

2

Quadratic Equations

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**Points to Remember:**

- Standard form of the quadratic equation:**

The equation $ax^2 + bx + c = 0$, where a, b, c are real numbers and $a \neq 0$ is called **quadratic equation** in variable x .

The equation $ax^2 + bx + c = 0$ is called standard form of quadratic equation.

The highest index of variable is 2. So, it is a second degree equation in one variable.

Activity:

Complete the following table:

Quadratic equation	Standard form	a	b	c
$x^2 - 4 = 0$	$x^2 + 0x - 4 = 0$	1	0	-4
$y^2 = 2y - 7$	$y^2 - 2y + 7 = 0$	1	-2	7
$x^2 + 2x = 0$	$x^2 + 2x + 0 = 0$	1	2	0

- Which of the following are quadratic equations?** (Textbook page no. 31)

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

Solution:

$$3x^2 - 5x + 3 = 0$$

Here x is the only variable and maximum index of variable x is 2.

∴ It is a quadratic equation.

(ii) $9y^2 + 5 = 0$

Solution:

$$9y^2 + 5 = 0$$

Here y is the only variable and maximum index of variable y is 2.

∴ It is a quadratic equation.

(iii) $m^3 - 5m^2 + 4 = 0$

Solution:

$$m^3 - 5m^2 + 4 = 0$$

Here, m is the only variable but maximum index of variable m is not 2.

∴ It is not a quadratic equation.

(iv) $(l + 2)(l - 5) = 0$

Solution:

$$(l + 2)(l - 5) = 0$$

$$\therefore l(l - 5) + 2(l - 5) = 0$$

$$\therefore l^2 - 5l + 2l - 10 = 0$$

$$\therefore l^2 - 3l - 10 = 0$$

Here, l is the only variable and maximum index of variable l is 2.

∴ It is a quadratic equation.

MASTER KEY QUESTION SET - 2**Practice Set - 2.1 (Textbook Page No. 34)**

- (1) Write any two quadratic equations. (1 mark)**

Solution:

$x^2 + 3x + 4 = 0$ and $2x^2 - 5x + 7 = 0$ are quadratic equations in variable x .

- (2) Decide which of the following are quadratic equations.**

- (i) $x^2 + 5x - 2 = 0$ (1 mark)**

Solution:

$$x^2 + 5x - 2 = 0$$

Here, x is the only variable and maximum index of variable x is 2.

∴ **It is a quadratic equation in variable x .**

- (ii) $y^2 = 5y - 10$ (1 mark)**

Solution:

$$y^2 = 5y - 10$$

$$∴ y^2 - 5y + 10 = 0$$

Here, y is the only variable and maximum index of variable y is 2.

∴ **It is a quadratic equation in variable y .**

- (iii) $y^2 + \frac{1}{y} = 2$ (1 mark)**

Solution:

$$y^2 + \frac{1}{y} = 2$$

Multiplying both sides by y we get,

$$y^3 + 1 = 2y$$

$$\text{i.e. } y^3 - 2y + 1 = 0$$

Here maximum index of the variable y is 3 and not 2

∴ **It is not a quadratic equation.**

- (iv) $x + \frac{1}{x} = -2$ (1 mark)**

Solution:

$$x + \frac{1}{x} = -2$$

Multiplying both sides by x we get,

$$x^2 + 1 = -2x$$

$$\text{i.e. } x^2 + 2x + 1 = 0$$

Here, x is the only variable and maximum index of variable x is 2.

∴ **It is a quadratic equation in variable x .**

- (v) $(m + 2)(m - 5) = 0$ (1 mark)**

Solution:

$$(m + 2)(m - 5) = 0$$

$$∴ m(m - 5) + 2(m - 5) = 0$$

$$∴ m^2 - 5m + 2m - 10 = 0$$

$$∴ m^2 - 3m - 10 = 0$$

Here, m is the only variable and maximum index of variable m is 2.

∴ **It is a quadratic equation in variable m .**

- (vi) $m^3 + 3m^2 - 2 = 3m^3$ (1 mark)**

Solution:

$$m^3 + 3m^2 - 2 = 3m^3$$

$$∴ 3m^3 - m^3 - 3m^2 + 2 = 0$$

$$∴ 2m^3 - 3m^2 + 2 = 0$$

Here, maximum index of the variable m is 3 and not 2

∴ **It is not a quadratic equation in variable m .**

Problem Set - 2 (Textbook Page No. 54)

- (2) Which of the following are quadratic equations?**

- (i) $x^2 + 2x + 11 = 0$ (1 mark)**

Solution:

$$x^2 + 2x + 11 = 0$$

Here, x is the only variable and maximum index of variable x is 2.

∴ **It is a quadratic equation in variable x .**

- (ii) $x^2 - 2x + 5 = x^2$ (1 mark)**

Solution:

$$x^2 - 2x + 5 = x^2$$

$$∴ x^2 - x^2 - 2x + 5 = 0$$

$$∴ -2x + 5 = 0$$

Here, maximum index of variable x is 1 and not 2.

∴ **It is not a quadratic equation.**

- (iii) $(x + 2)^2 = 2x^2$ (1 mark)**

Solution:

$$(x + 2)^2 = 2x^2 \quad [\text{Using } (a + b)^2 = a^2 + 2ab + b^2]$$

$$∴ x^2 + 4x + 4 = 2x^2$$

$$∴ 2x^2 - x^2 - 4x - 4 = 0$$

$$∴ x^2 - 4x - 4 = 0$$

Here, x is the only variable and maximum index of variable x is 2.

∴ **It is a quadratic equation in variable x .**

Practice Set - 2.1 (Textbook Page No. 34)

- (3) Write the following equations in the form of $ax^2 + bx + c = 0$, then write the values of a, b, c for each equation.**

- (i) $2y = 10 - y^2$ (1 mark)**

Solution:

$$2y = 10 - y^2$$

$$\therefore y^2 + 2y - 10 = 0$$

Comparing with $ay^2 + by + c = 0$ we get,

$$a = 1, b = 2, c = -10$$

(ii) $(x - 1)^2 = 2x + 3$ (1 mark)

Solution:

$$(x - 1)^2 = 2x + 3$$

$$\therefore x^2 - 2x + 1 = 2x + 3 \dots [\text{Using } (a - b)^2 = a^2 - 2ab + b^2]$$

$$\therefore x^2 - 2x - 2x + 1 - 3 = 0$$

$$\therefore x^2 - 4x - 2 = 0$$

Comparing with $ax^2 + bx + c = 0$ we get,

$$a = 1, b = -4, c = -2$$

(iii) $x^2 + 5x = -(3 - x)$ (1 mark)

Solution:

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

$$\therefore x^2 + 5x = -3 + x$$

$$\therefore x^2 + 5x - x + 3 = 0$$

$$\therefore x^2 + 4x + 3 = 0$$

Comparing with $ax^2 + bx + c = 0$ we get,

$$a = 1, b = 4, c = 3$$

(iv) $3m^2 = 2m^2 - 9$ (1 mark)

Solution:

$$3m^2 = 2m^2 - 9$$

$$\therefore 3m^2 - 2m^2 + 9 = 0$$

$$\therefore m^2 + 9 = 0$$

$$\therefore m^2 + 0m + 9 = 0$$

Comparing with $am^2 + bm + c = 0$ we get,

$$a = 1, b = 0, c = 9$$

(v) $p(3 + 6p) = -5$ (1 mark)

Solution:

$$p(3 + 6p) = -5$$

$$\therefore 3p + 6p^2 = -5$$

$$\therefore 6p^2 + 3p + 5 = 0$$

Comparing with $ap^2 + bp + c = 0$ we get,

$$a = 6, b = 3, c = 5$$

(vi) $x^2 - 9 = 13$ (1 mark)

Solution:

$$x^2 - 9 = 13$$

$$\therefore x^2 - 9 - 13 = 0$$

$$\therefore x^2 - 22 = 0$$

$$\therefore x^2 + 0x - 22 = 0$$

Comparing with $ax^2 + bx + c = 0$ we get,

$$a = 1, b = 0, c = -22$$

equation [or the value for which both the sides of equation are equal] are called solutions or the **roots of the equations.**

• Determine whether

(i) $x = \frac{3}{2}$ and

(ii) $x = -2$ are the roots of the quadratic equation $2x^2 - 7x + 6 = 0$

Solution:

(i) By substituting $x = \frac{3}{2}$ in LHS we get,

$$\text{LHS} = 2\left(\frac{3}{2}\right)^2 - 7\left(\frac{3}{2}\right) + 6$$

$$= 2 \times \frac{9}{4} - \frac{21}{2} + 6$$

$$= \frac{9}{2} - \frac{21}{2} + 6$$

$$= \frac{-12}{2} + 6$$

$$= -6 + 6$$

$$= 0$$

$$\therefore \text{LHS} = \text{RHS}$$

$\therefore$ The given equation is satisfied.

$\therefore x = \frac{3}{2}$ is the root of the given quadratic equation.

(ii) By substituting $x = -2$ in LHS, we get,

$$\text{LHS} = 2(-2)^2 - 7(-2) + 6$$

$$= 2 \times 4 + 14 + 6$$

$$= 8 + 20$$

$$= 28$$

$$\therefore \text{LHS} \neq \text{RHS}$$

$\therefore x = -2$ is not the root of the given quadratic equation.

Activity:

(Textbook page no. 33)

If $x = 5$ is a root of the quadratic equation $kx^2 - 14x - 5 = 0$, then find the value of k by completing the following activities.

Solution:

One of the roots of equation $kx^2 - 14x - 5 = 0$ is $\boxed{5}$

Substituting $x = \boxed{5}$ in given equation.

$$\therefore k\boxed{5}^2 - 14\boxed{5} - 5 = 0.$$

$$\therefore 25k - 70 - 5 = 0.$$

$$\therefore 25k - \boxed{75} = 0.$$

$$\therefore 25k = \boxed{75}.$$

$$\therefore k = \frac{\boxed{75}}{\boxed{25}} = 3.$$



Points to Remember:

Roots of a quadratic equation:

The values of the variable which satisfy the

Practice Set - 2.1 (Textbook Page No. 34)

- (4) Determine whether the values given against each of the quadratic equation are the roots of the equation.

(i) $x^2 + 4x - 5 = 0$, $x = 1, -1$ (2 marks)

Solution:

$$x^2 + 4x - 5 = 0$$

- (a) By substituting $x = 1$ in L.H.S., we get,

$$\begin{aligned} \text{LHS} &= (1)^2 + 4(1) - 5 \\ &= 1 + 4 - 5 \\ &= 5 - 5 \\ &= 0 \end{aligned}$$

$$\therefore \text{LHS} = \text{RHS}$$

$\therefore$ The given equation is satisfied.

$\therefore$ $x = 1$ is the root of the given quadratic equation.

- (b) By substituting $x = -1$ in L.H.S., we get,

$$\begin{aligned} \text{LHS} &= (-1)^2 + 4(-1) - 5 \\ &= 1 - 4 - 5 \\ &= -8 \end{aligned}$$

$$\therefore \text{LHS} \neq \text{RHS}$$

$\therefore$ $x = -1$ is not the root of the given quadratic equation.

(ii) $2m^2 - 5m = 0$, $m = 2, \frac{5}{2}$ (2 marks)

Solution:

$$2m^2 - 5m = 0$$

- (a) By substituting $m = 2$ in L.H.S., we get,

$$\begin{aligned} \text{LHS} &= 2(2)^2 - 5(2) \\ &= 2 \times 4 - 10 \\ &= 8 - 10 \\ &= -2 \end{aligned}$$

$$\therefore \text{LHS} \neq \text{RHS}$$

$\therefore$ $m = 2$ is not the root of the given quadratic equation.

- (b) By substituting $m = \frac{5}{2}$ in L.H.S. we get,

$$\begin{aligned} \text{LHS} &= 2\left(\frac{5}{2}\right)^2 - 5\left(\frac{5}{2}\right) \\ &= 2 \times \frac{25}{4} - \frac{25}{2} \\ &= \frac{25}{2} - \frac{25}{2} \\ &= 0 \end{aligned}$$

$$\therefore \text{LHS} = \text{RHS}$$

$\therefore$ The given equation is satisfied.

$\therefore$ $m = \frac{5}{2}$ is the root of the given quadratic equation.

- (5) Find k if $x = 3$ is a root of equation $kx^2 - 10x + 3 = 0$. (2 marks)

Solution:

$x = 3$ is one of the roots of the given quadratic equation.

$\therefore$ It satisfies the given equation.

Substituting $x = 3$ in given quadratic equation.

$$\therefore k(3)^2 - 10(3) + 3 = 0.$$

$$\therefore 9k - 30 + 3 = 0.$$

$$\therefore 9k - 27 = 0.$$

$$\therefore 9k = 27.$$

$$\therefore k = \frac{27}{9}.$$

$$\therefore k = 3.$$

- (6) One of the roots of equation $5m^2 + 2m + k = 0$ is $-\frac{7}{5}$. Complete the following activity to find the value of ' k '. (2 marks)

Solution:

$-\frac{7}{5}$ is the root of the equation $5m^2 + 2m + k = 0$

$\therefore$ Put $m = -\frac{7}{5}$ in the equation,

$$\therefore 5 \times \left(-\frac{7}{5}\right)^2 + 2 \times \left(-\frac{7}{5}\right) + k = 0$$

$$\therefore \frac{49}{5} + \left(-\frac{14}{5}\right) + k = 0$$

$$\therefore 7 + k = 0$$

$$\therefore k = -7$$

Problem Set - 2 (Textbook Page No. 54)

- (4) One of the roots of quadratic equation $2x^2 + kx - 2 = 0$ is -2 , find k . (2 marks)

Solution:

$x = -2$ is the root of the given quadratic equation.

$\therefore$ It satisfies the given equation.

Substituting $x = -2$ in given equation,

$$\therefore 2(-2)^2 + k(-2) - 2 = 0$$

$$\therefore 2 \times 4 - 2k - 2 = 0$$

$$\therefore 8 - 2k - 2 = 0$$

$$\therefore 6 - 2k = 0$$

$$\therefore 2k = 6$$

$$\therefore k = \frac{6}{2}$$

$$\therefore k = 3.$$



Points to Remember:

Methods for solving quadratic equations:

- (i) Factorisation method
- (ii) Completing square method
- (iii) Formula method

(I) Solution of a quadratic equation by factorisation:

- If the product of two numbers is zero, then at least one of them must be zero, i.e. If $a \times b = 0$, then either $a = 0$ or $b = 0$
- To solve a quadratic equation by factorisation, first write the equation in the form of $ax^2 + bx + c = 0$, then find the factors of it.

If $(px + q)$ and $(rx + t)$ are the factors of $ax^2 + bx + c$, then the given quadratic equation will be

$$(px + q)(rx + t) = 0$$

$$\therefore px + q = 0 \text{ or } rx + t = 0$$

$$\therefore x = \frac{-q}{p} \text{ or } x = \frac{-t}{r}$$

$\therefore$ The roots of given quadratic equation are $\frac{-q}{p}$ and $\frac{-t}{r}$

Practice Set - 2.2 (Textbook Page No. 36)

- (1) Solve the following quadratic equations by factorization.

(i) $x^2 - 15x + 54 = 0$

(2 marks)

Solution:

$$x^2 - 15x + 54 = 0$$

$$\therefore x^2 - 9x - 6x + 54 = 0$$

$$\therefore x(x - 9) - 6(x - 9) = 0$$

$$\therefore (x - 9)(x - 6) = 0$$

$$\therefore x - 9 = 0 \text{ or } x - 6 = 0$$

$$\therefore x = 9 \text{ or } x = 6$$

$\therefore$ The roots of given quadratic equation are 9 and 6.

