

Natural Numbers \mathbb{N}

1, 2, 3, ...

\mathbb{N}_0 : 0, 1, 2, ...

Integer \mathbb{Z}

$$0 + n = n + 0 = n$$

} additive identity

$$1 \cdot n = n \cdot 1 = n$$

} Multiplicative identity

$$n + (-n) = 0$$

} $-n$ is the additive inverse

Missing inverses!

Rational Numbers: \mathbb{Q}

$$\frac{p}{q}, p, q \in \mathbb{Z}$$

Multiplicative inverse:

$$n \cdot \frac{1}{n} = 1$$

e.g. $7 \cdot \frac{1}{7} = 1$ so $\frac{1}{7}$ is the inverse of 7.

Primes and Factors:

$$42 = 2 \cdot 3 \cdot 7$$

$$144 = 2 \cdot 72 = 2 \cdot 2 \cdot 36 = 2 \cdot 2 \cdot 2 \cdot 18 = 2 \cdot 2 \cdot 2 \cdot 2 \cdot 9$$

$$= 2 \cdot 2 \cdot 2 \cdot 2 \cdot 3 \cdot 3 = 2^4 \cdot 3^2$$

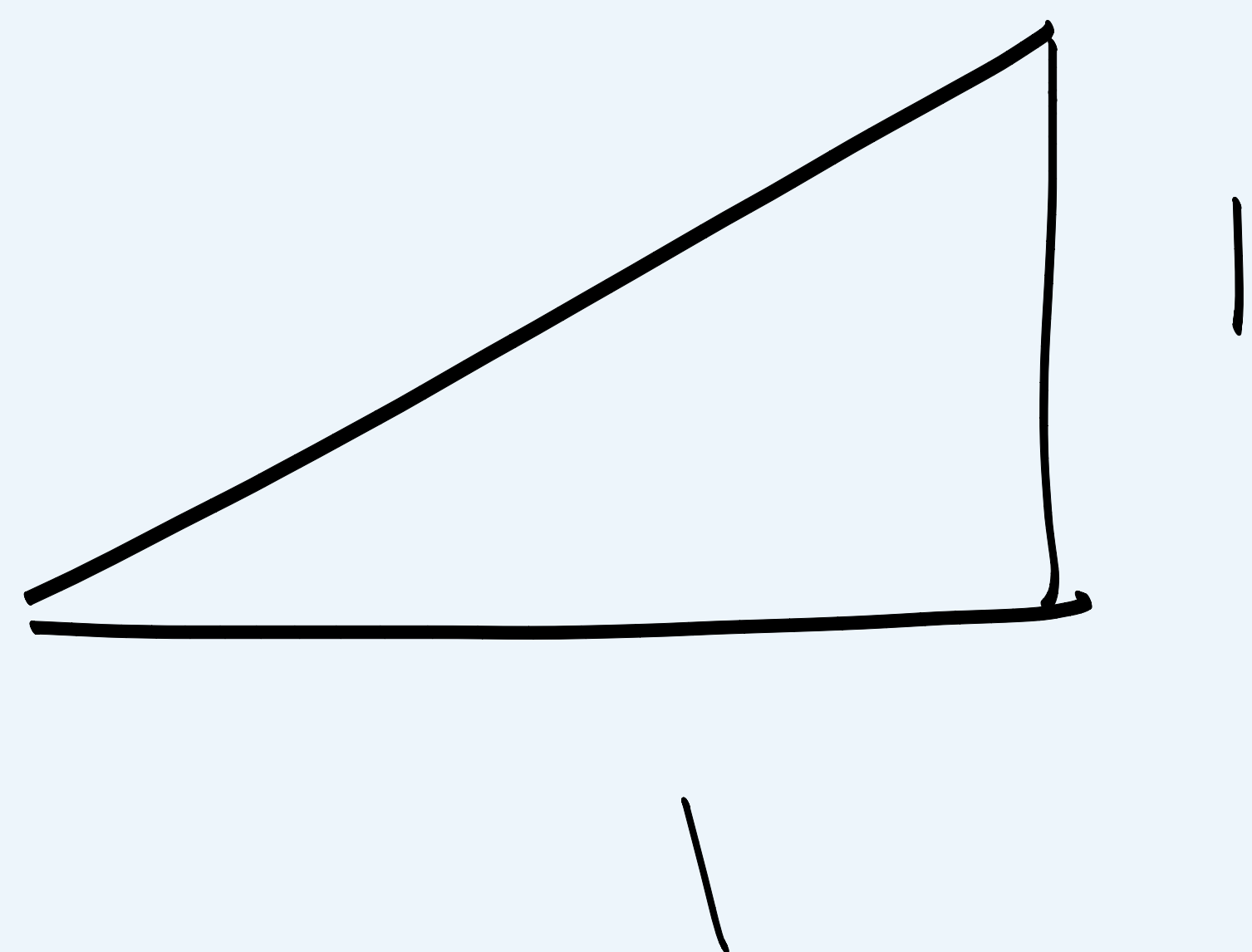
Remainder:

$$9 = 2 \cdot 4 + \underbrace{1}_{\text{The remainder}}$$

$$74 = 2 \cdot 37 + 0$$

$$2 \mid 128, 7 \mid 49, 3 \nmid 4$$

Irrational:



$$a^2 + b^2 = c^2$$

$$1^2 + 1^2 = c^2$$

$$c^2 = 2$$

Real:

$$\mathbb{I} + \mathbb{Q} = \mathbb{R}$$

Number Systems:

