

Pair of Linear Equations in Two Variables

EXERCISE - 3.1

1. (i) Let the number of boys be x and number of girls be y .

$$\therefore x + y = 10 \quad \dots (1)$$

$$\therefore \text{Number of girls} = [\text{Number of boys}] + 4$$

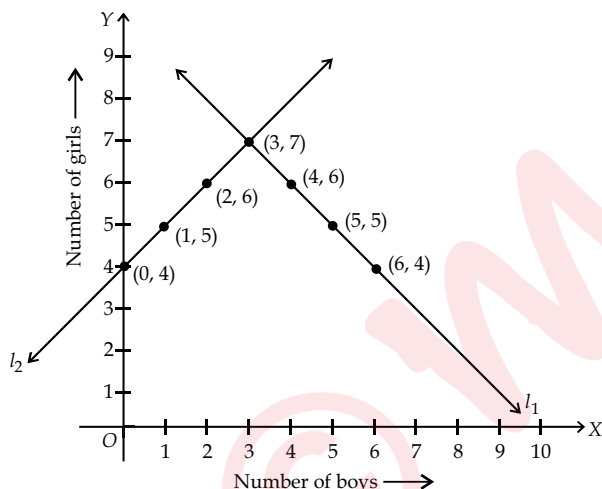
$$\therefore y = x + 4 \quad \dots (2)$$

Now, from equation (1), we have $l_1 : y = 10 - x$

x	6	4	5
y	4	6	5

And from equation (2), we have $l_2 : y = x + 4$

x	0	1	2
y	4	5	6



Since, l_1 and l_2 intersect at the point $(3, 7)$.

\therefore The solution of the given pair of linear equations is $x = 3, y = 7$

\therefore Required number of boys and girls are 3 and 7 respectively.

- (ii) Let the cost of a pencil is ₹ x and cost of a pen is ₹ y . Since, cost of 5 pencils + Cost of 7 pens = ₹ 50

$$\Rightarrow 5x + 7y = 50 \quad \dots (1)$$

Also, cost of 7 pencils + cost of 5 pens = ₹ 46

$$\Rightarrow 7x + 5y = 46 \quad \dots (2)$$

Now, from equation (1), we have

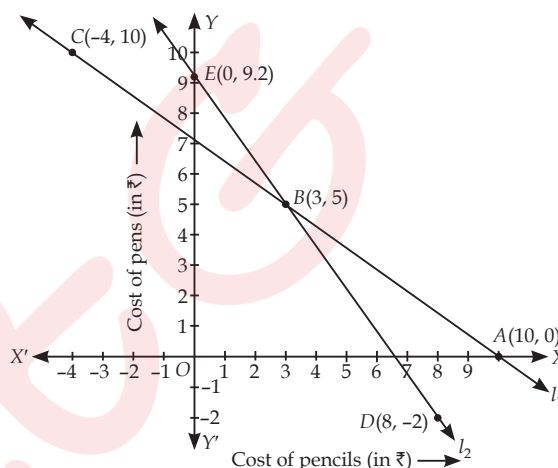
$$l_1 : y = \frac{50 - 5x}{7}$$

x	10	3	-4
y	0	5	10

And from equation (2), we have

$$l_2 : y = \frac{46 - 7x}{5}$$

x	8	3	0
y	-2	5	9.2



Since, l_1 and l_2 intersect at $B(3, 5)$.

\therefore Cost of a pencil is ₹ 3 and cost of a pen is ₹ 5.

2. Comparing the given equations with

$$a_1x + b_1y + c_1 = 0, a_2x + b_2y + c_2 = 0, \text{ we have}$$

- (i) For, $5x - 4y + 8 = 0, 7x + 6y - 9 = 0$

$$a_1 = 5, b_1 = -4, c_1 = 8 \text{ and } a_2 = 7, b_2 = 6, c_2 = -9$$

$$\therefore \frac{a_1}{a_2} = \frac{5}{7}, \frac{b_1}{b_2} = \frac{-4}{6} = \frac{-2}{3} \Rightarrow \frac{a_1}{a_2} \neq \frac{b_1}{b_2}$$

So, the lines are intersecting, i.e., they intersect at a unique point.

- (ii) For, $9x + 3y + 12 = 0, 18x + 6y + 24 = 0$, we have

$$a_1 = 9, b_1 = 3, c_1 = 12 \text{ and } a_2 = 18, b_2 = 6, c_2 = 24$$

$$\therefore \frac{a_1}{a_2} = \frac{9}{18} = \frac{1}{2}, \frac{b_1}{b_2} = \frac{3}{6} = \frac{1}{2} \text{ and } \frac{c_1}{c_2} = \frac{12}{24} = \frac{1}{2}$$

$$\Rightarrow \frac{a_1}{a_2} = \frac{b_1}{b_2} = \frac{c_1}{c_2}$$

So, the lines are coincident.

- (iii) For, $6x - 3y + 10 = 0, 2x - y + 9 = 0$, we have

$$a_1 = 6, b_1 = -3, c_1 = 10 \text{ and } a_2 = 2, b_2 = -1, c_2 = 9$$

$$\therefore \frac{a_1}{a_2} = \frac{6}{2} = 3, \frac{b_1}{b_2} = \frac{-3}{-1} = 3, \frac{c_1}{c_2} = \frac{10}{9} \Rightarrow \frac{a_1}{a_2} = \frac{b_1}{b_2} \neq \frac{c_1}{c_2}$$

So, the lines are parallel.

