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Quadratic Equation: Meaning of a Quadratic Equation, Sum and Product of Roots of a Quadratic Equation (For CBSE, ICSE, IAS, NET, NRA 2022)

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Quadratic Equation

- A quadratic equation can be defined as the polynomial equation with two as the highest degree.
- Quadratic equation may also be called as univariate since the quadratic include only one unknown term or variable.
- There will be solutions for the equation since quadratics have a degree equal to two.

This equation can be expressed in the form of

$$ax^2 + bx + c \dots (i)$$

Here x is the unknown variable and a, b and c are the constant terms.

The roots of the equation in (i) will be:

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$\Rightarrow x = \frac{-b}{2a} \pm \sqrt{\frac{b^2 - 4ac}{2a}} \dots (ii)$$

There will be two solutions for x and the same is being indicated by the plus/minus signs.

$b^2 - 4ac$ is the discriminant of the equation $ax^2 + bx + c = 0$ and the same can be denoted by D or Δ

Using (ii) We have,

$$x = \frac{-b}{2a} \pm \sqrt{\frac{D}{2a}}$$

If α and β represent the roots of the above equation, then the relationship between the roots of quadratic equation and the coefficients a, b and c can be represented as:

Sum of roots $\alpha + \beta = \frac{-b}{a}$ and Product of roots $\alpha\beta = \frac{c}{a}$

Proof of Quadratic Equation

$$ax^2 + bx + c = 0 \rightarrow (i)$$

$$\Rightarrow ax^2 + bx = -c \rightarrow (ii)$$

$$\Rightarrow x^2 + \frac{b}{a}x = -\frac{c}{a} \rightarrow (iii)$$

$$\Rightarrow x^2 + \frac{b}{a}x + \frac{b^2}{4a^2} = \frac{b^2}{4a^2} - \frac{c}{a} \rightarrow (iv)$$

$$\Rightarrow \left(x + \frac{b}{2a}\right)^2 = \frac{b^2}{4a^2} - \frac{c}{a} \rightarrow (v)$$

$$\Rightarrow \left(x + \frac{b}{2a}\right)^2 = \frac{b^2}{4a^2} - \frac{4ac}{4a^2} \rightarrow (vi)$$

$$\Rightarrow \left(x + \frac{b}{2a}\right)^2 = \frac{b^2 - 4ac}{4a^2} \rightarrow (vii)$$

On squaring both sides, we get

$$\left(x + \frac{b}{2a}\right) = \sqrt{\frac{b^2 - 4ac}{4a^2}} \rightarrow (viii)$$

$$\Rightarrow x = -\frac{b}{2a} \pm \sqrt{\frac{b^2 - 4ac}{4a^2}} \rightarrow (ix)$$

$$\Rightarrow x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} \rightarrow (x)$$

Applications of Quadratic Equation

- For solving problems related in finding out area of rectangle, parallelogram and so on.
- It is also useful in solving word problems involving Distance, speed, and time, etc.

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