(ii) $x^2 + x - 20 = 0$

(2 marks)

Solution:

$$x^2 + x - 20 = 0$$

$$\therefore x^2 + 5x - 4x - 20 = 0$$

$$\therefore x(x + 5) - 4(x + 5) = 0$$

$$\therefore (x + 5)(x - 4) = 0$$

$$\therefore x + 5 = 0 \text{ or } x - 4 = 0$$

$$\therefore x = -5 \text{ or } x = 4$$

$\therefore$ The roots of given quadratic equation are -5 and 4.

(iii) $2y^2 + 27y + 13 = 0$

(2 marks)

Solution:

$$2y^2 + 27y + 13 = 0$$

$$\therefore 2y^2 + 26y + y + 13 = 0$$

$$\therefore 2y(y + 13) + 1(y + 13) = 0$$

$$\therefore (y + 13)(2y + 1) = 0$$

$$\therefore y + 13 = 0 \text{ or } 2y + 1 = 0$$

$$\therefore y = -13 \text{ or } 2y = -1$$

$$\therefore y = -13 \text{ or } y = \frac{-1}{2}$$

$\therefore$ The roots of given quadratic equation are -13 and $\frac{-1}{2}$.

(iv) $5m^2 = 22m + 15$

(2 marks)

Solution:

$$5m^2 = 22m + 15$$

$$\therefore 5m^2 - 22m - 15 = 0$$

$$\therefore 5m^2 - 25m + 3m - 15 = 0$$

$$\therefore 5m(m - 5) + 3(m - 5) = 0$$

$$\therefore (m - 5)(5m + 3) = 0$$

$$\therefore m - 5 = 0 \text{ or } 5m + 3 = 0$$

$$\therefore m = 5 \text{ or } 5m = -3$$

$$\therefore m = 5 \text{ or } m = \frac{-3}{5}$$

$\therefore$ The roots of given quadratic equation are 5 and $\frac{-3}{5}$.

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

(3 marks)

Solution:

$$2x^2 - 2x + \frac{1}{2} = 0$$

Multiplying throughout by 2, we get

$$4x^2 - 4x + 1 = 0$$

$$\therefore 4x^2 - 2x - 2x + 1 = 0$$

$$\therefore 2x(2x - 1) - 1(2x - 1) = 0$$

$$\therefore (2x - 1)(2x - 1) = 0$$

$$\therefore 2x - 1 = 0 \text{ or } 2x - 1 = 0$$

$$\therefore 2x = 1 \text{ or } 2x = 1$$

$$\therefore x = \frac{1}{2} \text{ or } x = \frac{1}{2}$$

$\therefore$ The root of given quadratic equation are $\frac{1}{2}$ and $\frac{1}{2}$.

(vi) $6x - \frac{2}{x} = 1$

(2 marks)

Solution:

$$6x - \frac{2}{x} = 1$$

Multiplying both the sides by x , we get

$$6x^2 - 2 = x$$

$$\therefore 6x^2 - x - 2 = 0$$

$$\therefore 6x^2 - 4x + 3x - 2 = 0$$

$$\therefore 2x(3x - 2) + 1(3x - 2) = 0$$

$$\therefore (3x - 2)(2x + 1) = 0$$

$$\therefore 3x - 2 = 0 \text{ or } 2x + 1 = 0$$

$$\therefore 3x = 2 \quad \text{or } 2x = -1$$

$$\therefore x = \frac{2}{3} \quad \text{or } x = -\frac{1}{2}$$

$\therefore$ The roots of the given quadratic equation are $\frac{2}{3}$ and $-\frac{1}{2}$.

- (vii) $\sqrt{2}x^2 + 7x + 5\sqrt{2} = 0$ to solve this quadratic equation by factorisation, complete the following activity. (3 marks)

Solution:

$$\sqrt{2}x^2 + 7x + 5\sqrt{2} = 0$$

$$\therefore \sqrt{2}x^2 + 5x + 2x + 5\sqrt{2} = 0$$

$$\therefore x(\sqrt{2}x + 5) + \sqrt{2}(\sqrt{2}x + 5) = 0$$

$$\therefore (\sqrt{2}x + 5)(x + \sqrt{2}) = 0$$

$$\therefore \sqrt{2}x + 5 = 0 \text{ or } x + \sqrt{2} = 0$$

$$\therefore x = -\frac{5}{\sqrt{2}} \quad \text{or } x = -\sqrt{2}$$

$\therefore -\frac{5}{\sqrt{2}}$ and $-\sqrt{2}$ are roots of the equation.

- *(viii) $3x^2 - 2\sqrt{6}x + 2 = 0$ (3 marks)

Solution:

$$3x^2 - 2\sqrt{6}x + 2 = 0$$

$$\therefore 3x^2 - \sqrt{6}x - \sqrt{6}x + 2 = 0$$

$$\therefore \sqrt{3}x(\sqrt{3}x - \sqrt{2}) - \sqrt{2}(\sqrt{3}x - \sqrt{2}) = 0$$

$$\therefore (\sqrt{3}x - \sqrt{2})(\sqrt{3}x - \sqrt{2}) = 0$$

$$\therefore \sqrt{3}x - \sqrt{2} = 0 \text{ or } \sqrt{3}x - \sqrt{2} = 0$$

$$\therefore x = \frac{\sqrt{2}}{\sqrt{3}} \quad \text{or } x = \frac{\sqrt{2}}{\sqrt{3}}$$

$\therefore$ The root of given quadratic equation are $\frac{\sqrt{2}}{\sqrt{3}}$ and $\frac{\sqrt{2}}{\sqrt{3}}$.

- (ix) $2m(m - 24) = 50$ (3 marks)

Solution:

$$2m(m - 24) = 50$$

$$\therefore 2m^2 - 48m = 50$$

$$\therefore 2m^2 - 48m - 50 = 0$$

$$\therefore m^2 - 24m - 25 = 0 \quad \dots (\text{Dividing both sides by 2})$$

$$\therefore m^2 - 25m + m - 25 = 0$$

$$\therefore m(m - 25) + 1(m - 25) = 0$$

$$\therefore (m - 25)(m + 1) = 0$$

$$\therefore m - 25 = 0 \text{ or } m + 1 = 0$$

$$\therefore m = 25 \quad \text{or } m = -1$$

$\therefore$ The roots of given quadratic equation are 25 and -1.

- (x) $25m^2 = 9$ (2 marks)

Solution:

$$25m^2 = 9$$

$$\therefore 25m^2 - 9 = 0$$

$$\therefore (5m)^2 - (3)^2 = 0$$

$$\therefore (5m + 3)(5m - 3) = 0 \quad \dots [\because a^2 - b^2 = (a + b)(a - b)]$$

$$\therefore 5m = -3 \text{ or } 5m = 3$$

$$\therefore m = -\frac{3}{5} \text{ or } m = \frac{3}{5}$$

$\therefore$ The roots of given quadratic equation are $\frac{3}{5}$ and $-\frac{3}{5}$.

- (xii) $m^2 - 11 = 0$ (2 marks)

Solution:

$$m^2 - 11 = 0$$

$$\therefore m^2 - (\sqrt{11})^2 = 0$$

$$\therefore (m + \sqrt{11})(m - \sqrt{11}) = 0 \dots [\because a^2 - b^2 = (a + b)(a - b)]$$

$$\therefore m + \sqrt{11} = 0 \text{ or } m - \sqrt{11} = 0$$

$$\therefore m = -\sqrt{11} \text{ or } m = \sqrt{11}$$

$\therefore$ The roots of given quadratic equation are $-\sqrt{11}$ and $\sqrt{11}$.

- (xi) $7m^2 = 21m$ (2 marks)

Solution:

$$7m^2 = 21m$$

$$\therefore 7m^2 - 21m = 0$$

$$\therefore 7m(m - 3) = 0$$

$$\therefore 7m = 0 \text{ or } m - 3 = 0$$

$$\therefore m = 0 \text{ or } m = 3$$

$$\therefore m = 0 \text{ or } m = 3$$

$\therefore$ The roots of given quadratic equation are 0 and 3.

Problem Set - 2 (Textbook Page No. 54)

- (7) Solve the following quadratic equations:

- (iii) $(2x + 3)^2 = 25$ (3 marks)

Solution:

$$(2x + 3)^2 = 25$$

$$\therefore (2x + 3)^2 - 25 = 0$$

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

$$\therefore (2x + 3 + 5)(2x + 3 - 5) = 0$$

$$\dots [\because a^2 - b^2 = (a + b)(a - b)]$$

$$\begin{aligned}\therefore (2x + 8)(2x - 2) &= 0 \\ \therefore 2x + 8 &= 0 \text{ or } 2x - 2 = 0 \\ \therefore 2x &= -8 \text{ or } 2x = 2 \\ \therefore x &= \frac{-8}{2} \text{ or } x = \frac{2}{2} \\ \therefore x &= -4 \text{ or } x = 1\end{aligned}$$

$\therefore$ The roots of given quadratic equation are -4 and 1 .

(ii) $x^2 - \frac{3x}{10} - \frac{1}{10} = 0$

Solution:

$$x^2 - \frac{3x}{10} - \frac{1}{10} = 0$$

Multiplying both sides by 10 we get,

$$10x^2 - 3x - 1 = 0$$

$$\therefore 10x^2 - 5x + 2x - 1 = 0$$

$$\therefore 5x(2x - 1) + 1(2x - 1) = 0$$

$$\therefore (2x - 1)(5x + 1) = 0$$

$$\therefore 2x - 1 = 0 \text{ or } 5x + 1 = 0$$

$$\therefore 2x = 1 \text{ or } 5x = -1$$

$$\therefore x = \frac{1}{2} \text{ or } x = \frac{-1}{5}$$

$\therefore$ The roots of given quadratic equation are $\frac{1}{2}$ and $\frac{-1}{5}$.



Points to Remember:

(II) Solution of a quadratic equation by completing the square:

(Assuming the variable involved in equation to be x)

Step 1 : Check the coefficient of x^2 , it has to be 1. If not, then make it 1 by dividing each term by the coefficient of x^2 .

Step 2 : Find the term to be added by using the

$$\text{formula} = \left[\frac{1}{2} \times \text{coefficient of } x \right]^2$$

Step 3 : Add and subtract the term found in step 2, due to which the addition of first three terms becomes a complete square.

Step 4 : Express first three term as a complete square and send remaining two constant terms to R.H.S.

Step 5 : Take square roots on both sides.

Step 6 : Find the value of x and write the final answer.

Practice Set - 2.3 (Textbook Page No. 39)

Solve the following quadratic equations by completing the square method.

(1) $x^2 + x - 20 = 0$

(3 marks)

Solution:

$$x^2 + x - 20 = 0$$

Term to be added

$$= \left[\frac{1}{2} \times \text{coefficient of } x \right]^2$$

$$= \left(\frac{1}{2} \times 1 \right)^2$$

$$= \left(\frac{1}{2} \right)^2$$

$$= \frac{1}{4}$$

$$\therefore x^2 + x + \frac{1}{4} - \frac{1}{4} - 20 = 0$$

$$\therefore \left(x + \frac{1}{2} \right)^2 = \frac{1}{4} + 20$$

$$\therefore \left(x + \frac{1}{2} \right)^2 = \frac{1 + 80}{4}$$

$$\therefore \left(x + \frac{1}{2} \right)^2 = \frac{81}{4}$$

$$\therefore x + \frac{1}{2} = \pm \frac{9}{2}$$

... (Taking square root)

$$\therefore x + \frac{1}{2} = \frac{9}{2} \text{ or } x + \frac{1}{2} = -\frac{9}{2}$$

$$\therefore x = \frac{9}{2} - \frac{1}{2} \text{ or } x = -\frac{9}{2} - \frac{1}{2}$$

$$\therefore x = \frac{9-1}{2} \text{ or } x = \frac{-9-1}{2}$$

$$\therefore x = \frac{8}{2} \text{ or } x = \frac{-10}{2}$$

$$\therefore x = 4 \text{ or } x = -5$$

$\therefore$ The roots of given quadratic equation are 4 and -5 .

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

(3 marks)

Solution:

$$x^2 + 2x - 5 = 0$$

Term to be added

$$= \left[\frac{1}{2} \times \text{coefficient of } x \right]^2$$

$$= \left(\frac{1}{2} \times 2 \right)^2$$

$$= 1$$

$$\therefore x^2 + 2x + 1 - 1 - 5 = 0$$

$$\begin{aligned}\therefore (x+1)^2 &= 1+5 \\ \therefore (x+1)^2 &= 6 \\ \therefore x+1 &= \pm \sqrt{6} \quad \dots \text{(Taking square root)} \\ \therefore x+1 &= \sqrt{6} \quad \text{or } x+1 = -\sqrt{6} \\ \therefore x &= -1 + \sqrt{6} \quad \text{or } x = -1 - \sqrt{6}\end{aligned}$$

The roots of given quadratic equation are $-1 + \sqrt{6}$ and $-1 - \sqrt{6}$.

(3) $m^2 - 5m = -3$ (3 marks)

Solution:

$$\begin{aligned}m^2 - 5m &= -3 \\ \text{Term to be added} &= \left[\frac{1}{2} \times \text{coefficient of } m \right]^2 \\ &= \left(\frac{1}{2} \times (-5) \right)^2 \\ &= \left(\frac{-5}{2} \right)^2 \\ &= \frac{25}{4} \\ \therefore m^2 - 5m + 3 &= 0 \\ \therefore m^2 - 5m + \frac{25}{4} - \frac{25}{4} + 3 &= 0 \\ \therefore \left(m - \frac{5}{2} \right)^2 &= \frac{25}{4} - 3 \\ \therefore \left(m - \frac{5}{2} \right)^2 &= \frac{25 - 12}{4} \\ \therefore \left(m - \frac{5}{2} \right)^2 &= \frac{13}{4} \\ \therefore m - \frac{5}{2} &= \pm \frac{\sqrt{13}}{2} \quad \dots \text{(Taking square root)}\end{aligned}$$

$$\begin{aligned}\therefore m - \frac{5}{2} &= \frac{\sqrt{13}}{2} \quad \text{or } m - \frac{5}{2} = -\frac{\sqrt{13}}{2} \\ \therefore m &= \frac{5}{2} + \frac{\sqrt{13}}{2} \quad \text{or } m = \frac{5}{2} - \frac{\sqrt{13}}{2} \\ \therefore m &= \frac{5 + \sqrt{13}}{2} \quad \text{or } m = \frac{5 - \sqrt{13}}{2}\end{aligned}$$

The roots of given quadratic equation are $\frac{5 + \sqrt{13}}{2}$ and $\frac{5 - \sqrt{13}}{2}$.