3. (i) For, $3x + 2y = 5, 2x - 3y = 7$, we have

$$a_1 = 3, b_1 = 2, c_1 = -5 \text{ and } a_2 = 2, b_2 = -3, c_2 = -7$$

$$\therefore \frac{a_1}{a_2} = \frac{3}{2}, \frac{b_1}{b_2} = \frac{2}{-3} \text{ and } \frac{c_1}{c_2} = \frac{-5}{-7} = \frac{5}{7}$$

$$\therefore \frac{a_1}{a_2} \neq \frac{b_1}{b_2}$$

So, lines are intersecting i.e., they intersect at a unique point.

\therefore It is consistent pair of equations.

(ii) For, $2x - 3y = 8$, $4x - 6y = 9$, we have

$$a_1 = 2, b_1 = -3, c_1 = -8 \text{ and } a_2 = 4, b_2 = -6, c_2 = -9$$

$$\therefore \frac{a_1}{a_2} = \frac{2}{4} = \frac{1}{2}, \frac{b_1}{b_2} = \frac{-3}{-6} = \frac{1}{2} \text{ and } \frac{c_1}{c_2} = \frac{-8}{-9} = \frac{8}{9}$$

$$\text{Here, } \frac{a_1}{a_2} = \frac{b_1}{b_2} \neq \frac{c_1}{c_2}$$

So, lines are parallel i.e., the given pair of linear equations has no solution.

\therefore It is inconsistent pair of equations.

(iii) For, $\frac{3}{2}x + \frac{5}{3}y = 7$, $9x - 10y = 14$, we have

$$a_1 = \frac{3}{2}, b_1 = \frac{5}{3}, c_1 = -7 \text{ and } a_2 = 9, b_2 = -10, c_2 = -14$$

$$\therefore \frac{a_1}{a_2} = \frac{3/2}{9} = \frac{3}{2} \times \frac{1}{9} = \frac{1}{6},$$

$$\frac{b_1}{b_2} = \frac{5/3}{-10} = \frac{5}{3} \times \frac{1}{-10} = -\frac{1}{6} \text{ and } \frac{c_1}{c_2} = \frac{-7}{-14} = \frac{1}{2}$$

$$\text{Here, } \frac{a_1}{a_2} \neq \frac{b_1}{b_2}. \text{ So lines are intersecting.}$$

So, the given pair of linear equations has a unique solution.

\therefore It is a consistent pair of equations.

(iv) For, $5x - 3y = 11$, $-10x + 6y = -22$, we have

$$a_1 = 5, b_1 = -3, c_1 = -11 \text{ and } a_2 = -10, b_2 = 6, c_2 = 22$$

$$\therefore \frac{a_1}{a_2} = \frac{5}{-10} = -\frac{1}{2}, \frac{b_1}{b_2} = \frac{-3}{6} = -\frac{1}{2} \text{ and } \frac{c_1}{c_2} = \frac{-11}{22} = -\frac{1}{2}$$

$$\text{Here, } \frac{a_1}{a_2} = \frac{b_1}{b_2} = \frac{c_1}{c_2}$$

So, lines are coincident.

\therefore The given pair of linear equations has infinitely many solutions.

Thus, they are consistent.

(v) For, $\frac{4}{3}x + 2y = 8$, $2x + 3y = 12$, we have

$$a_1 = \frac{4}{3}, b_1 = 2, c_1 = -8 \text{ and } a_2 = 2, b_2 = 3, c_2 = -12$$

$$\therefore \frac{a_1}{a_2} = \frac{4/3}{2} = \frac{4}{3} \times \frac{1}{2} = \frac{2}{3}, \frac{b_1}{b_2} = \frac{2}{3} \text{ and } \frac{c_1}{c_2} = \frac{-8}{-12} = \frac{2}{3}$$

$$\text{Since, } \frac{a_1}{a_2} = \frac{b_1}{b_2} = \frac{c_1}{c_2}$$

So, the lines are coincident i.e., they have infinitely many solutions.

\therefore The given pair of linear equations are consistent.

4. (i) For, $x + y = 5$, $2x + 2y = 10$, we have

$$a_1 = 1, b_1 = 1, c_1 = -5 \text{ and } a_2 = 2, b_2 = 2, c_2 = -10$$

$$\therefore \frac{a_1}{a_2} = \frac{1}{2}, \frac{b_1}{b_2} = \frac{1}{2} \text{ and } \frac{c_1}{c_2} = \frac{-5}{-10} = \frac{1}{2}$$

$$\Rightarrow \frac{a_1}{a_2} = \frac{b_1}{b_2} = \frac{c_1}{c_2}$$

So, lines are coincident.

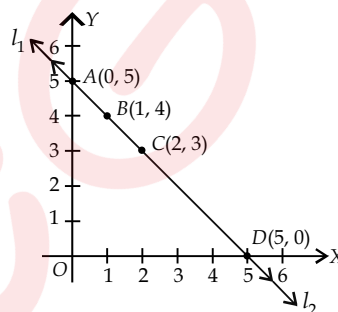
\therefore The given pair of linear equations are consistent.

$$l_1 : x + y = 5 \Rightarrow y = 5 - x$$

x	0	5	1
y	5	0	4

$$l_2 : 2x + 2y = 10 \Rightarrow x + y = 5 \Rightarrow y = 5 - x$$

x	2	0	5
y	3	5	0



From graph, it is clear that lines l_1 and l_2 are coincident.

