Natural Numbers $\mathbb{N}$

$1, 2, 3 \ldots\ldots$

$\mathbb{N}_0 : 0, 1, 2 \ldots\ldots$

Integers : $\mathbb{Z}$

$0 + n = n + 0 = n$ } additive identity

$1 \cdot n = n \cdot 1 = n$ } Multiplicative identity

$n + (-n) = 0$ } $-n$ is the additive inverse

missing invers!

Rational Numbers: $\mathbb{Q}$

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

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:

$42 = 2 \cdot 3 \cdot 7$

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

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

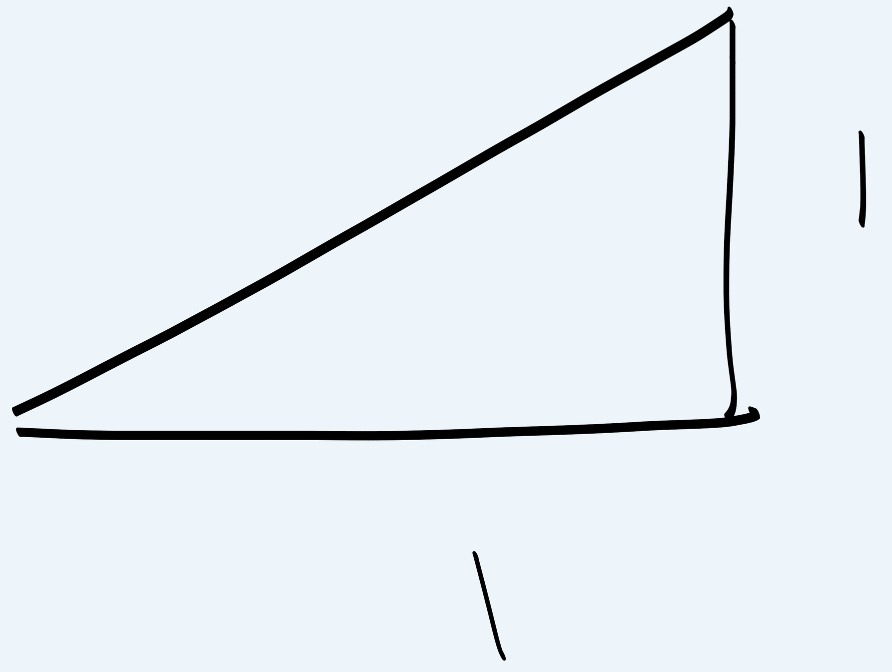
Remainder:

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

$74 = 2 \cdot 37 + 0$

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

Irrational:



$$a^2+b^2=c^2$$
$$1^2+1^2=c^2$$
$$c^2=2$$

Real:

$$I+Q=R$$

Number Systems:

Decimal System:

Deci = 10

Positional System

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

123.456

$1\cdot 10^2 + 2\cdot 10^1 + 3\cdot 10^0 . 4\cdot 10^{-1} + 5\cdot 10^{-2} + 6\cdot 10^{-3}$

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

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

Systems:	Allowed	Base
Decimal:	0-9	10
Binary:	0, 1	2
Hexadecimal:	0-9, A-F	16
Octal:	0-7	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:

$$\begin{array}{cccc} 2^3 & 2^2 & 2^1 & 2^0 \end{array}$$

$$13_{10} = 8+5 = 8+4+1 = 2^3 + 2^2 + 2^0 = 1101$$

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

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

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

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

1 1 1 0 0 1 0

$11 + 7 = 18$

$$\downarrow$$

10010

$$\begin{array}{r} {\scriptstyle 1\,1\,1} \\ 1011 \\ 111 \\ \hline 10010 \end{array}$$

$11 = 8 + 2 + 1$

1011

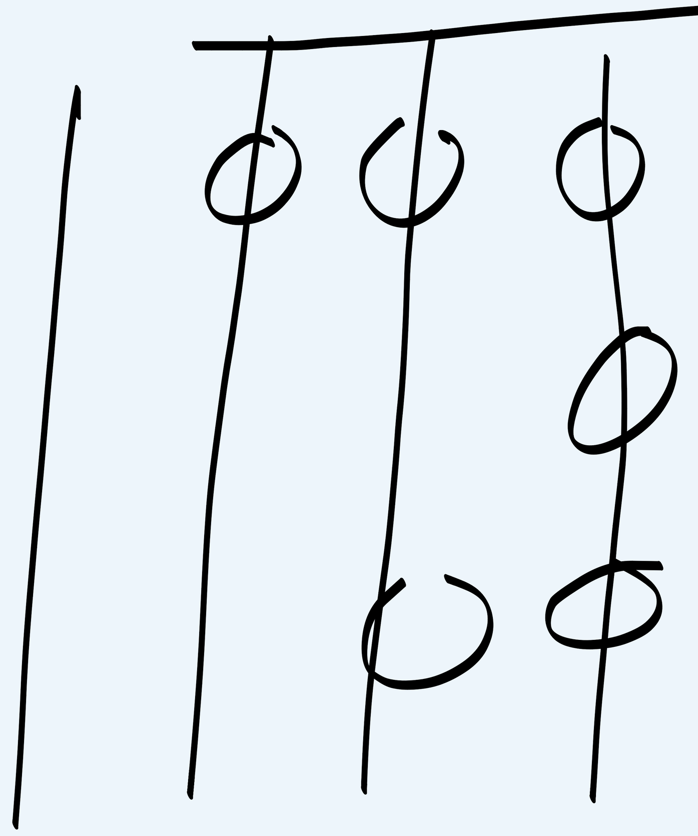
$7 = 4 + 2 + 1$

111

$$\begin{array}{r} {\scriptstyle 1\;1\;1} \\ 110101 \\ 101110 \\ \hline 1100011 \end{array}$$

Multiplication:

107×280



4

$\times$

3

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

$$
\begin{array}{r}
1001110 \\
\times \quad 101 \\
\hline
1001110 \\
100111000 \\
\hline
110000110 \\
\hline\hline
\end{array}
$$

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	0	2	1
011	000	010	001

Hex:

$A = 10, B = 11 \ldots\ldots F = 15 \quad + 0-9$

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

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

5 E B 5 2

0101 1110 1011 0101

ex:

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

$$= 7D0_{16}$$

$$\boxed{11.35}$$