponent}$$

$$0.1010 \times 0011 \quad \leftarrow \text{justify to } 0011.$$

$$\underbrace{1.11101000}_{\text{normalised}} \times 1111 \quad (\text{normalised})$$

$$0.1010 \times 0011$$

$$1.1111 \times 0011$$

$$0.1010 \times 0011$$

Justify 0.100×10000 to 10000

$$= 0.000 \times 10000$$

Justification can result in loss of information.

Never lose information with normalisation.

Floating-point addition

$$0.0110 \times 10010 + 1.001 \times 1111$$

Method:

1. Normalise both numbers
2. Justify on max exponent
3. Add Mantissas only.
4. (Normalise again).

$$= 0.1100 \times 10001 + 1.001 \times 1111 \quad (\text{normalise})$$

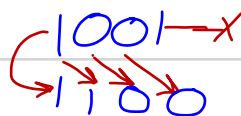
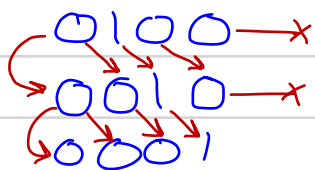
$$= 0.1100 \times 10001 + 1.1100 \times 10001 \quad (\text{justify and match formats})$$

$$\begin{array}{r} 0.1100 \\ + 1.1100 \\ \hline [1] 0.1000 \quad \text{no overflow + carry} \end{array}$$

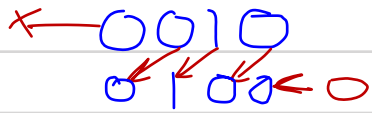
$$= \underline{0.1000 \times 10001} \quad (\text{normalised}).$$

Shifting revision

Arithmetic shift (right)



Arithmetic shift (left)



$$0.11001e0101 - 0.01101e0010$$

$$= 0.11001e0101 - 0.11010e0001$$

$$= 0.11001e0101 -$$
$$0.00001e0101$$

$$= (0.11001 - 0.00001)$$
$$e0101$$

$$= 0.11000e0101$$

$$0.11010$$

$$0.01101$$

$$0.00110$$

$$0.00011$$

$$0.00001$$

1

2

3

4