\therefore They have infinitely many solutions.

(ii) For, $x - y = 8$, $3x - 3y = 16$

$$\therefore a_1 = 1, b_1 = -1, c_1 = -8 \text{ and } a_2 = 3, b_2 = -3, c_2 = -16$$

$$\therefore \frac{a_1}{a_2} = \frac{1}{3}, \frac{b_1}{b_2} = \frac{-1}{-3} = \frac{1}{3} \text{ and } \frac{c_1}{c_2} = \frac{-8}{-16} = \frac{1}{2} \therefore \frac{a_1}{a_2} = \frac{b_1}{b_2} \neq \frac{c_1}{c_2}$$

\therefore The pair of linear equations is inconsistent and lines are parallel.

\therefore The given system of equations has no solution.

(iii) For, $2x + y - 6 = 0$, $4x - 2y - 4 = 0$

$$a_1 = 2, b_1 = 1, c_1 = -6 \text{ and } a_2 = 4, b_2 = -2, c_2 = -4$$

$$\frac{a_1}{a_2} = \frac{2}{4} = \frac{1}{2}, \frac{b_1}{b_2} = \frac{1}{-2} = -\frac{1}{2}, \frac{c_1}{c_2} = \frac{-6}{-4} = \frac{3}{2}$$

$$\text{Here, } \frac{a_1}{a_2} \neq \frac{b_1}{b_2}$$

\therefore Lines are intersecting.

So, it is a consistent pair of linear equations.

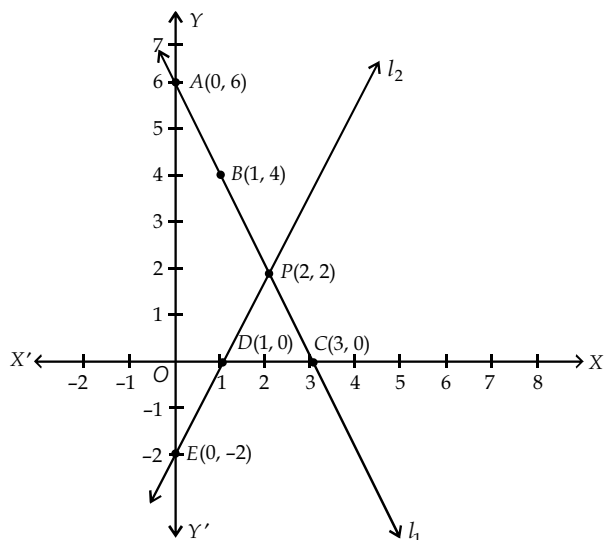
\therefore It has a unique solution.

$$l_1 : y = 6 - 2x$$

x	0	3	1
y	6	0	4

$$\text{and } l_2 : y = \frac{4x - 4}{2}$$

x	0	1	2
y	-2	0	2



$\therefore l_1$ and l_2 intersect each other at $P(2, 2)$

$\therefore x = 2$ and $y = 2$

(iv) For, $2x - 2y - 2 = 0$, $4x - 4y - 5 = 0$

$\therefore a_1 = 2, b_1 = -2, c_1 = -2$ and $a_2 = 4, b_2 = -4, c_2 = -5$

$\therefore \frac{a_1}{a_2} = \frac{2}{4} = \frac{1}{2}, \frac{b_1}{b_2} = \frac{-2}{-4} = \frac{1}{2}, \frac{c_1}{c_2} = \frac{-2}{-5} = \frac{2}{5}$

$\Rightarrow \frac{a_1}{a_2} = \frac{b_1}{b_2} \neq \frac{c_1}{c_2}$

So, the given pair of linear equations is inconsistent and lines are parallel.

Thus, the given system of equations has no solution.

5. Let the width of the garden be x m and the length of the garden be y m.

According to question, $4 + x = y$... (i)

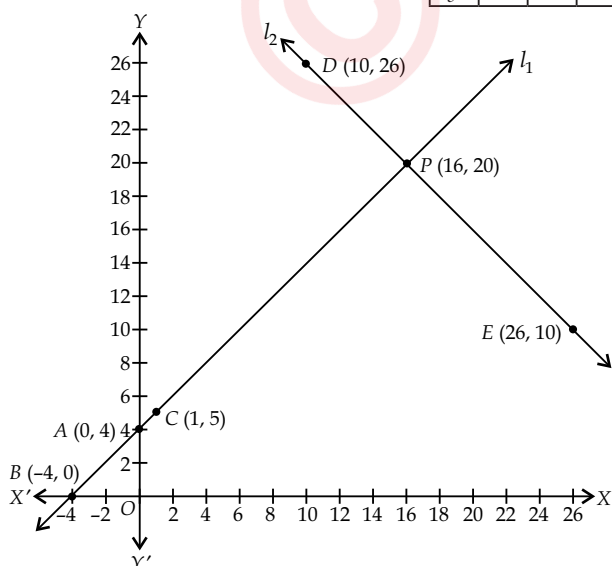
Also, $\frac{1}{2}(\text{perimeter}) = 36 \Rightarrow y + x = 36$... (ii)

From (i), $l_1 : y = x + 4$,

x	0	-4	1
y	4	0	5

From (ii), $l_2 : x + y = 36 \Rightarrow y = 36 - x$,

x	10	26	16
y	26	10	20



The lines l_1 and l_2 intersect each other at $P(16, 20)$.