(4) $9y^2 - 12y + 2 = 0$ (3 marks)

Solution:

$$\begin{aligned}9y^2 - 12y + 2 &= 0 \\ \text{Dividing both sides by 9, we get,} \\ y^2 - \frac{12}{9}y + \frac{2}{9} &= 0 \\ \therefore y^2 - \frac{4}{3}y + \frac{2}{9} &= 0\end{aligned}$$

Term to be added

$$\begin{aligned}&= \left[\frac{1}{2} \times \text{coefficient of } y \right]^2 \\ &= \left(\frac{1}{2} \times \left(-\frac{4}{3} \right) \right)^2 \\ &= \left(\frac{-2}{3} \right)^2 \\ &= \frac{4}{9}\end{aligned}$$

$$\therefore y^2 - \frac{4}{3}y + \frac{4}{9} - \frac{4}{9} + \frac{2}{9} = 0$$

$$\therefore \left(y - \frac{2}{3} \right)^2 = \frac{4}{9} - \frac{2}{9}$$

$$\therefore \left(y - \frac{2}{3} \right)^2 = \frac{4 - 2}{9}$$

$$\therefore \left(y - \frac{2}{3} \right)^2 = \frac{2}{9}$$

$$\therefore y - \frac{2}{3} = \pm \frac{\sqrt{2}}{3} \quad \dots \text{(Taking square root)}$$

$$\therefore y - \frac{2}{3} = \frac{\sqrt{2}}{3} \quad \text{or } y - \frac{2}{3} = -\frac{\sqrt{2}}{3}$$

$$\therefore y = \frac{2}{3} + \frac{\sqrt{2}}{3} \quad \text{or } y = \frac{2}{3} - \frac{\sqrt{2}}{3}$$

$$\therefore y = \frac{2 + \sqrt{2}}{3} \quad \text{or } y = \frac{2 - \sqrt{2}}{3}$$

The roots of given quadratic equation are $\frac{2 + \sqrt{2}}{3}$ and $\frac{2 - \sqrt{2}}{3}$.

(5) $2y^2 + 9y + 10 = 0$ (3 marks)

Solution:

$$2y^2 + 9y + 10 = 0$$

Dividing both sides by 2 we get,

$$y^2 + \frac{9}{2}y + \frac{10}{2} = 0$$

$$\therefore y^2 + \frac{9}{2}y + 5 = 0$$

Term to be added

$$= \left[\frac{1}{2} \times \text{coefficient of } y \right]^2$$

$$= \left(\frac{1}{2} \times \frac{9}{2} \right)^2$$

$$= \left(\frac{9}{4} \right)^2$$

$$= \frac{81}{16}$$

$$\therefore y^2 + \frac{9}{2}y + \frac{81}{16} - \frac{81}{16} + 5 = 0$$

$$\begin{aligned}\therefore \left(y + \frac{9}{4}\right)^2 &= \frac{81}{16} - 5 \\ \therefore \left(y + \frac{9}{4}\right)^2 &= \frac{81 - 80}{16} \\ \therefore \left(y + \frac{9}{4}\right)^2 &= \frac{1}{16} \\ \therefore y + \frac{9}{4} &= \pm \frac{1}{4} \quad \dots \text{(Taking square root)} \\ \therefore y + \frac{9}{4} &= \frac{1}{4} \text{ or } y + \frac{9}{4} = -\frac{1}{4} \\ \therefore y &= -\frac{9}{4} + \frac{1}{4} \text{ or } y = -\frac{9}{4} - \frac{1}{4} \\ \therefore y &= \frac{-9+1}{4} \text{ or } y = \frac{-9-1}{4} \\ \therefore y &= \frac{-8}{4} \text{ or } y = \frac{-10}{4} \\ \therefore y &= -2 \text{ or } y = \frac{-5}{2} \\ \therefore \text{The roots of given quadratic equation are } & \mathbf{-2 \text{ and } \frac{-5}{2}.}\end{aligned}$$

(6) $5x^2 = 4x + 7$ (3 marks)

Solution:

$$\begin{aligned}5x^2 &= 4x + 7 \\ \therefore 5x^2 - 4x - 7 &= 0 \\ \text{Dividing both sides by 5 we get,} \\ x^2 - \frac{4}{5}x - \frac{7}{5} &= 0 \\ \text{Term to be added} \\ &= \left[\frac{1}{2} \times \text{coefficient of } x\right]^2 \\ &= \left(\frac{1}{2} \times \frac{-4}{5}\right)^2 \\ &= \left(\frac{-2}{5}\right)^2 \\ &= \frac{4}{25} \\ \therefore x^2 - \frac{4}{5}x + \frac{4}{25} - \frac{4}{25} - \frac{7}{5} &= 0 \\ \therefore \left(x - \frac{2}{5}\right)^2 &= \frac{4}{25} + \frac{7}{5} \\ \therefore \left(x - \frac{2}{5}\right)^2 &= \frac{4+35}{25} \\ \therefore \left(x - \frac{2}{5}\right)^2 &= \frac{39}{25} \\ \therefore x - \frac{2}{5} &= \pm \frac{\sqrt{39}}{5} \quad \dots \text{[Taking square root]}\end{aligned}$$

$$\begin{aligned}\therefore x - \frac{2}{5} &= \frac{\sqrt{39}}{5} \text{ or } x - \frac{2}{5} = -\frac{\sqrt{39}}{5} \\ \therefore x &= \frac{2}{5} + \frac{\sqrt{39}}{5} \text{ or } x = \frac{2}{5} - \frac{\sqrt{39}}{5} \\ \therefore x &= \frac{2+\sqrt{39}}{5} \text{ or } x = \frac{2-\sqrt{39}}{5}\end{aligned}$$

The roots of given quadratic equation are $\frac{2+\sqrt{39}}{5}$ and $\frac{2-\sqrt{39}}{5}$.

Points to Remember:

Formula for solving a quadratic equation:

$$ax^2 + bx + c = 0, \text{ Here, } a \neq 0.$$

Dividing both sides by a , we get,

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

Term to be added

$$= \left[\frac{1}{2} \times \text{coefficient of } x\right]^2$$

$$= \left(\frac{1}{2} \times \frac{b}{a}\right)^2$$

$$= \left(\frac{b}{2a}\right)^2$$

$$= \frac{b^2}{4a^2}$$

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

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

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

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

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

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

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

The roots of quadratic equation are denoted by α (Alpha) and β (Beta).

$$\therefore \alpha = \frac{-b + \sqrt{b^2 - 4ac}}{2a} \text{ and } \beta = \frac{-b - \sqrt{b^2 - 4ac}}{2a}$$

If we put value of a , b , c of equation $ax^2 + bx + c = 0$ in $\frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$, then we get the roots of the equation.

$\therefore x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ is the formula for solving quadratic equation.

Activity:

Solve the equation $2x^2 + 13x + 15 = 0$ by factorisation method, by completing the square method and by using the formula. Verify that you will get the same roots every time.

Solution:

(i) By Factorisation method,

$$2x^2 + 13x + 15 = 0$$

$$2x^2 + 10x + 3x + 15 = 0$$

$$2x(x + 5) + 3(x + 5) = 0$$

$$(x + 5)(2x + 3) = 0$$

$$(x + 5) = 0 \text{ or } (2x + 3) = 0$$

$$\therefore x = -5 \text{ or } x = \frac{-3}{2}$$

(ii) By Completing Square Method,

$$2x^2 + 13x + 15 = 0$$

Dividing both sides by 2,

$$x^2 + \frac{13}{2}x + \frac{15}{2} = 0$$

Term to be added

$$= \left[\frac{1}{2} \times \text{coefficient of } x \right]^2$$

$$= \left[\frac{1}{2} \times \frac{13}{2} \right]^2$$

$$= \left(\frac{13}{4} \right)^2$$

$$= \frac{169}{16}$$

$$= x^2 + \frac{13}{2}x + \frac{169}{16} - \frac{169}{16} + \frac{15}{2} = 0$$

$$\therefore \left(x + \frac{13}{4} \right)^2 = \frac{169}{16} - \frac{15}{2}$$

$$\therefore \left(x + \frac{13}{4} \right)^2 = \frac{49}{16}$$

$$\therefore x + \frac{13}{4} = \pm \frac{7}{4} \quad (\text{taking square root})$$

$$\therefore x + \frac{13}{4} = \frac{7}{4} \text{ or } x + \frac{13}{4} = -\frac{7}{4}$$

$$\therefore x = -\frac{13}{4} + \frac{7}{4} \text{ or } x = -\frac{13}{4} - \frac{7}{4}$$

$$\therefore x = \frac{-6}{4} \text{ or } x = \frac{-20}{4}$$

$$\therefore x = \frac{-3}{2} \text{ or } x = -5$$

(iii) By Formula

$$2x^2 + 13x + 15 = 0$$

Comparing with $ax^2 + bx + c = 0$, we get,

$$a = 2, b = 13, c = 15$$

$$\begin{aligned} \therefore b^2 - 4ac &= (13)^2 - 4 \times 2 \times 15 \\ &= 169 - 120 \\ &= 49 \end{aligned}$$

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

$$= \frac{-13 \pm \sqrt{49}}{2 \times 2}$$

$$= \frac{-13 \pm 7}{4}$$

$$\therefore x = \frac{-13 + 7}{4} \text{ or } x = \frac{-13 - 7}{4}$$

$$\therefore x = \frac{-6}{4} \text{ or } x = \frac{-20}{4}$$

$$\therefore x = \frac{-3}{2} \text{ or } x = -5$$

Using above three methods, we get the same roots as -5 and $\frac{-3}{2}$

Practice Set - 2.4 (Textbook Page No. 43)

(1) Compare the given quadratic equation to the general form and write values of a , b , c .

$$(i) x^2 - 7x + 5 = 0$$

(1 mark)

Solution:

$$x^2 - 7x + 5 = 0$$

Comparing with $ax^2 + bx + c = 0$, we get,

$$a = 1, b = -7, c = 5$$

$$(ii) 2m^2 = 5m - 5$$

(1 mark)

Solution:

$$2m^2 = 5m - 5$$

$$\therefore 2m^2 - 5m + 5 = 0$$

Comparing with $am^2 + bm + c = 0$, we get,

$$a = 2, b = -5, c = 5$$

$$(iii) y^2 = 7y$$

(1 mark)

Solution:

$$y^2 = 7y$$

$$\therefore y^2 - 7y = 0$$

$$\therefore y^2 - 7y + 0 = 0$$

Comparing with $ay^2 + by + c = 0$, we get,

$$a = 1, b = -7, c = 0$$

(2) Solve using formula.

(i) $x^2 + 6x + 5 = 0$

(3 marks)

Solution:

$$x^2 + 6x + 5 = 0$$

Comparing with $ax^2 + bx + c = 0$, we get,

$$a = 1, b = 6, c = 5$$

$$\begin{aligned} \therefore b^2 - 4ac &= (6)^2 - 4 \times 1 \times 5 \\ &= 36 - 20 \\ &= 16 \end{aligned}$$

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

$$\therefore x = \frac{-6 \pm \sqrt{16}}{2 \times 1}$$

$$\therefore x = \frac{-6 \pm 4}{2}$$

$$\therefore x = \frac{-6 + 4}{2} \quad \text{or } x = \frac{-6 - 4}{2}$$

$$\therefore x = \frac{-2}{2} \quad \text{or } x = \frac{-10}{2}$$

$$\therefore x = -1 \quad \text{or } x = -5$$

The roots of given quadratic equation are -1 and -5.

(ii) $x^2 - 3x - 2 = 0$

(3 marks)

Solution:

$$x^2 - 3x - 2 = 0$$

Comparing with $ax^2 + bx + c = 0$, we get,

$$a = 1, b = -3, c = -2.$$

$$\begin{aligned} \therefore b^2 - 4ac &= (-3)^2 - 4 \times 1 \times (-2) \\ &= 9 + 8 \\ &= 17 \end{aligned}$$

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

$$\therefore x = \frac{-(-3) \pm \sqrt{17}}{2 \times 1}$$

$$\therefore x = \frac{3 \pm \sqrt{17}}{2}$$

$$\therefore x = \frac{3 + \sqrt{17}}{2} \quad \text{or } x = \frac{3 - \sqrt{17}}{2}$$

The roots of given quadratic equation are $\frac{3 - \sqrt{17}}{2}$ and $\frac{3 + \sqrt{17}}{2}$.

(iii) $3m^2 + 2m - 7 = 0$

(3 marks)

Solution:

$$3m^2 + 2m - 7 = 0$$

Comparing with $am^2 + bm + c = 0$, we get,

$$a = 3, b = 2, c = -7.$$

$$\begin{aligned} \therefore b^2 - 4ac &= (2)^2 - 4 \times 3 \times (-7) \\ &= 4 + 84 \\ &= 88 \end{aligned}$$

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

...(Formula)

$$\therefore m = \frac{-2 \pm \sqrt{88}}{2 \times 3}$$

$$\therefore m = \frac{-2 \pm \sqrt{4 \times 22}}{6}$$

$$\therefore m = \frac{-2 \pm 2\sqrt{22}}{6}$$

$$\therefore m = \frac{2(-1 \pm \sqrt{22})}{6}$$

$$\therefore m = \frac{-1 \pm \sqrt{22}}{3}$$

$$\therefore m = \frac{-1 + \sqrt{22}}{3} \quad \text{or } m = \frac{-1 - \sqrt{22}}{3}$$

The roots of given quadratic equation are $\frac{-1 - \sqrt{22}}{3}$ and $\frac{-1 + \sqrt{22}}{3}$.

(iv) $5m^2 - 4m - 2 = 0$

(3 marks)

Solution:

$$5m^2 - 4m - 2 = 0$$

Comparing with $am^2 + bm + c = 0$, we get,

$$a = 5, b = -4, c = -2.$$

$$\begin{aligned} \therefore b^2 - 4ac &= (-4)^2 - 4 \times 5 \times (-2) \\ &= 16 + 40 \\ &= 56 \end{aligned}$$

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

...(Formula)

$$\therefore m = \frac{-(-4) \pm \sqrt{56}}{2 \times 5}$$

$$\therefore m = \frac{4 \pm \sqrt{4 \times 14}}{10}$$

$$\therefore m = \frac{4 \pm 2\sqrt{14}}{10}$$

$$\therefore m = \frac{2(2 \pm \sqrt{14})}{10}$$

$$\therefore m = \frac{2 \pm \sqrt{14}}{5}$$

$$\therefore m = \frac{2 + \sqrt{14}}{5} \text{ or } m = \frac{2 - \sqrt{14}}{5}$$

$\therefore$ The roots of given quadratic equation are $\frac{2 - \sqrt{14}}{5}$ and $\frac{2 + \sqrt{14}}{5}$.

(v) $y^2 + \frac{1}{3}y = 2$ (3 marks)

Solution:

$$y^2 + \frac{1}{3}y = 2$$

$$3y^2 + y = 6 \quad \dots(\text{Multiplying both sides by 3})$$

$$\therefore 3y^2 + y - 6 = 0$$

Comparing with $ay^2 + by + c = 0$ we get,
 $a = 3, b = 1, c = -6$.

$$\begin{aligned} \therefore b^2 - 4ac &= (1)^2 - 4 \times 3 \times (-6) \\ &= 1 + 72 \\ &= 73 \end{aligned}$$

$$\therefore y = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} \quad \dots (\text{Formula})$$

$$\therefore y = \frac{-1 \pm \sqrt{73}}{2 \times 3}$$

$$\therefore y = \frac{-1 \pm \sqrt{73}}{6}$$

$$\therefore y = \frac{-1 + \sqrt{73}}{6} \text{ or } y = \frac{-1 - \sqrt{73}}{6}$$

$\therefore$ The roots of given quadratic equation are $\frac{-1 + \sqrt{73}}{6}$ and $\frac{-1 - \sqrt{73}}{6}$.

(vi) $5x^2 + 13x + 8 = 0$ (3 marks)

Solution:

$$5x^2 + 13x + 8 = 0$$

Comparing with $ax^2 + bx + c = 0$, we get,

$$a = 5, b = 13, c = 8$$

$$\begin{aligned} \therefore b^2 - 4ac &= (13)^2 - 4 \times 5 \times 8 \\ &= 169 - 160 \\ &= 9 \end{aligned}$$

$$\therefore x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} \quad \dots(\text{Formula})$$

$$= \frac{-13 \pm \sqrt{9}}{2 \times 5}$$

$$= \frac{-13 \pm 3}{10}$$

$$\therefore x = \frac{-13 + 3}{10} \text{ or } x = \frac{-13 - 3}{10}$$

$$\therefore x = \frac{-10}{10} \text{ or } x = \frac{-16}{10}$$

$$\therefore x = -1 \text{ or } x = \frac{-8}{5}$$

$\therefore$ The roots of given quadratic equation are -1 and $\frac{-8}{5}$.