Decimal System:

$$\text{Deci} = 10$$

$$\text{Positional System} \left\{ \begin{aligned} 3459 &= \underline{3} \cdot 1000 + \underline{4} \cdot 100 + \underline{5} \cdot 10 + 9 \cdot 1 \\ &= 3 \cdot 10^3 + 4 \cdot 10^2 + 5 \cdot 10^1 + 9 \cdot 10^0 \end{aligned} \right.$$

$$10^{-1} = 0.1 = \frac{1}{10}$$

$$10^{-2} = 0.01 = \frac{1}{10^2} = \frac{1}{100}$$

$$\begin{array}{cccccc} & 1 & 2 & 3 & 4 & 5 & 6 \\ & 1 \cdot 10^2 & + 2 \cdot 10^1 & + 3 \cdot 10^0 & + 4 \cdot 10^{-1} & + 5 \cdot 10^{-2} & + 6 \cdot 10^{-3} \end{array}$$

Systems:

Decimal:

Binary:

Hexadecimal:

Octal:

Allowed

Use

0-9

0, 1

0-9, A-F

0-7

10

2

16

8

$$2^0 = 1$$

$$2^1 = 2$$

$$2^2 = 4$$

$$2^3 = 8$$

$$2^4 = 16$$

$$2^5 = 32$$

$$2^6 = 64$$

$$2^7 = 128$$

$$2^8 = 256$$

$$2^9 = 512$$

$$2^{10} = 1024$$

$$2^{11} = 2048$$

$$2^{12} = 4096$$

Binary:

$$13_{10} = 8 + 4 + 1 = 2^3 + 2^2 + 2^0 = \begin{matrix} 2^3 & 2^2 & 2^1 & 2^0 \\ | & | & 0 & | \end{matrix}$$

$$\underline{1} \cdot 2^3 + \underline{1} \cdot 2^2 + \underline{0} \cdot 2^1 + \underline{1} \cdot 2^0$$

$$114 = 2^6 + 50 = 64 + 32 + 18 = 64 + 32 + 16 + 2$$

$$= 2^6 + 2^5 + 2^4 + 2^1$$

$$\square 2^6 + \square 2^5 + \underline{1} \cdot 2^{\square} + \underline{0} \cdot 2^3 + \underline{0} \cdot 2^2 + \underline{1} \cdot 2^1 + \underline{0} \cdot 2^0$$

1 1 1 0 0 1 0

$$11 + 7 = 18$$

↓

10010

1'0'1'

111

10010

$$11 = 8 + 2 + 1$$

1011

$$7 = 4 + 2 + 1$$

111

1'1'1'
110101

101110

1100011

Multiplication:

$$\begin{array}{r} 107 \times 280 \\ \hline \end{array}$$

Diagram illustrating the multiplication of 107 by 280 using a grid method. The grid is divided into four columns by three vertical lines. The first column contains one circle, the second contains two circles, and the third contains three circles. The fourth column is empty. The circles are arranged in a way that suggests the calculation of the product.

L_1
 \times
 3

$$\begin{array}{r} 100 \\ 11 \\ \hline 100 \\ 1000 \\ \hline 1100 \end{array}$$

1 0 0 1 1 1 0

1 0 1

1 1 0 0 1 1 1 0

1 0 0 1 1 1 0 0 0

1 1 0 0 0 0 1 1 0

Octal:

$$12_8 = 1 \cdot 8^1 + 2 \cdot 8^0 = 10_{10}$$

$$3021_8 = 3 \cdot 8^3 + 0 \cdot 8^2 + 2 \cdot 8^1 + 1 \cdot 8^0 = 1553_{10}$$

3
011

0
000

2
010

1
001

Hex:

A = 10, B = 11 ... F = 15 + 0-9

$$123_{16} = 1 \cdot 16^2 + 2 \cdot 16^1 + 3 \cdot 16^0 = 256 + 32 + 3 = 291_{10}$$

$$A2E = 10 \cdot 16^2 + 2 \cdot 16^1 + 14 \cdot 16^0 =$$

S
0101

E
1110

B
1011

S
0101

2

ex:

$$2000_{10} \stackrel{16}{=} 7 \cdot 16^2 + 208 = \underline{7} \cdot 16^2 + \underline{13} \cdot 16^1 + 0 \cdot 16^0$$
$$(1792) \qquad \qquad \qquad = 7D0_{16}$$

11.35