$\therefore x = 16$ and $y = 20$

So, Length = 20 m and width = 16 m

6. (i) Let the pair of linear equations be $2x + 3y - 8 = 0$, where $a_1 = 2, b_1 = 3$ and $c_1 = -8$ and $a_2x + b_2y + c_2 = 0$.

For intersecting lines, we have

$$\frac{2}{a_2} \neq \frac{3}{b_2} \neq \frac{-8}{c_2}$$

\therefore We can have $a_2 = 3, b_2 = 2$ and $c_2 = -7$

\therefore The required equation will be

$$3x + 2y - 7 = 0$$

(ii) For parallel lines, we have

$$\frac{a_1}{a_2} = \frac{b_1}{b_2} \neq \frac{c_1}{c_2}$$

\therefore Line parallel to $2x + 3y - 8 = 0$, can be taken as $2x + 3y - 12 = 0$

(iii) For coincident lines, we have

$$\frac{a_1}{a_2} = \frac{b_1}{b_2} = \frac{c_1}{c_2}$$

\therefore Line coincident to $2x + 3y - 8 = 0$ can be taken as $2(2x + 3y - 8 = 0)$

$$\Rightarrow 4x + 6y - 16 = 0$$

7. We have, $x - y + 1 = 0$... (i)

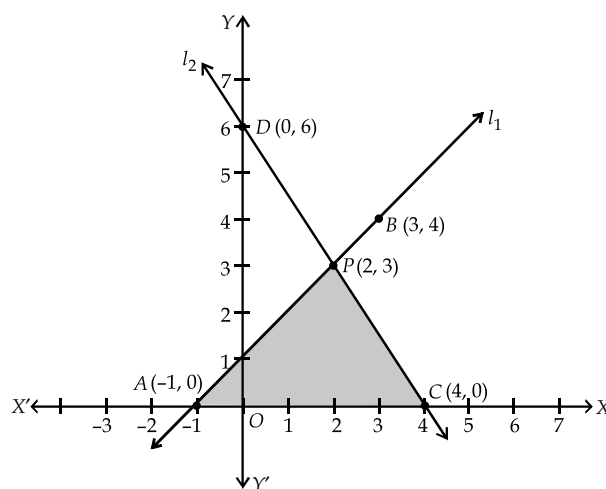
and $3x + 2y - 12 = 0$... (ii)

From (i), $l_1 : x - y + 1 = 0 \Rightarrow y = x + 1$

x	2	-1	3
y	3	0	4

From (ii), $l_2 : 3x + 2y - 12 = 0 \Rightarrow y = \frac{12 - 3x}{2}$

x	2	4	0
y	3	0	6



The lines l_1 and l_2 intersect at $P(2, 3)$. Thus, co-ordinates of the vertices of the shaded triangular region are $C(4, 0)$, $A(-1, 0)$ and $P(2, 3)$.

EXERCISE - 3.2

1. (i) We have, $x + y = 14$

and $x - y = 4$

From equation (1), we have $x = (14 - y)$

Substituting this value of x in (2), we get

$$(14 - y) - y = 4 \Rightarrow 14 - 2y = 4$$

$$\Rightarrow -2y = -10 \Rightarrow y = 5$$

Now, substituting $y = 5$ in (1), we get

$$x + 5 = 14 \Rightarrow x = 9$$

Hence, $x = 9, y = 5$ is the required solution.

(ii) We have, $s - t = 3$

$$\text{and } \frac{s}{3} + \frac{t}{2} = 6$$

From (1), we have $s = (3 + t)$

Substituting this value of s in (2), we get

$$\frac{(3+t)}{3} + \frac{t}{2} = 6 \Rightarrow 2(3+t) + 3(t) = 6 \times 6$$

$$\Rightarrow 6 + 2t + 3t = 36 \Rightarrow 5t = 30 \Rightarrow t = \frac{30}{5} = 6$$

Substituting $t = 6$ in (3) we get, $s = 3 + 6 = 9$

Thus, $s = 9, t = 6$ is the required solution.

(iii) We have, $3x - y = 3$

$$9x - 3y = 9$$

From (1), $y = (3x - 3)$

Substituting this value of y in (2), we get

$$9x - 3(3x - 3) = 9$$

$$\Rightarrow 9x - 9x + 9 = 9 \Rightarrow 9 = 9, \text{ which is true statement.}$$

\therefore The equations (1) and (2) have infinitely many solutions.

To find these solutions, we put $x = k$ (any real constant) in (3), we get

$$y = 3k - 3$$

$\therefore x = k, y = 3k - 3$ is the required solution, where k is any real number.