Problem Set - 2 (Textbook Page No. 54)

(7) Solve the following quadratic equations:

(i) $\frac{1}{x+5} = \frac{1}{x^2}$ (3 marks)

Solution:

$$\frac{1}{x+5} = \frac{1}{x^2} \quad (x \neq 0, x+5 \neq 0)$$

$$\therefore x+5 = x^2 \quad \dots(\text{By Invertendo})$$

$$\therefore x^2 - x - 5 = 0$$

Comparing with $ax^2 + bx + c = 0$, we get,

$$a = 1, b = -1, c = -5.$$

$$\begin{aligned} \therefore b^2 - 4ac &= (-1)^2 - 4 \times 1 \times -5 \\ &= 1 + 20 \\ &= 21 \end{aligned}$$

$$\therefore x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} \quad \dots(\text{Formula})$$

$$= \frac{-(-1) \pm \sqrt{21}}{2 \times 1}$$

$$= \frac{1 \pm \sqrt{21}}{2}$$

$$\therefore x = \frac{1 + \sqrt{21}}{2} \text{ or } x = \frac{1 - \sqrt{21}}{2}$$

The roots of given quadratic equation are $\frac{1 - \sqrt{21}}{2}$ and $\frac{1 + \sqrt{21}}{2}$.

(iv) $m^2 + 5m + 5 = 0$ (3 marks)

Solution:

$$m^2 + 5m + 5 = 0$$

Comparing with $am^2 + bm + c = 0$, we get,

$$a = 1, b = 5, c = 5.$$

$$\begin{aligned} \therefore b^2 - 4ac &= (5)^2 - 4 \times 1 \times 5 \\ &= 25 - 20 \\ &= 5 \end{aligned}$$

$$\therefore m = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} \quad \dots(\text{Formula})$$

$$= \frac{-5 \pm \sqrt{5}}{2 \times 1}$$

$$= \frac{-5 \pm \sqrt{5}}{2}$$

$$\therefore m = \frac{-5 + \sqrt{5}}{2} \text{ or } m = \frac{-5 - \sqrt{5}}{2}$$

$\therefore$ The roots of given quadratic equation are $\frac{-5 + \sqrt{5}}{2}$ and $\frac{-5 - \sqrt{5}}{2}$.

(v) $5m^2 + 2m + 1 = 0$ (3 marks)

Solution:

$$5m^2 + 2m + 1 = 0$$

Comparing with $am^2 + bm + c = 0$, we get,

$$a = 5, b = 2, c = 1.$$

$$\begin{aligned} \therefore b^2 - 4ac &= (2)^2 - 4 \times 5 \times 1 \\ &= 4 - 20 \\ &= -16 \end{aligned}$$

$\therefore b^2 - 4ac < 0$, roots of given quadratic equation are not real.

(vi) $x^2 - 4x - 3 = 0$

Solution:

$$x^2 - 4x - 3 = 0$$

Comparing with $ax^2 + bx + c = 0$, we get,

$$a = 1, b = -4, c = -3.$$

$$\begin{aligned} \therefore b^2 - 4ac &= (-4)^2 - 4 \times 1 \times -3 \\ &= 16 + 12 \\ &= 28 \end{aligned}$$

$$\therefore x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} \quad \text{(Formula)}$$

$$\therefore x = \frac{-(-4) \pm \sqrt{28}}{2 \times 1}$$

$$\therefore x = \frac{4 \pm \sqrt{4 \times 7}}{2}$$

$$\therefore x = \frac{4 \pm \sqrt{4 \times 7}}{2}$$

$$\therefore x = \frac{4 \pm 2\sqrt{7}}{2}$$

$$\therefore x = \frac{2(2 \pm \sqrt{7})}{2}$$

$$\therefore x = 2 \pm \sqrt{7}$$

$$\therefore x = 2 + \sqrt{7} \text{ or } x = 2 - \sqrt{7}$$

$\therefore$ The roots of given quadratic equation are $2 + \sqrt{7}$ and $2 - \sqrt{7}$.

Practice Set - 2.4 (Textbook Page No. 44)

- (3) With the help of the flow chart given below solve the equation $x^2 + 2\sqrt{3}x + 3 = 0$ using formula. (3 marks)

Compare equations $x^2 + 2\sqrt{3}x + 3 = 0$ and $ax^2 + bx + c = 0$ find the values of a, b, c

Find the value of $b^2 - 4ac$

Substitute values of a, b, c and find roots

Write formula to solve quadratic equation

Solution:

$$x^2 + 2\sqrt{3}x + 3 = 0$$

Comparing with $ax^2 + bx + c = 0$, we get,

$$a = 1, b = 2\sqrt{3}, c = 3.$$

$$\begin{aligned} \therefore b^2 - 4ac &= (2\sqrt{3})^2 - 4 \times 1 \times 3 \\ &= 12 - 12 \\ &= 0 \end{aligned}$$

$$\therefore x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} \quad \dots(\text{Formula})$$

$$\begin{aligned} \therefore x &= \frac{-2\sqrt{3} \pm \sqrt{0}}{2 \times 1} \\ &= \frac{-2\sqrt{3} \pm 0}{2} \end{aligned}$$

$$\therefore x = \frac{-2\sqrt{3}}{2}$$

$$\therefore x = -\sqrt{3}$$

$\therefore$ The root of given quadratic equation is $-\sqrt{3}$.

Points to Remember:

• Nature of roots of a quadratic equation

We know that the roots of the quadratic equation $ax^2 + bx + c = 0$, ($a \neq 0$) are

$$\alpha = \frac{-b + \sqrt{b^2 - 4ac}}{2a}, \beta = \frac{-b - \sqrt{b^2 - 4ac}}{2a}$$

Here the nature of the roots of the quadratic equation is determined by the value of $b^2 - 4ac$, which is called as **discriminant** of the quadratic equation and it is denoted by Δ (**Delta**).

- (1) If $b^2 - 4ac > 0$, then $\sqrt{b^2 - 4ac}$ is positive real and therefore roots of equation are real and unequal.

$$\text{e.g. } \alpha = \frac{-b + \sqrt{b^2 - 4ac}}{2a}, \beta = \frac{-b - \sqrt{b^2 - 4ac}}{2a}$$

- (2) If $b^2 - 4ac = 0$, then $\sqrt{b^2 - 4ac} = 0$ and therefore roots of equation are **real and equal**,

$$\text{So, } \alpha = \frac{-b}{2a} \text{ and } \beta = \frac{-b}{2a}$$

i.e. both the roots are real and equal, we say that the equation has repeated roots.

- (3) If $b^2 - 4ac < 0$, then $\sqrt{b^2 - 4ac}$ is not a real number and therefore equation **does not have real roots**.

Note : If $b^2 - 4ac > 0$ and $b^2 - 4ac$ is not a perfect square, then the roots of the quadratic equation are irrational and occur in pair. They are conjugate of each other.

Activity : Fill in the blanks. ..(Textbook Pg. No. 44)

	Value of discriminant	Nature of roots
(1)	50	Real and unequal
(2)	-30	No real roots
(3)	0	Real and equal

Example:

Determine the nature of roots of the quadratic equations.
(Textbook Pg. No. 45)

- (i) $2x^2 - 5x + 7 = 0$

Solution:

$$2x^2 - 5x + 7 = 0$$

Comparing with $ax^2 + bx + c = 0$, we get,

$$a = 2, b = -5, c = 7$$

$$\begin{aligned}\therefore b^2 - 4ac &= (-5)^2 - 4 \times 2 \times 7 \\ &= 25 - 56 \\ &= -31\end{aligned}$$

As $b^2 - 4ac < 0$, the roots of the equation are not real.

- (ii) $x^2 + 2x - 9 = 0$

Solution:

$$x^2 + 2x - 9 = 0$$

Comparing with $ax^2 + bx + c = 0$, we get

$$a = 1, b = 2, c = -9$$

$$\begin{aligned}\therefore b^2 - 4ac &= (2)^2 - 4 \times 1 \times (-9) \\ &= 4 + 36 \\ &= 40\end{aligned}$$

As $b^2 - 4ac > 0$, the roots of the equation are real and unequal.

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

Solution:

$$\sqrt{3}x^2 + 2\sqrt{3}x + \sqrt{3} = 0$$

Compare with $ax^2 + bx + c = 0$,

$$a = \sqrt{3}, b = 2\sqrt{3}, c = \sqrt{3}$$

$$\begin{aligned}\therefore b^2 - 4ac &= (2\sqrt{3})^2 - 4 \times \sqrt{3} \times \sqrt{3} \\ &= 12 - 12 \\ &= 0\end{aligned}$$

$\therefore b^2 - 4ac = 0$, the roots of the equation are real and equal.

Practice Set - 2.5 (Textbook Page No. 49)

- (2) Find the value of discriminant.

- (i) $x^2 + 7x - 1 = 0$

(2 marks)

Solution:

$$x^2 + 7x - 1 = 0$$

Comparing with $ax^2 + bx + c = 0$, we get

$$a = 1, b = 7, c = -1$$

$$\begin{aligned}\Delta &= b^2 - 4ac \\ &= (7)^2 - 4 \times 1 \times (-1) \\ &= 49 + 4\end{aligned}$$

$$\therefore \Delta = 53$$

- (ii) $2y^2 - 5y + 10 = 0$

(2 marks)

Solution:

$$2y^2 - 5y + 10 = 0$$

Comparing with $ay^2 + by + c = 0$ we get,

$$a = 2, b = -5, c = 10$$

$$\begin{aligned}\Delta &= b^2 - 4ac \\ &= (-5)^2 - 4 \times 2 \times 10 \\ &= 25 - 80\end{aligned}$$

$$\therefore \Delta = -55$$

- (iii) $\sqrt{2}x^2 + 4x + 2\sqrt{2} = 0$

(2 marks)

Solution:

$$\sqrt{2}x^2 + 4x + 2\sqrt{2} = 0$$

Comparing with $ax^2 + bx + c = 0$, we get,

$$a = \sqrt{2}, b = 4, c = 2\sqrt{2}$$

$$\begin{aligned}\Delta &= b^2 - 4ac \\ &= (4)^2 - 4 \times \sqrt{2} \times 2\sqrt{2} \\ &= 16 - 16\end{aligned}$$

$$\therefore \Delta = 0$$

Problem Set - 2 (Textbook Page No. 54)

- (3) Find the value of discriminant for each of the following equations.

- (i) $2y^2 - y + 2 = 0$

(2 marks)

Solution:

$$2y^2 - y + 2 = 0$$

Comparing with $ay^2 + by + c = 0$ we get,

$$a = 2, b = -1, c = 2$$

$$\begin{aligned}\Delta &= b^2 - 4ac \\ &= (-1)^2 - 4 \times 2 \times 2 \\ &= 1 - 16\end{aligned}$$

$$\therefore \Delta = -15$$

(ii) $5m^2 - m = 0$ (2 marks)

Solution:

$$\begin{aligned}5m^2 - m + 0 &= 0 \\ \text{Comparing with } am^2 + bm + c &= 0 \text{ we get,} \\ a = 5, b = -1, c &= 0 \\ \Delta &= b^2 - 4ac \\ &= (-1)^2 - 4 \times 5 \times 0 \\ &= 1 - 0\end{aligned}$$

$$\therefore \Delta = 1$$

(iii) $\sqrt{5}x^2 - x - \sqrt{5} = 0$ (2 marks)

Solution:

$$\begin{aligned}\sqrt{5}x^2 - x - \sqrt{5} &= 0 \\ \text{Comparing with } ax^2 + bx + c &= 0, \text{ we get,} \\ \therefore a = \sqrt{5}, b = -1, c &= -\sqrt{5} \\ \Delta &= b^2 - 4ac \\ &= (-1)^2 - 4 \times \sqrt{5} \times (-\sqrt{5}) \\ &= 1 + 20\end{aligned}$$

$$\therefore \Delta = 21$$

Practice Set - 2.5 (Textbook Page No. 49)

(3) Determine the nature of roots of the following quadratic equations.

(i) $x^2 - 4x + 4 = 0$ (2 marks)

Solution:

$$\begin{aligned}x^2 - 4x + 4 &= 0 \\ \text{Comparing with } ax^2 + bx + c &= 0 \text{ we get,} \\ a = 1, b = -4, c &= 4 \\ \Delta &= b^2 - 4ac \\ &= (-4)^2 - 4 \times 1 \times 4 \\ &= 16 - 16\end{aligned}$$

$$\therefore \Delta = 0$$

As $\Delta = 0$, the roots of the quadratic equation are real and equal.

(ii) $2y^2 - 7y + 2 = 0$ (2 marks)

Solution:

$$\begin{aligned}2y^2 - 7y + 2 &= 0 \\ \text{Comparing with } ay^2 + by + c &= 0 \text{ we get,} \\ a = 2, b = -7, c &= 2 \\ \Delta &= b^2 - 4ac \\ &= (-7)^2 - 4 \times 2 \times 2 \\ &= 49 - 16\end{aligned}$$

$$\therefore \Delta = 33$$

As $\Delta > 0$, the roots of the quadratic equation are real and unequal.

(iii) $m^2 + 2m + 9 = 0$ (2 marks)

Solution:

$$\begin{aligned}m^2 + 2m + 9 &= 0 \\ \text{Comparing with } am^2 + bm + c &= 0 \text{ we get,}\end{aligned}$$

$$\therefore a = 1, b = 2, c = 9$$

$$\begin{aligned}\Delta &= b^2 - 4ac \\ &= (2)^2 - 4 \times 1 \times 9 \\ &= 4 - 36\end{aligned}$$

$$\therefore \Delta = -32$$

As $\Delta < 0$, the roots of the quadratic equation are not real.

Problem Set - 2 (Textbook Page No. 54)

(6) Determine the nature of roots for each of the quadratic equations.

(i) $3x^2 - 5x + 7 = 0$ (2 marks)

Solution:

$$\begin{aligned}3x^2 - 5x + 7 &= 0 \\ \text{Comparing with } ax^2 + bx + c &= 0, \text{ we get,} \\ a = 3, b = -5, c &= 7 \\ \Delta &= b^2 - 4ac \\ &= (-5)^2 - 4 \times 3 \times 7 \\ &= 25 - 84\end{aligned}$$

$$\therefore \Delta = -59$$

As $\Delta < 0$, the roots of the quadratic equation are not real.

(ii) $\sqrt{3}x^2 + \sqrt{2}x - 2\sqrt{3} = 0$ (2 marks)

Solution:

$$\begin{aligned}\sqrt{3}x^2 + \sqrt{2}x - 2\sqrt{3} &= 0 \\ \text{Comparing with } ax^2 + bx + c &= 0, \text{ we get,} \\ a = \sqrt{3}, b = \sqrt{2}, c &= -2\sqrt{3}\end{aligned}$$

$$\begin{aligned}\Delta &= b^2 - 4ac \\ &= (\sqrt{2})^2 - 4 \times \sqrt{3} \times (-2\sqrt{3}) \\ &= 2 + 24\end{aligned}$$

$$\therefore \Delta = 26$$

As $\Delta > 0$, the roots of the quadratic equation are real and unequal.

