

Numbers:

Complex numbers: $Z = R + iI$, R and I are Real numbers and: $i = \sqrt{-1}$

" R " is the real part and " iI " is the imaginary part. Ex.: $Z = 2 - i3$

1. **Real numbers "R"**: all numbers including "Rational" and "Irrational" numbers as follows.

Rational numbers "Q" is defined as the ratio of $(\frac{m}{n})$, m and n are Integers but $n \neq 0$. $Q \in R$

The ratio can be summarized in one of the following cases:

Examples: $\frac{-12}{4} = -3$, an integer.

$\frac{19}{8} = 2.375$, an ending decimal.

$\frac{7}{3} = 2.33333 \dots = 2.\overline{3}$, a repeating decimal.

Note: A rational number cannot be an endless decimals, but due to limitation of number of digits in calculators sometimes the end or repeating digits cannot be seen:

$\frac{17}{13} = 1.30769230769$ or $\frac{19}{23} = 0.82608695652$

Natural numbers "N", are whole numbers used for counting: $\{0, 1, 2, 3, 4, 5, \dots\}$. $N \in Z \in Q \in R$

Note: This set, in some books is called Whole numbers " W ", and they exclude 0 from natural numbers.

Integers "Z": are positive and negative natural numbers, $Z = + / - \{N\}$. $Z \in Q \in R$

Irrational numbers " \overline{Q} ": or Q' : are endless decimals, it happen in the case of "not perfect root". $\overline{Q} \in R$

Ex.: $\sqrt{5}$, $\sqrt[3]{4}$, this set also includes " π " = 3.14159265359 and " e " = 2.71828182846 (natural logarithm base). π and e are **Transcendental** numbers, they are not the solution of an algebraic equation like;

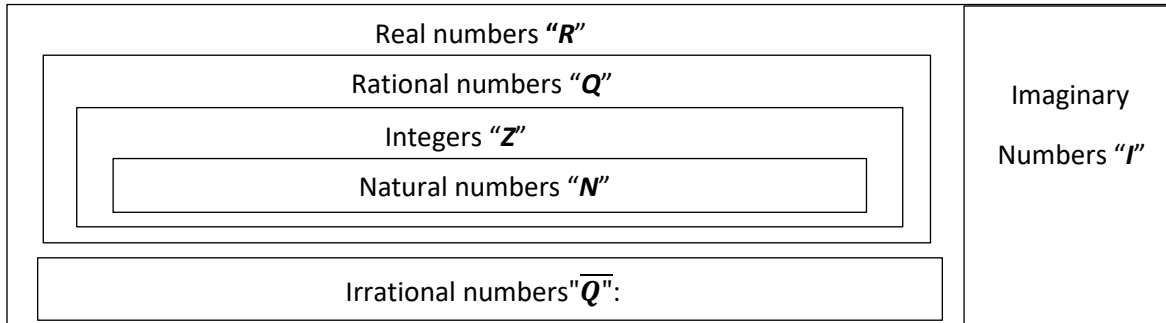
$$x^2 - 5 = 0 \quad \text{then: } x = \mp\sqrt{5}$$

Numbers are summarized in the following diagram:

Continue in page 2.

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Complex numbers



2. Imaginary numbers: are the square root of a negative number which will be treated with 2 separate factors: $\sqrt{-1}$ represented by "i" and a real number "r"

Ex.:
$$z = 3 + \sqrt{-2} = 3 + i\sqrt{2}$$

Notes:
$$i = \sqrt{-1}$$

$$i^2 = -1$$

$$i^3 = -1i = -i$$

$$i^4 = +1$$

Prime Numbers:

Are natural numbers which are only divisible by 1, and themselves, means their only factors are 1 and themselves. 0, 1 are not a prime number.

Ex. {2, 3, 5, 7, 11, 13, 17, 19, 23, 29, 31, 37, 41, 43, 47, 53, 59, 61, 67, 71, 73, 79, 83, 89, 91, 97, ... }

Exponential Rules:

$$u^{-m} = \frac{1}{u^m} \quad \& \quad u^{\frac{m}{n}} = \sqrt[n]{u^m}$$

$$u^m \cdot u^n = u^{m+n} \quad \& \quad \frac{u^m}{u^n} = u^{m-n}$$

$$(u^m)^n = u^{m \cdot n}$$

$$u^m \cdot v^m = (u \cdot v)^m$$