(iv) We have, $0.2x + 0.3y = 1.3$

and $0.4x + 0.5y = 2.3$

From (1), we have

$$y = \frac{1.3 - 0.2x}{0.3}$$

Substituting the value of y in (2), we get

$$0.4x + 0.5 \left[\frac{1.3 - 0.2x}{0.3} \right] = 2.3 \Rightarrow 0.4x + \left[\frac{0.65 - 0.1x}{0.3} \right] = 2.3$$

$$\Rightarrow 0.3 \times 0.4x + 0.65 - 0.1x = 0.3 \times 2.3$$

$$\Rightarrow 0.12x + 0.65 - 0.1x = 0.69$$

$$\Rightarrow 0.02x = 0.69 - 0.65 = 0.04 \Rightarrow x = \frac{0.04}{0.02} = 2$$

$$\text{From (3), } y = \frac{1.3 - 0.2(2)}{0.3} \Rightarrow y = \frac{1.3 - 0.4}{0.3} = \frac{0.9}{0.3} = 3$$

Thus, $x = 2$ and $y = 3$ is the required solution.

(v) We have, $\sqrt{2}x + \sqrt{3}y = 0$

and $\sqrt{3}x - \sqrt{8}y = 0$

From (2), we have

$$\sqrt{3}x = \sqrt{8}y \Rightarrow x = \frac{\sqrt{8}}{\sqrt{3}}y$$

...(1)

...(2)

Substituting the value of x in (1), we get

$$\sqrt{2} \left[\frac{\sqrt{8}}{\sqrt{3}}y \right] + \sqrt{3}y = 0$$

$$\Rightarrow \frac{\sqrt{16}}{\sqrt{3}}y + \sqrt{3}y = 0 \Rightarrow \frac{4}{\sqrt{3}}y + \sqrt{3}y = 0$$

$$\Rightarrow \left[\frac{4}{\sqrt{3}} + \sqrt{3} \right]y = 0 \Rightarrow y = 0$$

Substituting $y = 0$ in (3), we get $x = 0$

Thus, $x = 0$ and $y = 0$ is the required solution.

...(1)

...(2)

...(3)

(vi) We have, $\frac{3x}{2} - \frac{5y}{3} = -2$... (1) and $\frac{x}{3} + \frac{y}{2} = \frac{13}{6}$... (2)

From (2), we have $\frac{x}{3} = \frac{13}{6} - \frac{y}{2}$

$$\Rightarrow x = 3 \times \left(\frac{13}{6} - \frac{y}{2} \right) \Rightarrow x = \left[\frac{13}{2} - \frac{3y}{2} \right] \quad \dots (3)$$

Substituting the value of x in (1), we get

$$\frac{3}{2} \left[\frac{13}{2} - \frac{3y}{2} \right] - \frac{5y}{3} = -2$$

$$\Rightarrow \frac{39}{4} - \frac{9y}{4} - \frac{5y}{3} = -2 \Rightarrow \frac{117 - 27y - 20y}{12} = -2$$

...(1)

...(2)

...(3)

$$\Rightarrow 117 - 47y = -24 \Rightarrow -47y = -24 - 117 = -141$$

$$\Rightarrow y = \frac{-141}{-47} = 3$$

Now, substituting $y = 3$ in (3), we get

$$x = \frac{13}{2} - \frac{3}{2}(3) \Rightarrow x = \frac{13}{2} - \frac{9}{2} = \frac{4}{2} = 2$$

Thus, $x = 2$ and $y = 3$ is the required solution.

2. We have, $2x + 3y = 11$... (1)

and $2x - 4y = -24$... (2)

From (1), we have

$$2x = 11 - 3y$$

$$\Rightarrow x = \left[\frac{11 - 3y}{2} \right] \quad \dots (3)$$

Substituting this value of x in (2), we get

$$2 \left[\frac{11 - 3y}{2} \right] - 4y = -24 \Rightarrow 11 - 3y - 4y = -24$$

$$\Rightarrow -7y = -24 - 11 = -35 \Rightarrow y = \frac{-35}{-7} = 5$$

Substituting $y = 5$ in (3), we get

$$x = \frac{11 - 3(5)}{2} \Rightarrow x = \frac{11 - 15}{2} \Rightarrow x = \frac{-4}{2} = -2$$

Thus, $x = -2$ and $y = 5$ is the required solution.

Also, $y = mx + 3 \Rightarrow 5 = m(-2) + 3$

$$\Rightarrow -2m = 5 - 3 \Rightarrow -2m = 2 \Rightarrow m = -1.$$

3. (i) Let the two numbers be x and y such that $x > y$.

\therefore Difference between two numbers = 26

$$\Rightarrow x - y = 26 \quad \dots (1)$$

Again, one number = 3[the other number]

$$\Rightarrow x = 3y \quad [\because x > y] \quad \dots (2)$$

Substituting $x = 3y$ in (1), we get

$$3y - y = 26 \Rightarrow 2y = 26 \Rightarrow y = \frac{26}{2} = 13$$

Now, substituting $y = 13$ in (2), we get

$$x = 3(13) \Rightarrow x = 39$$

Thus, two numbers are 39 and 13.

(ii) Let the two angles be x and y such that $x > y$.

\therefore The larger angle exceeds the smaller by 18°

$$\therefore x = y + 18^\circ \quad \dots(1)$$

Also, sum of two supplementary angles = 180°

$$\therefore x + y = 180^\circ \quad \dots(2)$$

Substituting the value of x from (1) in (2), we get

$$(18^\circ + y) + y = 180^\circ$$

$$\Rightarrow 2y = 180^\circ - 18^\circ = 162^\circ \Rightarrow y = \frac{162^\circ}{2} = 81^\circ$$

Substituting $y = 81^\circ$ in (1), we get

$$x = 18^\circ + 81^\circ = 99^\circ$$

Thus, $x = 99^\circ$ and $y = 81^\circ$ is the required solution.