(iii) $m^2 - 2m + 1 = 0$ (2 marks)

Solution:

$$m^2 - 2m + 1 = 0$$

Comparing with $am^2 + bm + c = 0$ we get,

$$a = 1, b = -2, c = 1$$

$$\Delta = b^2 - 4ac$$

$$= (2)^2 - 4 \times 1 \times 1$$

$$= 4 - 4$$

$$\therefore \Delta = 0$$

As $\Delta = 0$, the roots of the quadratic equation are real and equal.

Practice Set - 2.5 (Textbook Page No. 50)

- (7) The roots of the each of the following quadratic equations are real and equal, find k .

(i) $3y^2 + ky + 12 = 0$

(3 marks)

Solution:

$$3y^2 + ky + 12 = 0$$

Comparing the above equation with $ay^2 + by + c = 0$

[$y = x$], we get,

$$a = 3, b = k, c = 12$$

$$\Delta = b^2 - 4ac$$

$$= (k)^2 - 4 \times 3 \times 12$$

$$\therefore \Delta = k^2 - 144$$

The roots are real and equal, so Δ must be zero.

$$\therefore k^2 - 144 = 0$$

$$\therefore k^2 = 144$$

$$\therefore k = \pm 12$$

$$k = 12 \text{ or } k = -12$$

(ii) $kx(x - 2) + 6 = 0$

(3 marks)

Solution:

$$kx(x - 2) + 6 = 0$$

$$\therefore kx^2 - 2kx + 6 = 0$$

Comparing with $ax^2 + bx + c = 0$, we get,

$$a = k, b = -2k, c = 6$$

$$\Delta = b^2 - 4ac$$

$$= (-2k)^2 - 4 \times k \times 6$$

$$\therefore \Delta = 4k^2 - 24k$$

The roots are real and equal, so Δ must be zero.

$$\therefore 4k^2 - 24k = 0$$

$$\therefore 4k(k - 6) = 0$$

$$\therefore 4k = 0 \text{ or } k - 6 = 0$$

$$\therefore k = \frac{0}{4} \text{ or } k = 6$$

i.e. $k = 0$ or $k = 6$.

As $a = k$ and in quadratic equation $a \neq 0$

$$\therefore k \neq 0$$

$$\therefore k = 6$$

Problem Set - 2 (Textbook Page No. 54)

- (8) Find m if $(m - 12)x^2 + 2(m - 12)x + 2 = 0$ has real and equal roots. (4 marks)

Solution:

$$(m - 12)x^2 + 2(m - 12)x + 2 = 0$$

Comparing with $ax^2 + bx + c = 0$, we get,

$$a = m - 12, b = 2(m - 12), c = 2$$

$$\Delta = b^2 - 4ac$$

$$= [2(m - 12)]^2 - 4 \times (m - 12) \times 2$$

$$\therefore \Delta = 4(m^2 - 24m + 144) - 8(m - 12)$$

$$= 4m^2 - 96m + 576 - 8m + 96$$

$$\therefore \Delta = 4m^2 - 104m + 672$$

The roots are real and equal so Δ must be zero.

$$\therefore 4m^2 - 104m + 672 = 0$$

$$\therefore m^2 - 26m + 168 = 0 \text{ ..(Dividing both sides by 4)}$$

$$\therefore m^2 - 14m - 12m + 168 = 0$$

$$\therefore m(m - 14) - 12(m - 14) = 0$$

$$\therefore (m - 14)(m - 12) = 0$$

$$\therefore m - 14 = 0 \text{ or } m - 12 = 0$$

$$\therefore m = 14 \text{ or } m = 12$$

Since $m - 12 = a$ and in quadratic equation $a \neq 0$

$$\therefore m \neq 12$$

$$\therefore m = 14$$



Points to Remember:

Relation between roots of the quadratic equation and coefficients:

If α and β are the roots of the quadratic equation $ax^2 + bx + c = 0$, then

$$\alpha + \beta = \frac{-b + \sqrt{b^2 - 4ac}}{2a} + \frac{-b - \sqrt{b^2 - 4ac}}{2a}$$

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

$$= \frac{-2b}{2a}$$

$$\alpha + \beta = \frac{-b}{a}$$

$$\text{Also, } \alpha \times \beta = \frac{-b + \sqrt{b^2 - 4ac}}{2a} \times \frac{-b - \sqrt{b^2 - 4ac}}{2a}$$

$$= \frac{(-b + \sqrt{b^2 - 4ac}) \times (-b - \sqrt{b^2 - 4ac})}{4a^2}$$

$$= \frac{(-b)^2 - (b^2 - 4ac)}{4a^2}$$

$$= \frac{b^2 - b^2 + 4ac}{4a^2}$$

$$= \frac{4ac}{4a^2}$$

$$\alpha \times \beta = \frac{c}{a}$$

Activity :

Fill in the empty boxes below properly

(Textbook pg. no. 46)

For $10x^2 + 10x + 1 = 0$, $\alpha + \beta = \boxed{-1}$ and $\alpha \times \beta = \boxed{\frac{1}{10}}$

Working:

$$\alpha + \beta = \frac{-b}{a}$$

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

$$\alpha \times \beta = \frac{c}{a}$$

$$= \frac{1}{10}$$

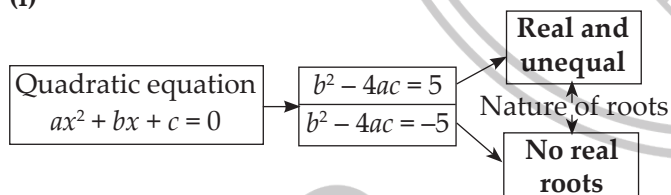
Some Identities:

- (i) $\alpha^2 + \beta^2 = (\alpha + \beta)^2 - 2\alpha\beta$
- (ii) $\alpha^3 + \beta^3 = (\alpha + \beta)^3 - 3\alpha\beta(\alpha + \beta)$
- (iii) $\alpha^3 - \beta^3 = (\alpha - \beta)^3 + 3\alpha\beta(\alpha - \beta)$
- (iv) $(\alpha - \beta)^2 = (\alpha + \beta)^2 - 4\alpha\beta$

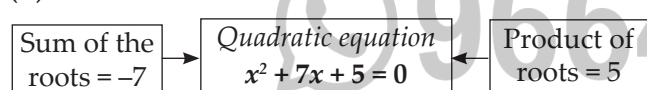
Practice Set - 2.5 (Textbook Page No. 49)

(1) Fill in the gaps and complete. (1 mark each)

(i)



(ii)



(iii) If α, β are the roots of quadratic equation, then

$$2x^2 - 4x - 3 = 0 \rightarrow \begin{cases} \alpha + \beta = 2 \\ \alpha \times \beta = \frac{-3}{2} \end{cases}$$

Working: $\alpha + \beta = \frac{-b}{a} = \frac{-(-4)}{2} = 2$

$$\alpha \times \beta = \frac{c}{a} = \frac{-3}{2}$$

- * (5) Sum of the roots of a quadratic equation is double their product. Find k if equation is $x^2 - 4kx + k + 3 = 0$. (3 marks)**

Solution:

Let α and β are the roots of the given quadratic equation

$$x^2 - 4kx + k + 3 = 0$$

Comparing with $ax^2 + bx + c = 0$ we get,

$$a = 1, b = -4k, c = k + 3$$

$$\therefore \alpha + \beta = \frac{-b}{a} = \frac{-(-4k)}{1} = 4k \text{ and}$$

$$\alpha \times \beta = \frac{c}{a} = \frac{k + 3}{1} = k + 3$$

$$\text{Now, } \alpha + \beta = 2 \times (\alpha \times \beta) \quad \dots \text{ (Given)}$$

$$4k = 2 \times (k + 3)$$

$$4k = 2k + 6$$

$$\therefore 4k - 2k = 6$$

$$\therefore 2k = 6$$

$$\therefore k = \frac{6}{2}$$

$$\therefore \boxed{k = 3}$$

*** (6) α, β are roots of $y^2 - 2y - 7 = 0$ find,**

- (i) $\alpha^2 + \beta^2$ (ii) $\alpha^3 + \beta^3$

(3 marks)

Solution:

$$y^2 - 2y - 7 = 0$$

Comparing with $ay^2 + by + c = 0$ we get,

$$a = 1, b = -2, c = -7$$

$$\therefore \alpha + \beta = \frac{-b}{a} = \frac{-(-2)}{1} = 2 \text{ and}$$

$$\alpha \times \beta = \frac{c}{a} = \frac{-7}{1} = -7$$

$$(i) \alpha^2 + \beta^2 = (\alpha + \beta)^2 - 2\alpha\beta$$

$$= (2)^2 - 2 \times (-7)$$

$$= 4 + 14$$

$$\therefore \boxed{\alpha^2 + \beta^2 = 18}$$

$$(ii) \alpha^3 + \beta^3 = (\alpha + \beta)^3 - 3\alpha\beta(\alpha + \beta)$$

$$= (2)^3 - 3 \times (-7) \times (2)$$

$$= 8 + 42$$

$$\therefore \boxed{\alpha^3 + \beta^3 = 50}$$



Points to Remember:

To obtain a quadratic equation having given roots.

If α and β are the roots of the quadratic equation, then $x = \alpha$ or $x = \beta$

$$\therefore x - \alpha = 0 \text{ or } x - \beta = 0$$

$$\therefore (x - \alpha)(x - \beta) = 0$$

$$\therefore x^2 - \alpha x - \beta x + \alpha\beta = 0$$

$$\therefore x^2 - (\alpha + \beta)x + \alpha\beta = 0$$

$$\text{i.e. } x^2 - (\text{Sum of the roots})x + \text{Product of the roots} = 0$$

Activity I :

Write the quadratic equation if addition of the roots is 10 and product of roots is 9. (Textbook Pg. no. 48)

$$\therefore \text{Quadratic equation : } x^2 - 10x + 9 = 0$$

Activity II :

What will be the quadratic equation if $\alpha = 2$, $\beta = 5$.
(Textbook Pg. no. 48)

It can be written as:

$$x^2 - (2 + 5)x + 2 \times 5 = 0$$

$$\therefore x^2 - 7x + 10 = 0$$

Practice Set - 2.5 (Textbook Page No. 50)

- (4) Form the quadratic equation from the roots given below.

- (i) 0 and 4

(2 marks)

Solution

Let α and β are the roots of the quadratic equation

Let $\alpha = 0$ and $\beta = 4$

$$\therefore \alpha + \beta = 0 + 4 = 4 \text{ and}$$

$$\alpha \times \beta = 0 \times 4 = 0$$

Then, the quadratic equation is

$$x^2 - (\alpha + \beta)x + \alpha\beta = 0$$

$$\therefore x^2 - 4x + 0 = 0$$

$$\therefore x^2 - 4x = 0$$

- (ii) 3 and -10

(2 marks)

Solution

Let α and β are the roots of the quadratic equation

Let $\alpha = 3$ and $\beta = -10$

$$\therefore \alpha + \beta = 3 + (-10) = -7 \text{ and}$$

$$\alpha \times \beta = 3 \times (-10) = -30$$

Then the quadratic equation is

$$x^2 - (\alpha + \beta)x + \alpha\beta = 0$$

$$\therefore x^2 - (-7)x - 30 = 0$$

$$\therefore x^2 + 7x - 30 = 0$$

- (iii) $\frac{1}{2}$ and $-\frac{1}{2}$

(2 marks)

Solution

Let α and β are the roots of the quadratic equation.

Let $\alpha = \frac{1}{2}$ and $\beta = -\frac{1}{2}$

$$\therefore \alpha + \beta = \frac{1}{2} + \left(-\frac{1}{2}\right) = 0 \text{ and}$$

$$\alpha \times \beta = \frac{1}{2} \times -\frac{1}{2} = -\frac{1}{4}$$

Then the quadratic equation is

$$x^2 - (\alpha + \beta)x + \alpha\beta = 0$$

$$x^2 - (0)x + \left(-\frac{1}{4}\right) = 0$$

$$\therefore x^2 - \frac{1}{4} = 0$$

$$\therefore 4x^2 - 1 = 0 \quad \dots \text{[Multiplying both sides by 4]}$$

- (iv) $2 - \sqrt{5}$ and $2 + \sqrt{5}$ (2 marks)

Solution

Let α and β are the roots of the quadratic equation.

Let $\alpha = 2 - \sqrt{5}$ and $\beta = 2 + \sqrt{5}$

$$\therefore \alpha + \beta = 2 - \sqrt{5} + 2 + \sqrt{5} = 4 \text{ and}$$

$$\alpha \times \beta = (2 - \sqrt{5}) \times (2 + \sqrt{5})$$

$$= 2^2 - (\sqrt{5})^2$$

$$= 4 - 5$$

$$= -1$$

Then, required quadratic equation is

$$x^2 - (\alpha + \beta)x + \alpha\beta = 0$$

$$\therefore x^2 - 4x - 1 = 0$$

Problem Set - 2 (Textbook Page No. 54)

- (5) Two roots of quadratic equations are given; frame the equation.

- (i) 10 and -10

(2 marks)

Solution:

Let α and β are the roots of the quadratic equation

Let $\alpha = 10$ and $\beta = -10$

$$\therefore \alpha + \beta = 10 + (-10) = 0 \text{ and}$$

$$\alpha \times \beta = 10 \times -10 = -100$$

Then required quadratic equation is

$$x^2 - (\alpha + \beta)x + \alpha\beta = 0$$

$$\therefore x^2 - (0)x + (-100) = 0$$

$$\therefore x^2 - 100 = 0$$

- (ii) $1 - 3\sqrt{5}$ and $1 + 3\sqrt{5}$

(2 marks)

Solution:

Let α and β are the roots of the quadratic equation

Let $\alpha = 1 - 3\sqrt{5}$ and $\beta = 1 + 3\sqrt{5}$

$$\therefore \alpha + \beta = 1 - 3\sqrt{5} + 1 + 3\sqrt{5} = 2 \text{ and}$$

$$\alpha \times \beta = (1 - 3\sqrt{5}) \times (1 + 3\sqrt{5})$$

$$= (1)^2 - (3\sqrt{5})^2$$

$$= 1 - 45$$

$$= -44$$

Then required quadratic equation is

$$x^2 - (\alpha + \beta)x + \alpha\beta = 0$$

$$\therefore x^2 - 2x - 44 = 0$$

- (iii) 0 and 7

(2 marks)

Solution:

Let α and β are the roots of the quadratic equation.

Let $\alpha = 0$ and $\beta = 7$

$$\therefore \alpha + \beta = 0 + 7 = 7 \text{ and}$$

$$\alpha \times \beta = 0 \times 7 = 0$$

Then, required quadratic equation is

$$x^2 - (\alpha + \beta)x + \alpha\beta = 0$$

$$\therefore x^2 - 7x + 0 = 0$$

$$\therefore \boxed{x^2 - 7x = 0}$$

- * (9) The sum of two roots of a quadratic equation is 5 and sum of their cubes is 35, find the equation. (4 marks)**

Solution

Let α and β are the roots of the quadratic equation.

