

## Solution of quadratic equation by formula method

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Consider a quadratic equation  $ax^2 + bx + c = 0$   $a \neq 0$  We rewrite the given equation as

$$x^2 + \frac{b}{a}x + \frac{c}{a} = 0$$

$$\Rightarrow x^2 + 2\left(\frac{b}{2a}\right)x + \frac{c}{a} = 0 \qquad \Rightarrow x^2 + 2\left(\frac{b}{2a}\right)x = -\frac{c}{a}$$

$$\text{Adding } \left(\frac{b}{2a}\right)^2 = \frac{b^2}{4a^2} \text{ both sides we get, } x^2 + 2\left(\frac{b}{2a}\right)x + \left(\frac{b}{2a}\right)^2 = \frac{b^2}{4a^2} - \frac{c}{a}$$

$$\text{That is, } \left(x + \frac{b}{2a}\right)^2 = \frac{b^2 - 4ac}{4a^2}$$

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

$$\text{So, we have } x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} \qquad (1)$$

$$\text{The solution set is } \left\{ \frac{-b + \sqrt{b^2 - 4ac}}{2a}, \frac{-b - \sqrt{b^2 - 4ac}}{2a} \right\}.$$

The formula given in equation (1) is known as **quadratic formula**.

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### Problem

Solve the equation  $\frac{1}{x+1} + \frac{2}{x+2} = \frac{4}{x+4}$ , where  $x+1 \neq 0$ ,  $x+2 \neq 0$ ,  $x+4 \neq 0$  using quadratic formula.

**Solution** Note that the given equation is not a quadratic equation.

Consider  $\frac{1}{x+1} + \frac{2}{x+2} = \frac{4}{x+4}$

That is,  $\frac{1}{x+1} = 2\left[\frac{2}{x+4} - \frac{1}{x+2}\right] = 2\left[\frac{2x+4-x-4}{(x+4)(x+2)}\right]$

$$\frac{1}{x+1} = 2\left[\frac{x}{(x+2)(x+4)}\right]$$

$$x^2 + 6x + 8 = 2x^2 + 2x$$

Thus, we have  $x^2 - 4x - 8 = 0$ , which is a quadratic equation.

(The above equation can also be obtained by taking LCM)

Using the quadratic formula (1) we get,

$$x = \frac{4 \pm \sqrt{16 - 4(1)(-8)}}{2(1)} = \frac{4 \pm \sqrt{48}}{2}$$

Thus,  $x = 2 + 2\sqrt{3}$  or  $2 - 2\sqrt{3}$

Hence, the solution set is  $\{2 - 2\sqrt{3}, 2 + 2\sqrt{3}\}$

Solve the following quadratic equations by completing the square .

(i)  $x^2 + 6x - 7 = 0$

(ii)  $x^2 + 3x + 1 = 0$

(iii)  $2x^2 + 5x - 3 = 0$

(iv)  $4x^2 + 4bx - (a^2 - b^2) = 0$

(v)  $x^2 - (\sqrt{3} + 1)x + \sqrt{3} = 0$

(vi)  $\frac{5x+7}{x-1} = 3x+2$

Solve the following quadratic equations using quadratic formula.

(i)  $x^2 - 7x + 12 = 0$

(ii)  $15x^2 - 11x + 2 = 0$

(iii)  $x + \frac{1}{x} = 2\frac{1}{2}$

(iv)  $3a^2x^2 - abx - 2b^2 = 0$

(v)  $a(x^2 + 1) = x(a^2 + 1)$

(vi)  $36x^2 - 12ax + (a^2 - b^2) = 0$

(vii)  $\frac{x-1}{x+1} + \frac{x-3}{x-4} = \frac{10}{3}$

(viii)  $a^2x^2 + (a^2 - b^2)x - b^2 = 0$

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**Solve some simple problems expressed in words and some problems describing day-to-day life situations involving quadratic equation.**

1. The sum of a number and its reciprocal is  $\frac{65}{8}$  . Find the number.
2. The difference of the squares of two positive numbers is 45. The square of the smaller number is four times the larger number. Find the numbers.
3. A farmer wishes to start a 100 sq.m rectangular vegetable garden. Since he has only 30 m barbed wire, he fences the sides of the rectangular garden letting his house compound wall act as the fourth side fence. Find the dimension of the garden.
4. A rectangular field is 20 m long and 14 m wide. There is a path of equal width all around it having an area of 111 sq. metres. Find the width of the path on the outside.
5. A train covers a distance of 90 km at a uniform speed. Had the speed been 15 km/hr more, it would have taken 30 minutes less for the journey. Find the original speed of the train.

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