(iii) Let the cost of a bat = ₹ x and the cost of a ball = ₹ y .

\therefore [cost of 7 bats] + [cost of 6 balls] = ₹ 3800

$$\Rightarrow 7x + 6y = 3800 \quad \dots(1)$$

Again, [cost of 3 bats] + [cost of 5 balls] = ₹ 1750

$$\Rightarrow 3x + 5y = 1750 \quad \dots(2)$$

From (2), we have

$$y = \left[\frac{1750 - 3x}{5} \right] \quad \dots(3)$$

Substituting this value of y in (1), we get

$$7x + 6 \left[\frac{1750 - 3x}{5} \right] = 3800$$

$$\Rightarrow 35x + 10500 - 18x = 19000$$

$$\Rightarrow 17x = 19000 - 10500 \Rightarrow x = \frac{8500}{17} = 500$$

Substituting $x = 500$ in (3), we get

$$y = \frac{1750 - 3(500)}{5} \Rightarrow y = \frac{1750 - 1500}{5} = \frac{250}{5} = 50$$

Thus, $x = 500$ and $y = 50$

\therefore Cost of a bat = ₹ 500 and cost of a ball = ₹ 50

(iv) Let fixed charges be ₹ x and charges per km be ₹ y .

\therefore Charges for the journey of 10 km = ₹ 105

$$\therefore x + 10y = 105 \quad \dots(1)$$

and charges for the journey of 15 km = ₹ 155

$$\therefore x + 15y = 155 \quad \dots(2)$$

From (1), we have

$$x = 105 - 10y \quad \dots(3)$$

Substituting the value of x in (2), we get

$$(105 - 10y) + 15y = 155$$

$$\Rightarrow 5y = 155 - 105 = 50 \Rightarrow y = 10$$

Substituting $y = 10$ in (3), we get

$$x = 105 - 10(10) \Rightarrow x = 105 - 100 = 5$$

Thus, $x = 5$ and $y = 10$

So, fixed charges = ₹ 5 and charges per km = ₹ 10.

Now, charges for 25 km = $x + 25y = 5 + 25(10)$

$$= 5 + 250 = ₹ 255$$

\therefore The charges for 25 km journey = ₹ 255

(v) Let the numerator = x and the denominator = y

\therefore Fraction = x/y

$$\text{Case I : } \frac{x+2}{y+2} = \frac{9}{11} \Rightarrow 11(x+2) = 9(y+2)$$

$$\Rightarrow 11x + 22 = 9y + 18$$

$$\Rightarrow 11x - 9y + 4 = 0 \quad \dots(1)$$

$$\text{Case II : } \frac{x+3}{y+3} = \frac{5}{6} \Rightarrow 6(x+3) = 5(y+3)$$

$$\Rightarrow 6x + 18 = 5y + 15$$

$$\Rightarrow 6x - 5y + 3 = 0 \quad \dots(2)$$

$$\text{Now, from (2), } x = \left[\frac{5y-3}{6} \right] \quad \dots(3)$$

Substituting this value of x in (1), we get

$$11 \left[\frac{5y-3}{6} \right] - 9y + 4 = 0$$

$$\Rightarrow 55y - 33 - 54y + 24 = 0 \Rightarrow y - 9 = 0 \Rightarrow y = 9$$

Now, substituting $y = 9$ in (3), we get

$$x = \frac{5(9)-3}{6} \Rightarrow x = \frac{45-3}{6} = \frac{42}{6} = 7$$

$$\therefore x = 7 \text{ and } y = 9 \Rightarrow \text{Fraction} = 7/9.$$

(vi) Let the present age of Jacob = x years and the present age of his son = y years.

\therefore 5 years hence, age of Jacob = $(x+5)$ years and age of his son = $(y+5)$ years

Given, [Age of Jacob after 5 years] = 3[Age of his son after 5 years]

$$\therefore x+5 = 3(y+5) \Rightarrow x+5 = 3y+15$$

$$\Rightarrow x - 3y - 10 = 0 \quad \dots(1)$$

5 years ago, age of Jacob = $(x-5)$ years and age of his son = $(y-5)$ years

Also, five years ago [Age of Jacob] = 7[Age of his son]

$$\therefore (x-5) = 7(y-5) \Rightarrow x-5 = 7y-35$$

$$\Rightarrow x - 7y + 30 = 0 \quad \dots(2)$$

$$\text{From (i), } x = 10 + 3y \quad \dots(3)$$

Substituting this value of x in (2), we get

$$(10 + 3y) - 7y + 30 = 0 \Rightarrow -4y = -40 \Rightarrow y = 10$$

Now, substituting $y = 10$ in (3), we get

$$x = 10 + 3(10) \Rightarrow x = 10 + 30 = 40$$

Thus, $x = 40$ and $y = 10$

\therefore Present age of Jacob = 40 years and present age of his son = 10 years

EXERCISE - 3.3

$$1. \quad (i) \text{ Elimination method : } x + y = 5 \quad \dots(1)$$

$$2x - 3y = 4 \quad \dots(2)$$

Multiplying (1) by 3, we get

$$3x + 3y = 15 \quad \dots(3)$$

$$\text{Adding (2) \& (3), we get } 5x = 19 \Rightarrow x = \frac{19}{5}$$

$$\text{Now, putting } x = \frac{19}{5} \text{ in (1), we get}$$

$$\frac{19}{5} + y = 5 \Rightarrow y = 5 - \frac{19}{5} = \frac{25-19}{5} = \frac{6}{5}$$