Let $\alpha + \beta = 5$ and $\alpha^3 + \beta^3 = 35$... (Given)

$$\therefore \alpha^3 + \beta^3 = (\alpha + \beta)^3 - 3\alpha\beta(\alpha + \beta)$$

$$\therefore 35 = (5)^3 - 3\alpha\beta(5)$$

$$\therefore 35 = 125 - 15\alpha\beta$$

$$\therefore 15\alpha\beta = 125 - 35$$

$$\therefore 15\alpha\beta = 90$$

$$\therefore \alpha\beta = \frac{90}{15}$$

$$\therefore \alpha\beta = 6$$

The required quadratic equation is

$$x^2 - (\alpha + \beta)x + \alpha\beta = 0$$

$$\therefore \boxed{x^2 - 5x + 6 = 0}$$

- (10) Find quadratic equation such that its roots are square of sum of the roots and square of difference of the roots of equation $2x^2 + 2(p + q)x + p^2 + q^2 = 0$ (4 marks)**

Solution

$$2x^2 + 2(p + q)x + p^2 + q^2 = 0$$

Comparing with $ax^2 + bx + c = 0$, we get,

$$a = 2, b = 2(p + q), c = p^2 + q^2$$

Let α and β are the roots of the quadratic equation.

$$\alpha + \beta = \frac{-b}{a} \quad \text{and} \quad \alpha\beta = \frac{c}{a}$$

$$\alpha + \beta = \frac{-2(p + q)}{2} \quad \text{and} \quad \alpha\beta = \frac{p^2 + q^2}{2} \quad \dots \text{(ii)}$$

$$\alpha + \beta = -(p + q) \quad \dots \text{(i)}$$

Let α_1 and β_1 are the roots of the quadratic equation.

$$\alpha_1 = (\alpha + \beta)^2 \quad \dots \text{(given)}$$

$$\beta_1 = (\alpha - \beta)^2$$

$$\therefore \alpha_1 = [-(p + q)]^2 \quad \dots \text{[from (i)]}$$

$$\therefore \alpha_1 = (p + q)^2 \quad \dots \text{(iii)}$$

$$\beta_1 = (\alpha - \beta)^2$$

$$\beta_1 = (\alpha + \beta)^2 - 4\alpha\beta \quad \{ \because (\alpha - \beta)^2 = (\alpha + \beta)^2 - 4\alpha\beta \}$$

$$\beta_1 = [-(p + q)]^2 - 4 \left(\frac{p^2 + q^2}{2} \right)$$

$$\beta_1 = (p + q)^2 - 2(p^2 + q^2)$$

$$\beta_1 = p^2 + 2pq + q^2 - 2p^2 - 2q^2$$

$$\beta_1 = -p^2 + 2pq - q^2$$

$$\beta_1 = -(p^2 - 2pq + q^2)$$

$$\beta_1 = -(p - q)^2 \quad \dots \text{(iv)}$$

Sum of the roots of the new equation

$$= \alpha_1 + \beta_1$$

$$= (p + q)^2 + [-(p - q)^2] \quad \dots \text{[from (iii) and (iv)]}$$

$$= p^2 + 2pq + q^2 - (p^2 - 2pq + q^2)$$

$$= p^2 + 2pq + q^2 - p^2 + 2pq - q^2$$

$$= 4pq$$

Product of roots of new equation = $\alpha_1 \beta_1$

$$= (p + q)^2 [-(p - q)^2] \quad \dots \text{[from (iii) and (iv)]}$$

$$= -(p + q)^2 \cdot (p - q)^2$$

$$= -[(p + q)(p - q)]^2$$

$$= -(p^2 - q^2)^2$$

The required new equation

$$x^2 - (\alpha_1 + \beta_1)x + \alpha_1 \beta_1 = 0$$

$$x^2 - 4pqx + [-(p^2 - q^2)^2] = 0$$

$$\therefore \boxed{x^2 - 4pqx - (p^2 - q^2)^2 = 0}$$



Points to Remember:

Application of quadratic equation

Quadratic equations are used to solve problems arising in our day to day life.

Look out for comparative statements whichever quantity comes in the later part of the statement is assumed as 'x'.

Practice Set - 2.6 (Textbook Page No. 52)

- (1) Product of Pragati's age 2 years ago and 3 years hence is 84. Find her present age. (3 marks)**

Solution:

Let the present age of Pragati be x years.

Pragati's age 2 years ago = $(x - 2)$ years and 3

years hence = $(x + 3)$ years.

According to given condition,

$$(x - 2)(x + 3) = 84$$

$$x(x + 3) - 2(x + 3) = 84$$

$$\therefore x^2 + 3x - 2x - 6 = 84$$

$$\therefore x^2 + x - 6 - 84 = 0$$

$$\therefore x^2 + x - 90 = 0$$

$$\therefore x^2 + 10x - 9x - 90 = 0$$

$$\therefore x(x + 10) - 9(x + 10) = 0$$

$$\therefore (x + 10)(x - 9) = 0$$

$$\therefore x + 10 = 0 \text{ or } x - 9 = 0$$

$$\therefore x = -10 \text{ or } x = 9$$

Now, age cannot be negative. $\therefore x \neq -10$

$$\therefore x = 9$$

$$\therefore \boxed{\text{The present age of Pragati is 9 years.}}$$

- (4) Vivek is older than Kishor by 5 years. The sum of the reciprocals of their ages is $\frac{1}{6}$. Find their present age. (3 marks)

Solution:

Let the present age of Kishor be x years.

∴ The present age of Vivek is $(x + 5)$ years.

According to given condition,

$$\frac{1}{x} + \frac{1}{x+5} = \frac{1}{6}$$

$$\therefore \frac{x+5+x}{x(x+5)} = \frac{1}{6}$$

$$\therefore \frac{2x+5}{x^2+5x} = \frac{1}{6}$$

$$\therefore x^2 + 5x = 12x + 30$$

$$\therefore x^2 + 5x - 12x - 30 = 0$$

$$\therefore x^2 - 7x - 30 = 0$$

$$\therefore x^2 - 10x + 3x - 30 = 0$$

$$\therefore x(x - 10) + 3(x - 10) = 0$$

$$\therefore (x - 10)(x + 3) = 0$$

$$\therefore x - 10 = 0 \text{ or } x + 3 = 0$$

$$\therefore x = 10 \text{ or } x = -3$$

$x \neq -3$ as age cannot be negative.

$$\therefore x = 10 \text{ and } x + 5 = 10 + 5 = 15.$$

∴ **The present age of Kishor is 10 years and present age of Vivek is 15 years.**

- (2) The sum of squares of two consecutive even natural number is 244. Find the numbers. (3 marks)

Solution:

Let the two consecutive even natural numbers be x and $x + 2$ years.

According to given condition,

$$x^2 + (x + 2)^2 = 244$$

$$\therefore x^2 + x^2 + 4x + 4 = 244 \dots [\text{Using } (a + b)^2 = a^2 + 2ab + b^2]$$

$$\therefore 2x^2 + 4x + 4 - 244 = 0$$

$$\therefore 2x^2 + 4x - 240 = 0$$

$$\therefore x^2 + 2x - 120 = 0 \dots [\text{Dividing both sides by 2}]$$

$$\therefore x^2 + 12x - 10x - 120 = 0$$

$$\therefore x(x + 12) - 10(x + 12) = 0$$

$$\therefore (x + 12)(x - 10) = 0$$

$$\therefore x + 12 = 0 \text{ or } x - 10 = 0$$

$$\therefore x = -12 \text{ or } x = 10$$

$x \neq -12$ as natural numbers cannot be negative.

$$\therefore x = 10 \text{ and } x + 2 = 10 + 2 = 12$$

∴

Problem Set- 2 (Textbook Page No. 54)

- * (12) The difference between squares of two numbers is 120. The square of smaller number is twice the greater number. Find the numbers. (4 marks)

Solution:

Let the bigger number be x .

Now, the difference between squares of two numbers is 120.

$$\therefore \text{Square of bigger number} - \text{Square of smaller number} = 120$$

$$\therefore x^2 - \text{square of smaller number} = 120$$

$$\therefore \text{Square of smaller number} = x^2 - 120$$

According to given condition,

$$x^2 - 120 = 2x$$

$$\therefore x^2 - 2x - 120 = 0$$

$$\therefore x^2 - 12x + 10x - 120 = 0$$

$$\therefore x(x - 12) + 10(x - 12) = 0$$

$$\therefore (x - 12)(x + 10) = 0$$

$$\therefore x - 12 = 0 \text{ or } x + 10 = 0$$

$$\therefore x = 12 \text{ or } x = -10$$

$$\text{If } x = -10 \text{ then } x^2 - 120 = (-10)^2 - 120$$

$$= 100 - 120$$

$$= -20$$

∴ $x = -10$ is not acceptable because square of smaller number cannot be negative.

$$\therefore x = 12$$

$$\text{Now, square of smaller number} = x^2 - 120$$

$$= (12)^2 - 120$$

$$= 144 - 120$$

$$= 24.$$

$$\therefore \text{Smaller number} = \sqrt{24} \text{ or } -\sqrt{24}$$

... (Taking square root)

∴ **The required numbers are 12 and $\sqrt{24}$ or 12 and $-\sqrt{24}$.**

Practice Set - 2.6 (Textbook Page No. 52)

- * (9) If 460 is divided by a natural number, quotient is 6 more than 5 times the divisor and remainder is 1 then find quotient and divisor. (4 marks)

Solution:

Let the divisor be x

$$\therefore \text{The quotient} = 5x + 6$$

Here, dividend = 460 and remainder = 1

Dividend = Divisor $\times$ Quotient + Remainder

$$\therefore 460 = x \times (5x + 6) + 1$$

$$\therefore 460 = 5x^2 + 6x + 1$$

$$\begin{aligned} \therefore 5x^2 + 6x + 1 - 460 &= 0 \\ \therefore 5x^2 + 6x - 459 &= 0 \\ \therefore 5x^2 - 45x + 51x - 459 &= 0 \\ \therefore 5x(x - 9) + 51(x - 9) &= 0 \\ \therefore (x - 9)(5x + 51) &= 0 \\ \therefore x - 9 = 0 \text{ or } 5x + 51 &= 0 \\ \therefore x = 9 \text{ or } x = \frac{-51}{5} \\ x \neq \frac{-51}{5} \text{ as natural numbers cannot be negative.} \\ \therefore x = 9 \text{ and } 5x + 6 &= 5 \times 9 + 6 = 51. \\ \therefore \text{The divisor is 9 and the quotient is 51.} \end{aligned}$$

Problem Set- 2 (Textbook Page No. 54)

- (11)** Mukund possesses ₹ 50 more than what Sagar possesses. The product of the amount they have is ₹ 15,000. Find the amounts each one has.

(3 marks)

Solution:Let the amount with Sagar be ₹ x .

$$\therefore \text{The amount with Mukund is } = ₹(x + 50)$$

According to given condition,

$$x \times (x + 50) = 15000$$

$$\therefore x^2 + 50x - 15000 = 0$$

$$\therefore x^2 + 150x - 100x - 15000 = 0$$

$$\therefore x(x + 150) - 100(x + 150) = 0$$

$$\therefore (x + 150)(x - 100) = 0$$

$$\therefore x + 150 = 0 \text{ or } x - 100 = 0$$

$$\therefore x = -150 \text{ or } x = 100$$

 $x \neq -150$ amount of rupees cannot be negative.

$$\therefore x = 100 \text{ and } x + 50 = 100 + 50 = 150$$

$$\therefore \text{The amount with Sagar is ₹ 100 and amount with Mukund is ₹ 150.}$$

Practice Set - 2.6 (Textbook Page No. 52)

- * (6)** Mr. Kasam runs a small business of making earthen pots. He makes certain number of pots on daily basis. Production cost of each pot is ₹ 40 more than 10 times total number of pots, he makes in one day. If production cost of all pots per day is ₹ 600, find production cost of one pot and number of pots he makes per day. (4 marks)

Solution:Let the number of pots made by Mr Kasam in each day be x .

$$\therefore \text{The cost price of each pot} = ₹(10x + 40)$$

$$\text{Total cost price of all pots made by him in one day} = ₹600$$

According to given condition,

$$x \times (10x + 40) = 600$$

$$\therefore 10x^2 + 40x = 600$$

$$\therefore 10x^2 + 40x - 600 = 0$$

$$\therefore x^2 + 4x - 60 = 0 \quad \dots (\text{Dividing both sides by 10})$$

$$\therefore x^2 + 10x - 6x - 60 = 0$$

$$\therefore x(x + 10) - 6(x + 10) = 0$$

$$\therefore (x + 10)(x - 6) = 0$$

$$\therefore x + 10 = 0 \text{ or } x - 6 = 0$$

$$\therefore x = -10 \text{ or } x = 6$$

 $x \neq -10$ as number of pots cannot be negative.

$$\begin{aligned} \therefore x = 6 \text{ and } 10x + 40 &= 10 \times 6 + 40 \\ &= 60 + 40 \\ &= 100 \end{aligned}$$

$$\therefore \text{Mr. Kasam is making 6 pots everyday and cost of each pot is ₹ 100.}$$

Problem Set- 2 (Textbook Page No. 54)

- * (13)** Ranjana wants to distribute 540 oranges among some students. If 30 students were more each would get 3 oranges less. Find the number of students. (4 marks)

Solution:Let the number of students be x .

Number of oranges = 540.

$$\therefore \text{Number of oranges each student get} = \frac{540}{x}$$

If there are $x + 30$ students, then number of oranges

$$\text{each student get} = \frac{540}{x + 30}$$

According to given condition,

$$\frac{540}{x} - \frac{540}{x + 30} = 3$$

$$\therefore 540 \left(\frac{1}{x} - \frac{1}{x + 30} \right) = 3$$

$$\therefore \frac{x + 30 - x}{x(x + 30)} = \frac{3}{540}$$

$$\therefore \frac{30}{x^2 + 30x} = \frac{1}{180}$$

$$\therefore x^2 + 30x = 5400$$

$$\therefore x^2 + 30x - 5400 = 0$$

$$\therefore x^2 + 90x - 60x - 5400 = 0$$

$$\therefore x(x + 90) - 60(x + 90) = 0$$

$$\therefore (x + 90)(x - 60) = 0$$

$$\therefore x + 90 = 0 \text{ or } x - 60 = 0$$

$$\therefore x = -90 \text{ or } x = 60$$

 $x \neq -90$ as number of students can not be negative.

$$\therefore x = 60$$

$$\therefore \text{The required number of students is 60.}$$

Practice Set - 2.6 (Textbook Page No. 52)

- (5) Suyash scored 10 marks more in second test than that in first. 5 times the score of the second test is same as square of the score in first test. Find his score in first test. (3 marks)

Solution:Let the marks scored by Suyash in first unit test be x .