$$\text{Thus, } x = \frac{19}{5} \text{ and } y = \frac{6}{5}$$

Substitution Method :

$$\text{We have, } x + y = 5 \Rightarrow y = 5 - x \quad \dots(1)$$

$$\text{and } 2x - 3y = 4 \quad \dots(2)$$

Put $y = 5 - x$ in (2), we get

$$2x - 3(5 - x) = 4 \Rightarrow 2x - 15 + 3x = 4$$

$$\Rightarrow 5x = 19 \Rightarrow x = \frac{19}{5}$$

$$\text{From (1), } y = 5 - \frac{19}{5} = \frac{25-19}{5} = \frac{6}{5}$$

$$\text{Hence, } x = \frac{19}{5} \text{ and } y = \frac{6}{5}$$

(ii) Elimination method :

$$3x + 4y = 10$$

$$2x - 2y = 2$$

Multiplying (2) by 2, we get

$$4x - 4y = 4$$

Adding (1) and (3), we get

$$\therefore 7x = 14 \Rightarrow x = \frac{14}{7} = 2$$

Putting $x = 2$ in (1), we get

$$3(2) + 4y = 10$$

$$\Rightarrow 4y = 10 - 6 = 4 \Rightarrow y = \frac{4}{4} = 1$$

Thus, $x = 2$ and $y = 1$

Substitution Method :

$$3x + 4y = 10 \Rightarrow y = \frac{10-3x}{4}$$

$$2x - 2y = 2 \Rightarrow x - y = 1$$

Putting $y = \frac{10-3x}{4}$ in (2), we get

$$x - \left(\frac{10-3x}{4}\right) = 1 \Rightarrow 4x - 10 + 3x = 4$$

$$\Rightarrow 7x = 14 \Rightarrow x = \frac{14}{7} = 2$$

Putting $x = 2$ in (1), we get

$$y = \frac{10-3 \times 2}{4} = \frac{10-6}{4} = \frac{4}{4} = 1$$

Hence, $x = 2$ and $y = 1$

(iii) Elimination method :

$$3x - 5y - 4 = 0$$

$$9x = 2y + 7 \text{ or } 9x - 2y - 7 = 0$$

Multiplying (1) by 3, we get

$$9x - 15y - 12 = 0$$

Subtracting (2) from (3), we get

$$\therefore 13y + 5 = 0 \Rightarrow y = \frac{-5}{13}$$

Substituting the value of y in (1), we get

$$3x - 5\left(\frac{-5}{13}\right) - 4 = 0 \Rightarrow 3x + \frac{25}{13} - 4 = 0$$

$$\Rightarrow 3x = \frac{-25+52}{13} = \frac{27}{13} \Rightarrow x = \frac{27}{13} \times \frac{1}{3} = \frac{9}{13}$$

$$\text{Thus, } x = \frac{9}{13} \text{ and } y = -\frac{5}{13}$$

Substitution Method :

$$3x - 5y - 4 = 0 \Rightarrow y = \frac{3x-4}{5}$$

$$9x - 2y - 7 = 0$$

Putting $y = \frac{3x-4}{5}$ in (2), we get

$$9x - 2\left(\frac{3x-4}{5}\right) - 7 = 0 \Rightarrow 45x - 6x + 8 - 35 = 0$$

$$\Rightarrow 39x = 27 \Rightarrow x = \frac{27}{39} = \frac{9}{13}$$

Putting $x = \frac{9}{13}$ in (1), we get

$$y = \frac{3 \times \frac{9}{13} - 4}{5} = \frac{27-52}{65} = \frac{-25}{65} \Rightarrow y = \frac{-5}{13}$$

Hence, $x = \frac{9}{13}$ and $y = \frac{-5}{13}$

(iv) Elimination method :

$$\dots(1) \quad \frac{x}{2} + \frac{2y}{3} = -1 \quad \dots(1)$$

$$\dots(2) \quad x - \frac{y}{3} = 3 \quad \dots(2)$$

Multiplying (2) by 2, we get

$$2x - \frac{2y}{3} = 6 \quad \dots(3)$$

Adding (1) and (3), we have

$$\frac{x}{2} + 2x = 5 \Rightarrow \frac{5}{2}x = 5 \Rightarrow x = 5 \times \frac{2}{5} = 2$$

Putting $x = 2$ in (1), we get

$$\dots(1) \quad \frac{2}{2} + \frac{2y}{3} = -1 \Rightarrow 1 + \frac{2y}{3} = -1$$

$$\dots(2) \quad \Rightarrow \frac{2y}{3} = -1 - 1 = -2 \Rightarrow y = -2 \times \frac{3}{2} = -3$$

Thus, $x = 2$ and $y = -3$

Substitution Method :

$$\frac{x}{2} + \frac{2y}{3} = -1 \quad \dots(1)$$

$$x - \frac{y}{3} = 3 \Rightarrow y = 3(x-3) \quad \dots(2)$$

Putting $y = 3(x-3)$ in (1) from (2), we get

$$\frac{x}{2} + \frac{2}{3} \times 3(x-3) = -1 \Rightarrow \frac{x}{2} + 2x - 6 = -1$$

$$\Rightarrow \frac{5x}{2} = 5 \Rightarrow x = 5 \times \frac{2}{5} = 2$$

Putting $x = 2$ in (2), we get

$$y = 3(2-3) = 3(-1) = -3$$

Hence, $x = 2$ and $y = -3$.