$\therefore$ The marks scored by him in second unit test is $(x + 10)$

According to given condition,

$$5 \times (x + 10) = x^2$$

$$\therefore 5x + 50 = x^2$$

$$\therefore x^2 - 5x - 50 = 0$$

$$\therefore x^2 - 10x + 5x - 50 = 0$$

$$\therefore x(x - 10) + 5(x - 10) = 0$$

$$\therefore (x - 10)(x + 5) = 0$$

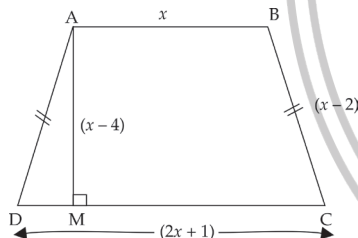
$$\therefore x - 10 = 0 \text{ or } x + 5 = 0$$

$$\therefore x = 10 \text{ or } x = -5$$

$x \neq -5$ as marks scored in unit test cannot be negative.

$$\therefore x = 10$$

$$\therefore \text{The marks scored by Suyash in first test is 10.}$$

*** (10)**

In the above fig. $\square ABCD$ is a trapezium $AB \parallel CD$ and its area is 33 cm^2 . From the information given in the figure, find the lengths of all sides of the $\square ABCD$. Fill in the empty boxes to get the solution. (3 marks)

Solution: $\square ABCD$ is a trapezium and $AB \parallel CD$

$$A(\square ABCD) = \frac{1}{2} (AB + CD) \times \boxed{AM}$$

$$\therefore 33 = \frac{1}{2} (x + 2x + 1) \times \boxed{(x - 4)}$$

$$\therefore \boxed{66} = (3x + 1) \times \boxed{(x - 4)}$$

$$\therefore 3x^2 + \boxed{(-11x)} - \boxed{70} = 0$$

$$\therefore 3x(x - 7) + 10(x - 7) = 0$$

$$\therefore (3x + 10)(x - 7) = 0$$

$$\therefore 3x + 10 = 0 \text{ or } \boxed{x - 7} = 0$$

$$\therefore x = \frac{-10}{3} \text{ or } x = \boxed{7}$$

But, length cannot be negative

$$\therefore x \neq \frac{-10}{3} \quad \therefore x = \boxed{7}$$

$$\therefore \boxed{AB = 7 \text{ cm}, CD = 15 \text{ cm}, AD = BC = 5 \text{ cm}}$$

Problem Set- 2 (Textbook Page No. 54)

- * (14)** Mr. Dinesh owns an agricultural farm at village Talvel. The length of the farm is 10 meter more than twice the breadth. In order to harvest rain water, he dug a square shape pond inside the farm. The side of pond is $\frac{1}{3}$ times of the breadth of the farm. The area of the farm is 20 times the area of the pond. Find the length and breadth of the farm and of the pond. (4 marks)

Solution:Let the breadth of rectangular field is $x \text{ m}$.

$$\therefore \text{Its length} = (2x + 10)$$

$$\text{Area of the farm} = (2x + 10) \times x \text{ sq.m}$$

$$\text{Now, side of a square pond} = \frac{1}{3} x \text{ m}$$

$$\begin{aligned} \therefore \text{Area of square pond} &= \text{side}^2 \\ &= \left(\frac{1}{3}x\right)^2 \\ &= \frac{1}{9}x^2 \text{ sq.m} \end{aligned}$$

According to given condition,

$$(2x + 10) \times x = 20 \times \frac{1}{9}x^2$$

$$\therefore 2x^2 + 10x = \frac{20x^2}{9}$$

$$\therefore 18x^2 + 90x = 20x^2$$

$$\therefore 90x = 20x^2 - 18x^2$$

$$\therefore 2x^2 - 90x = 0$$

$$\therefore 2x(x - 45) = 0$$

$$\therefore 2x = 0 \text{ or } x - 45 = 0$$

$$\therefore x = 0 \text{ or } x = 45$$

 $x \neq 0$ as breadth of field can not be zero.

$$\begin{aligned} \therefore x &= 45 \text{ and } (2x + 10) = 2 \times 45 + 10 \\ &= 90 + 10 \\ &= 100 \end{aligned}$$

$$\text{Also, } \frac{1}{3}x = \frac{1}{3} \times 45 = 15$$

$$\therefore \text{The length of rectangular field is 100 m and breadth is 45 m. Also, length of each side of square pond is 15 m.}$$

Practice Set - 2.6 (Textbook Page No. 52)

- * (8)** Pintu takes 6 days more than those of Nishu to complete certain work. If they work together, they finish it in 4 days. How many days would it take to complete the work if they work alone? (4 marks)

Solution:

Let Nishu take x days to complete the work.

$\therefore$ Pintu takes $(x + 6)$ days to complete the work.

$\therefore$ Work done by Nishu in 1 day = $\frac{1}{x}$

$\therefore$ Work done by Pintu in 1 day = $\frac{1}{x+6}$

$\therefore$ Work done by both of them in 1 day = $\frac{1}{x} + \frac{1}{x+6}$

But, together they complete the work in 4 days.

$\therefore$ Work done by both of them in 1 day = $\frac{1}{4}$

According to given condition,

$$\frac{1}{x} + \frac{1}{x+6} = \frac{1}{4}$$

$$\therefore \frac{x+6+x}{x(x+6)} = \frac{1}{4}$$

$$\therefore \frac{2x+6}{x^2+6x} = \frac{1}{4}$$

$$\therefore x^2+6x = 8x+24$$

$$\therefore x^2+6x-8x-24=0$$

$$\therefore x^2-2x-24=0$$

$$\therefore x^2-6x+4x-24=0$$

$$\therefore x(x-6)+4(x-6)=0$$

$$\therefore (x-6)(x+4)=0$$

$$\therefore x-6=0 \text{ or } x+4=0$$

$$\therefore x=6 \text{ or } x=-4$$

$x \neq -4$ as number of days cannot be negative.

$$\therefore x=6 \text{ and } x+6=6+6=12$$

$\therefore$ **Nishu takes 6 days and Pintu takes 12 days to complete the work.**

Problem Set- 2 (Textbook Page No. 54)

- * (15)** A tank fills completely in 2 hours if both the taps are open. If only one of the taps is open at the given time, the smaller tap takes 3 hours more than the larger one to fill the tank. How much time does each tap take to fill the tank completely. (4 marks)

Solution:

Let the bigger tap requires x hours to fill the tank.

$\therefore$ The smaller tap require $(x + 3)$ hours.

According to given condition,

$$\frac{1}{x} + \frac{1}{x+3} = \frac{1}{2}$$

$$\therefore \frac{x+3+x}{x(x+3)} = \frac{1}{2}$$

$$\therefore \frac{2x+3}{x^2+3x} = \frac{1}{2}$$

$$\therefore x^2+3x = 4x+6$$

$$\therefore x^2+3x-4x-6=0$$

$$\therefore x^2-x-6=0$$

$$\therefore x^2-3x+2x-6=0$$

$$\therefore x(x-3)+2(x-3)=0$$

$$\therefore (x-3)(x+2)=0$$

$$\therefore x-3=0 \text{ or } x+2=0$$

$$\therefore x=3 \text{ or } x=-2$$

$x \neq -2$ as time cannot be negative.

$$\therefore x=3 \text{ and } x+3=3+3=6$$

$\therefore$ **The bigger tap required 3 hours to fill the tank and the smaller tap required 6 hours.**

Practice Set - 2.6 (Textbook Page No. 52)

- * (7)** Pratik takes 8 hours to travel 36 km downstream and return to same spot. The speed of boat in still water is 12 km/hr. Find the speed of the water current. (4 marks)

Solution:

Let the speed of the river current be x km/h.

The speed of the boat in still water is 12 km/hr.

$\therefore$ The speed of the boat in downstream is $(12 + x)$ km/hr and the speed of boat in upstream is $(12 - x)$ km/hr. [$x < 12$]

$$\text{Time} = \frac{\text{Distance}}{\text{Speed}}$$

Time taken by boat to travel 36 km downstream.

$$= \left(\frac{36}{12+x} \right) \text{ hours}$$

Time taken by boat to travel 36 km upstream.

$$= \left(\frac{36}{12-x} \right) \text{ hours}$$

According to given condition,

$$\frac{36}{12+x} + \frac{36}{12-x} = 8$$

$$\therefore 36 \left(\frac{1}{12+x} + \frac{1}{12-x} \right) = 8$$

$$\therefore \frac{12-x+12+x}{(12+x)(12-x)} = \frac{8}{36}$$

$$\therefore \frac{24}{12^2 - x^2} = \frac{2}{9} \quad \dots [\text{Using } (a+b)(a-b) = a^2 - b^2]$$

$$\therefore \frac{24}{144 - x^2} = \frac{2}{9}$$

$$\therefore 24 \times 9 = 2(144 - x^2)$$

$$\therefore \frac{24 \times 9}{2} = 144 - x^2$$

$$\therefore 12 \times 9 = 144 - x^2$$

$$\therefore 108 = 144 - x^2$$

$$\therefore x^2 = 144 - 108$$

$$\therefore x^2 = 36$$

$$\therefore x^2 - 36 = 0$$

$$\therefore (x+6)(x-6) = 0$$

$$\therefore x+6=0 \text{ or } x-6=0$$

$$\therefore x = -6 \text{ or } x = 6$$

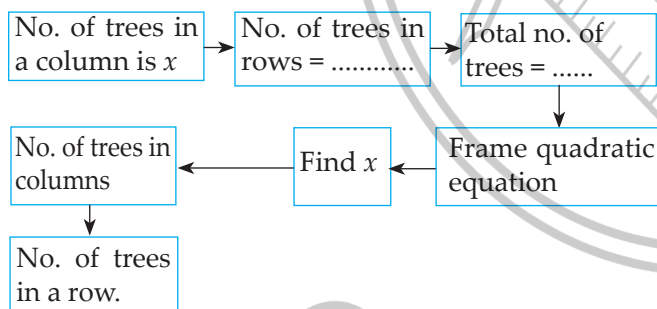
$x \neq -6$ as speed of river current cannot be negative.

$$\therefore x = 6.$$

$\therefore$ The speed of river current is 6 km/hr.

- (3) In the orange garden of Mr. Madhusudan there are 150 orange trees. The number of trees in each rows are 5 more than that in each column. Find the number of trees in each rows and each column with the help of following flow chart.

(3 marks)



Solution:

Let the number of trees planted in vertical rows be x .

$\therefore$ The number of trees planted in horizontal rows is $(x+5)$.

$\therefore$ The total number of trees planted $= x \times (x+5)$

But, the total number of trees planted is 150.

$$x \times (x+5) = 150$$

$$x^2 + 5x = 150$$

$$\therefore x^2 + 5x - 150 = 0$$

$$\therefore x^2 + 15x - 10x - 150 = 0$$

$$\therefore x(x+15) - 10(x+15) = 0$$

$$\therefore (x+15)(x-10) = 0$$

$$\therefore x+15=0 \text{ or } x-10=0$$

$$\therefore x = -15 \text{ or } x = 10$$

$x \neq -15$ as number of trees cannot be negative.

$$\therefore x = 10 \text{ and } x+5 = 10+5 = 15$$

$\therefore$ The number of trees planted in horizontal rows is 15 and 10 trees planted in vertical rows.

Problem Set - 2 (Textbook Page No. 53)

MCQ's

- (1) Choose the correct answers for the following questions. (1 mark each)

- (1) Which one is the quadratic equation ?

(A) $\frac{5}{x} - 3 = x^2$

(B) $x(x+5) = 2$

(C) $n-1 = 2n$

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

- (2) Out of the following equations which one is not a quadratic equation ?

(A) $x^2 + 4x = 11 + x^2$

(B) $x^2 = 4x$

(C) $5x^2 = 90$

(D) $2x - x^2 = x^2 + 5$

- (3) The roots of $x^2 + kx + k = 0$ are real and equal, find k .

(A) 0

(B) 4

(C) 0 or 4

(D) 2

- (4) For $\sqrt{2}x^2 - 5x + \sqrt{2} = 0$, find the value of the discriminant.

(A) -5

(B) 17

(C) $\sqrt{2}$

(D) $2\sqrt{2} - 5$

- (5) Which of the following quadratic equations has roots 3, 5 ?

(A) $x^2 - 15x + 8 = 0$

(B) $x^2 - 8x + 15 = 0$

(C) $x^2 + 3x + 5 = 0$

(D) $x^2 + 8x - 15 = 0$

- (6) Out of the following equations, find the equation having the sum of its roots -5.

(A) $3x^2 - 15x + 3 = 0$

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

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

(D) $3x^2 + 15x + 3 = 0$

- (7) $\sqrt{5}m^2 - \sqrt{5}m + \sqrt{5} = 0$ which of the following statement is true for this given equation ?

(A) real and unequal roots

(B) real and equal roots

(C) no real roots

(D) three roots

- (8) One of the roots of equation $x^2 + mx - 5 = 0$ is 2 find m .

(A) -2

(B) $-\frac{1}{2}$

(C) $\frac{1}{2}$

(D) 2

Additional MCQ's

- (9) The sum of roots $(\alpha + \beta) = \dots\dots\dots$
 (A) $\frac{-b}{a}$ (B) $\frac{b}{a}$ (C) $\frac{-c}{a}$ (D) $\frac{c}{a}$
- (10) The roots of a quadratic equation $y^2 - 16y + 63 = 0$ are $\dots\dots\dots$
 (A) -9 and -7 (B) -9 and 7
 (C) 9 and -7 (D) 9 and 7
- (11) If the roots of a quadratic equation are real and equal, then Δ must be $\dots\dots\dots$
 (A) zero (B) greater than zero
 (C) less than zero (D) equal to one
- (12) If one root of quadratic equation $kx^2 - 7x + 12 = 0$ is 3, then value of k is $\dots\dots\dots$
 (A) -1 (B) 1 (C) 3 (D) none of these
- (13) If one root of quadratic equation is $1 - \sqrt{3}$ then the other root is $\dots\dots\dots$
 (A) $1 - \sqrt{3}$ (B) $-1 - \sqrt{3}$
 (C) $1 + 2\sqrt{3}$ (D) $1 + \sqrt{3}$
- (14) If the roots of $ax^2 + bx + c = 0$ are real and equal then $\dots\dots\dots$
 (A) $b^2 - 4ac < 0$ (B) $b^2 - 4ac = 0$
 (C) $b^2 - 4ac > 0$ (D) cannot say
- (15) The value of discriminant of the equation $x^2 + x + 1 = 0$ is $\dots\dots\dots$
 (A) -4 (B) -3 (C) 3 (D) 4
- (16) In a quadratic equation, $\alpha + \beta = -4$ and $\alpha\beta = -1$, then required equation is $\dots\dots\dots$
 (A) $x^2 - 4x - 1 = 0$ (B) $x^2 + 4x - 1 = 0$
 (C) $x^2 + 4x + 1 = 0$ (D) $x^2 - 4x + 1 = 0$
- (17) The standard form of quadratic equation $x - \frac{5}{x} = 3x - 7$ is $\dots\dots\dots$
 (A) $2x^2 - 8x + 7 = 0$ (B) $2x^2 + 7x + 5 = 0$
 (C) $2x^2 - 7x + 5 = 0$ (D) $2x^2 - 5x + 7 = 0$
- (18) What is the nature of roots of quadratic equation $9x^2 - 12x + 4 = 0$?
 (A) real (B) equal
 (C) unequal (D) both A and B
- (19) Three times the square of natural number is 363 is written in the mathematical equation form as $\dots\dots\dots$
 (A) $x^2 + 3 = 363$ (B) $x^2 - 3 = 363$
 (C) $3x^2 = 363$ (D) $\frac{x^2}{3} = 363$

- (20) Which of the following is not a quadratic equation?

- (A) $\frac{-5}{3}x^2 = 2x + 9$ (B) $(x + 3)(x + 4)$
 (C) $\frac{5}{x} - 3 = x^2$ (D) $\frac{7}{m} = 3m + 5$

- (21) The product of the roots $(\alpha \times \beta) = \dots\dots\dots$

- (A) $\frac{-b}{a}$ (B) $\frac{-c}{a}$ (C) $\frac{b}{a}$ (D) $\frac{c}{a}$

- (22) $\alpha^3 + \beta^3 = \dots\dots\dots$

- (A) $(\alpha + \beta)^3 - 3\alpha\beta(\alpha + \beta)$
 (B) $(\alpha - \beta)^3 + 3\alpha\beta(\alpha - \beta)$
 (C) $(\alpha + \beta)^3 - 3\alpha\beta(\alpha - \beta)$
 (D) $(\alpha - \beta)^3 - 3\alpha\beta(\alpha - \beta)$

- (23) If one root of quadratic equation is $5 + \sqrt{5}$, then the product of roots is $\dots\dots\dots$

- (A) 30 (B) -20 (C) 20 (D) 125

ANSWERS

- (1) (B) $x(x + 5) = 2$ (2) (A) $x^2 + 4x = 11 + x^2$

- (3) (C) 0 or 4

Working:

$$x^2 + kx + k = 0$$

Comparing with $ax^2 + bx + c = 0$, we get $a = 1$,
 $b = k$, $c = k$

Since the equation has equal roots

$$\Delta = 0$$

$$\therefore b^2 - 4ac = 0$$

$$\therefore k^2 - 4(1)(k) = 0$$

$$\therefore k^2 - 4k = 0$$

$$\therefore k(k - 4) = 0$$

$$\therefore k = 0 \text{ or } k - 4 = 0$$

$$\therefore k = 0 \text{ or } k = 4$$

- (4) (B) 17

Working:

$$\sqrt{2}x^2 - 5x + \sqrt{2} = 0$$

Comparing with $ax^2 + bx + c = 0$ we get,

$$a = \sqrt{2}, b = -5, c = \sqrt{2}$$

$$\Delta = b^2 - 4ac$$

$$= (-5)^2 - 4(\sqrt{2})(\sqrt{2})$$

$$= 25 - 8$$

$$= 17$$

- (5) (B) $x^2 - 8x + 15 = 0$

Working:

$$\alpha = 3, \beta = 5$$

$$\alpha + \beta = 3 + 5 = 8$$

$$\alpha\beta = 3 \times 5 = 15$$

The required equation is $x^2 - (\alpha + \beta)x + \alpha\beta = 0$
 $x^2 - 8x + 15 = 0$

- (6) (D) $3x^2 + 15x + 3 = 0$

Working:

Sum of roots is -5 .