2. (i) Let the numerator = x and the denominator = y

\therefore Fraction = x/y

$$\text{Case I : } \frac{x+1}{y-1} = 1 \Rightarrow x+1 = y-1$$

$$\Rightarrow x - y = -2 \quad \dots(1)$$

$$\text{Case II : } \frac{x}{y+1} = \frac{1}{2} \Rightarrow x = \frac{1}{2}(y+1)$$

$$\Rightarrow x - \frac{y}{2} = \frac{1}{2} \quad \dots(2)$$

Subtracting (2) from (1), we have

$$-y + \frac{y}{2} = -2 - \frac{1}{2} \Rightarrow -\frac{1}{2}y = -\frac{5}{2} \Rightarrow y = 5$$

Now, putting $y = 5$ in (2), we have

$$x - \frac{5}{2} = \frac{1}{2} \Rightarrow x = \frac{1}{2} + \frac{5}{2} = \frac{6}{2} = 3$$

Thus, $x = 3$ and $y = 5$.

Hence, the required fraction = $3/5$

(ii) Let the present age of Nuri = x years and the present age of Sonu = y years

5 years ago :

Age of Nuri = $(x - 5)$ years and age of Sonu = $(y - 5)$ years

According to the question,

Age of Nuri = 3[Age of Sonu]

$$\Rightarrow x - 5 = 3[y - 5] \Rightarrow x - 5 = 3y - 15$$

$$\Rightarrow x - 3y + 10 = 0 \quad \dots(1)$$

10 years later :

Age of Nuri = $(x + 10)$ years and age of Sonu

= $(y + 10)$ years

According to the question :

Age of Nuri = 2[Age of Sonu]

$$\Rightarrow x + 10 = 2(y + 10) \Rightarrow x + 10 = 2y + 20$$

$$\Rightarrow x - 2y - 10 = 0 \quad \dots(2)$$

Subtracting (1) from (2), $y - 20 = 0 \Rightarrow y = 20$

Putting $y = 20$ in (1), we get

$$x - 3(20) + 10 = 0 \Rightarrow x - 50 = 0 \Rightarrow x = 50$$

Thus, $x = 50$ and $y = 20$

\therefore Age of Nuri = 50 years and age of Sonu = 20 years

(iii) Let the digit at unit's place = x and the digit at ten's place = y

\therefore The number = $10y + x$

The number obtained by reversing the digits = $10x + y$

$\therefore 9[\text{The number}] = 2[\text{Number obtained by reversing the digits}]$

$$\therefore 9[10y + x] = 2[10x + y] \Rightarrow 90y + 9x = 20x + 2y$$

$$\Rightarrow 11x - 88y = 0$$

$$\Rightarrow x - 8y = 0 \quad \dots(1)$$

Also, sum of the digits = 9

$$\therefore x + y = 9 \quad \dots(2)$$

Subtracting (1) from (2), we have

$$9y = 9 \Rightarrow y = 1$$

Putting $y = 1$ in (2), we get $x + 1 = 9 \Rightarrow x = 8$

Thus, $x = 8$ and $y = 1$

$$\therefore \text{The required number} = 10y + x = (10 \times 1) + 8 = 10 + 8 = 18$$

(iv) Let the number of 50 rupees notes = x

and the number of 100 rupees notes = y

According to the question,

Total number of notes = 25

$$\therefore x + y = 25 \quad \dots(1)$$

\therefore The value of all the notes = ₹ 2000

$$\therefore 50x + 100y = 2000$$

$$\Rightarrow x + 2y = 40 \quad \dots(2)$$

Subtracting (1) from (2), we get

$$y = 15$$

Putting $y = 15$ in (1), we get

$$x + 15 = 25 \Rightarrow x = 25 - 15 = 10$$

Thus, $x = 10$ and $y = 15$

\therefore Number of 50 rupees notes = 10 and number of 100 rupees notes = 15.

(v) Let the fixed charge (for the three days) = ₹ x and the additional charge for each extra day = ₹ y

\therefore Charge for 7 days = ₹ 27

$$\Rightarrow x + 4y = 27 \quad \dots(1) \quad [\because \text{Extra days} = 7 - 3 = 4]$$

Charge for 5 days = ₹ 21

$$\Rightarrow x + 2y = 21 \quad \dots(2) \quad [\because \text{Extra days} = 5 - 3 = 2]$$

Subtracting (2) from (1), we get

$$2y = 6 \Rightarrow y = 3$$

Putting $y = 3$ in (2), we have

$$x + 2(3) = 21 \Rightarrow x = 21 - 6 = 15$$

So, $x = 15$ and $y = 3$

\therefore Fixed charge = ₹ 15 and additional charge per day = ₹ 3.