For the equation $3x^2 + 15x + 5 = 0$

Comparing with $ax^2 + bx + c = 0$

$a = 3, b = 15, c = 3$

Product of roots = $\frac{c}{a} = \frac{-15}{3} = -5$

- (7) (C) no real roots

Working:

$\sqrt{5}m^2 - \sqrt{5}m + \sqrt{5} = 0$

Comparing with $am^2 + bm + c = 0$

$a = \sqrt{5}, b = -\sqrt{5}, c = \sqrt{5}$

$$\begin{aligned}\therefore b^2 - 4ac &= (-\sqrt{5})^2 - 4(\sqrt{5})(\sqrt{5}) \\ &= 5 - 20 \\ &= -15\end{aligned}$$

Since, $b^2 - 4ac < 0$

The equation has no real roots.

- (8) (C) $\frac{1}{2}$

Working:

Since 2 is the one of the root of $x^2 + mx - 5 = 0$,

It satisfies the equation

$\therefore$ Substituting $x = 2$ in the equation, we get

$$(2)^2 + m(2) - 5 = 0$$

$$\therefore 4 + 2m - 5 = 0$$

$$\therefore 2m - 1 = 0$$

$$\therefore 2m = 1$$

$$\therefore m = \frac{1}{2}$$

- (9) (A) $\frac{-b}{a}$

- (10) (D) 9 and 7

- (11) (A) zero

- (12) (C) 1

- (13) (D) $1 + \sqrt{3}$

- (14) (B) $b^2 - 4ac = 0$

- (15) (B) -3

- (16) (B) $x^2 + 4x - 1 = 0$

- (17) (C) $2x^2 - 7x + 5 = 0$

- (18) (D) both A and B

- (19) (C) $3x^2 = 363$

- (20) (C) $\frac{5}{x} - 3 = x^2$

- (21) (D) $\frac{c}{a}$

- (22) (A) $(\alpha + \beta)^3 - 3\alpha\beta(\alpha + \beta)$

- (23) (C) 20

PROBLEMS FOR PRACTICE

- (1) If $x = 9$ is one root of the quadratic equation $x^2 - 11x + k = 0$, then find the value of k .

(2 marks)

- (2) If one root of the quadratic equation

$$3y^2 - ky + 8 = 0 \text{ is } \frac{2}{3}, \text{ then find the value of } k.$$

(2 marks)

- (3) Determine whether the given values of x are the roots of given quadratic equation

$$6x^2 - x - 2 = 0,$$

$$x = \frac{-1}{2}, x = 5$$

(2 marks)

- (4) Which of the following are quadratic equations? (1 mark)

(i) $x - \frac{5}{x} = 3x - 9$ (ii) $(x + 3)(x - 4) = 0$

(iii) $\frac{5}{x} - 3 = x^2$ (iv) $n^3 - n + 4 = n^3$

(v) $x - 3 = 4x^2$

- (5) Write the quadratic equations in $ax^2 + bx + c = 0$ form and find the values of a, b, c . (2 marks)

(i) $m(m - 7) = 0$ (ii) $\frac{x^2 - 7}{x} = 7$

(iii) $x - \frac{6}{x} = 5$ (iv) $(x + 5)(x - 11)$

- (6) Solve the following quadratic equations by factorization method: (2 marks)

(i) $x^2 - 5x - 36 = 0$ (ii) $3y^2 - 14y + 8 = 0$

(iii) $64m^2 - 625 = 0$ (iv) $x^2 - 13x + 30 = 0$

(v) $16x^2 - 24x = 0$ (vi) $x^2 - 3\sqrt{3}x + 6 = 0$

(vii) $7x^2 + 4x - 20 = 0$ (viii) $m^2 - 7 = 0$

- (7) Solve the following quadratic equations by completing square method: (2 marks)

(i) $x^2 + 8x + 15 = 0$ (ii) $m^2 - 2m - 1 = 0$

(iii) $x^2 + 3x + 1 = 0$ (iv) $3y^2 + 7y + 1 = 0$

(v) $4p^2 + 7 = 12p$ (vi) $6m^2 + m = 2$

- (8) Solve the following quadratic equations by using formula method: (2 marks)

(i) $x^2 + 2x - 7 = 0$ (ii) $3x^2 + 8x + 3 = 0$

(iii) $5m^2 + 5m = 1$ (iv) $x^2 + 4x - 1 = 0$

(v) $4x^2 + x - 5 = 0$ (vi) $9y^2 - 5y - 4 = 0$

- (9) Find the value of discriminant for each of the following quadratic equations: (2 marks)

(i) $x^2 + 4x + 4 = 0$ (ii) $x^2 + 4x + 1 = 0$

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

- (10) Determine the nature of roots of the following quadratic equations from their discriminants: (2 marks)

(i) $x^2 - 8x + 16 = 0$ (ii) $2x^2 - 3x - 4 = 0$

(iii) $4x^2 - 8x + 9 = 0$

(11) Form the quadratic equation if its roots are

(i) 0 and -4 (ii) $\frac{1}{2}$ and $\frac{-3}{4}$

(iii) $(\sqrt{2} + \sqrt{3})$ and $(\sqrt{2} - \sqrt{3})$ (3 marks)

(12) Find the value of k for which given quadratic equations are real and equal roots. (3 marks)

(i) $k^2x^2 - 2(k-1)x + 4 = 0$ (ii) $4x^2 - 3kx + 1 = 0$

(13) If α and β are the roots of equation $x^2 - 4x + 1 = 0$, find (i) $\alpha^2 + \beta^2$ (ii) $\alpha^3 + \beta^3$ (3 marks)

(14) Find k, if one root of the equation $5x^2 + 6x + k = 0$ is five times the other. (3 marks)

(15) A man riding on a bicycle covers a distance of 60 km in a direction of wind and comes back to his original position in 8 hours. If the speed of the wind is 10 km/hr, find the speed of the bicycle. (4 marks)

(16) One tank can be filled up by two taps in 6 hours. The smaller tap alone takes 5 hours more than the bigger tap alone. Find the time required by each tap to fill the tank separately. (4 marks)

(17) The sum of the squares of two consecutive natural numbers is 113. Find the numbers. (4 marks)

(18) The sum of the squares of two consecutive natural numbers is 100. Find the numbers. (4 marks)

(19) For doing some work, Ganesh takes 10 days more than John. If both work together, they will complete the work in 12 days. Find the number of days if Ganesh work alone? (4 marks)

(20) In garden, there are some rows and columns. The number of trees in a row is greater than that in each column by 10. Find the number of trees in each row if the total number of trees are 200. (4 marks)

(21) The sum of reciprocals of Reshma's ages (in years) 3 years ago and 5 years after now is $\frac{1}{3}$. Find her present age. (4 marks)

ANSWERS

(1) $k = 18$

(2) $k = 14$

(3) $x = \frac{-1}{2}$ is the root and $x = 5$ is not the root of given equation.

(4) (i), (ii) and (v) are quadratic equations.

(5) (i) $m^2 - 7m + 0 = 0$ and $a = 1, b = -7, c = 0$

(ii) $x^2 - 7x - 7 = 0$ and $a = 1, b = -7, c = -7$

(iii) $x^2 - 5x - 6 = 0$ and $a = 1, b = -5, c = -6$

(iv) $x^2 - 6x - 55 = 0$ and $a = 1, b = -6, c = -55$

(6) (i) $x = 9$ or $x = -4$ (ii) $y = 4$ or $y = \frac{2}{3}$

(iii) $m = \frac{-25}{8}$ or $m = \frac{25}{8}$ (iv) $x = 10$ or $x = 3$

(v) $x = 0$ or $x = \frac{3}{2}$ (vi) $x = \sqrt{3}$ or $x = 2\sqrt{3}$

(vii) $x = -2$ or $x = \frac{10}{7}$ (viii) $x = \sqrt{7}$ or $x = -\sqrt{7}$

(7) (i) $x = -3$ or $x = -5$

(ii) $m = 1 + \sqrt{2}$ or $m = 1 - \sqrt{2}$

(iii) $m = \frac{-3 + \sqrt{5}}{2}$ or $m = \frac{-3 - \sqrt{5}}{2}$

(iv) $y = \frac{-7 + \sqrt{37}}{6}$ or $m = \frac{-7 - \sqrt{37}}{6}$

(v) $p = \frac{3 + \sqrt{2}}{2}$ or $p = \frac{3 - \sqrt{2}}{2}$

(vi) $m = \frac{1}{2}$ or $m = \frac{-2}{3}$

(8) (i) $-1 + 2\sqrt{2}$ and $-1 - 2\sqrt{2}$

(ii) $\frac{-4 + \sqrt{7}}{3}$ and $\frac{-4 - \sqrt{7}}{3}$

(iii) $\frac{-5 + 3\sqrt{5}}{10}$ and $\frac{-5 - 3\sqrt{5}}{10}$

(iv) $-2 + \sqrt{5}$ and $-2 - \sqrt{5}$

(v) 1 and $\frac{-5}{4}$

(vi) 1 and $\frac{-4}{9}$

(9) (i) 0 (ii) 12 (iii) -8

(10) (i) real and equal (ii) real and unequal

(iii) not real

(11) (i) $x^2 + 4x = 0$ (ii) $8x^2 + 2x - 3 = 0$

(iii) $x^2 - 2\sqrt{2}x - 1 = 0$

(12) (i) $k = -1$ or $k = \frac{1}{3}$ (ii) $k = \frac{-4}{3}$ or $k = \frac{4}{3}$

(13) (i) 14 (ii) 52

(14) $k = 1$

(15) 20 km/hr.

(16) 10 hours and 15 hours (17) 7 and 8

(18) 6 and 8

(19) 30 days

(20) 20

(21) 7 years

ASSIGNMENT - 2

Time : 1 Hr.

Marks : 20

Q.1. (A) Choose the proper alternatives for the question below:

(1)

- (1) If α and β are the roots of quadratic equation $2x^2 + 4x + 3 = 0$, then the value of $\alpha + \beta = \square$

(A) -2 (B) 2 (C) 34 (D) -4

(B) Perform the following activities:

(3)

- (1) Write the following quadratic equation in standard form: $(m + 4)(m - 10) = 0$

Solution: $\square m^2 - \square m - \square = 0$ is the standard form of quadratic equation.

- (3) If sum of the roots of quadratic equation is 10 and the product is 9, then form the quadratic equation:

Solution: $x^2 - \square x + \square = \square$

- (4) Find the values of a, b, c for the following quadratic equation by comparing with standard form: $x^2 - x - 3 = 0$

Solution: Quadratic Equation is $x^2 - x - 3 = 0$

Comparing with $ax^2 + bx + c = 0$, we get

a = $\square$, b = $\square$, c = $\square$

Q.2. Perform of the following activities: (Any 1)

(2)

- (1) Solve by factorization method : $m^2 - 25 = 0$

Solution: $m^2 - 25 = 0$

$\therefore (\dots\dots\dots)^2 - (\dots\dots\dots)^2 = 0$

$\therefore (\dots\dots\dots) (\dots\dots\dots) = 0$

$\therefore m = \dots\dots\dots$ or $m = \dots\dots\dots$

- (2) If $\alpha = -5$ and $\beta = 9$, then form the quadratic equation.

Solution: The required quadratic equation is

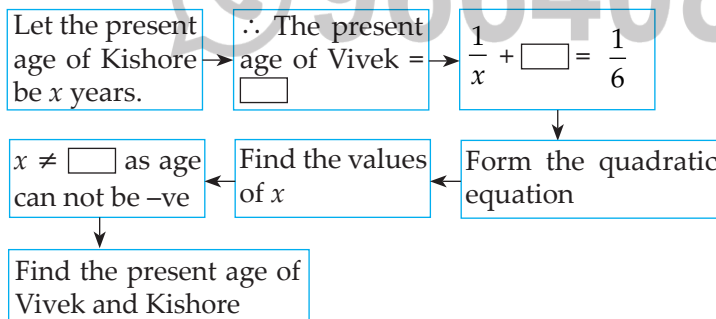
$x^2 + (\square + \square)x + \square \times \square = 0$

$\therefore x^2 - \square x - \square = 0$

Q.3. Perform the following activities: (Any 2)

(6)

- (1) Vivek is 5 years elder to Kishore. The sum of the reciprocal of their age is $\frac{1}{6}$. Find their present ages by completing the given flow chart.



- (2) Solve the following quadratic equation by formula method: $x^2 + 6x + 5 = 0$

Solution: $x^2 + 6x + 5 = 0$

Here, a = $\square$, b = $\square$, c = $\square$

$$b^2 - 4ac = \square^2 - 4 \times \square \times \square$$

$$= \square$$

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

$$\therefore x = \frac{-\square \pm \sqrt{\square}}{2 \times \square}$$

$$x = \frac{-\square \pm \square}{\square}$$

$$\therefore x = \square \text{ or } x = \square$$

- (3) If α and β are the roots of quadratic equation $x^2 + 5x - 1 = 0$ then, find (i) $\alpha^3 + \beta^3$ (ii) $\alpha^2 + \beta^2$

Solution: $x^2 + 5x - 1 = 0$

Here, $a = 1$, $b = 5$, $c = -1$

$$\alpha + \beta = \frac{-b}{a} = -\frac{5}{1},$$

$$\alpha \times \beta = \frac{c}{a} = \frac{-1}{1}$$

$$\alpha^3 + \beta^3 = (\alpha + \beta)^3 - 3\alpha\beta(\alpha + \beta)$$

$$= \square^3 - 3 \times \square \times \square$$

$$\therefore \alpha^3 + \beta^3 = \square$$

$$\alpha^2 + \beta^2 = (\alpha + \beta)^2 - 2\alpha\beta$$

$$= \square^2 - 2 \times \square$$

$$\therefore \alpha^2 + \beta^2 = \square$$

Q.4. Attempt of the following: (Any 2)

(8)

- (1) For doing some work, Pintu takes 6 days more than Nishu. If both work together, they complete the work in 4 days. Find the number of days if Pintu and Nishu work alone.
- (2) Find m , if the roots of the quadratic equation $(m - 12)x^2 + 2(m - 12)x + 2 = 0$ are real and equal.
- (3) Pratik travels by boat 36 km down a river and back in 8 hours. If the speed of his boat in still water is 12 km/hr, find the speed of the river current.

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