



NCERT SOLUTIONS

Pair of Linear Equation in Two Variables

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Ex - 3.1

Q1. Aftab tells his daughter, "Seven years ago, I was seven times as old as you were then. Also, three years from now, I shall be three times as old as you will be". (Isn't this interesting?) Represent this situation algebraically and graphically.

Sol. Let the present age of Aftab's daughter = x years.

and the present age of Aftab = y years ($y > x$)

According to the given conditions

Seven years ago,

$$(y - 7) = 7 \times (x - 7)$$

$$\text{i.e., } y - 7 = 7x - 49$$

$$\text{i.e., } 7x - y - 42 = 0 \quad \dots(\text{i})$$

Three years later, $(y + 3) = 3 \times (x + 3)$

$$\text{i.e., } y + 3 = 3x + 9$$

$$\text{i.e., } 3x - y + 6 = 0 \quad \dots(\text{ii})$$

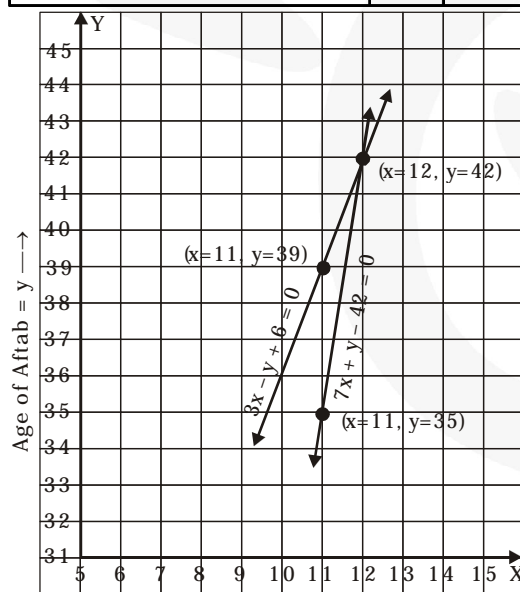
Thus, the algebraic relations are $7x - y - 42 = 0$, $3x - y + 6 = 0$.

Now, we represent the problem graphically as below : $7x - y - 42 = 0 \quad \dots(\text{i})$

Age of Aftab's daughter = x	11	12
Age of Aftab = $y = 7x - 42$	35	42

$3x - y + 6 = 0 \quad \dots(\text{ii})$

Age of Aftab's daughter = x	11	12
Age of Aftab = $y = 3x + 6$	39	42



Age of Daughter = $x \rightarrow$

From the graph, we find that

$$x = 12$$

$$\text{and } y = 42$$

Thus, the present age of Aftab's daughter = 12 years

and the present age of Aftab = 42 years

Q2. The coach of a cricket team buys 3 bats and 6 balls for ₹ 3900. Later, she buys another bat and 3 more balls of the same kind for ₹ 1300. Represent this situation algebraically and geometrically.

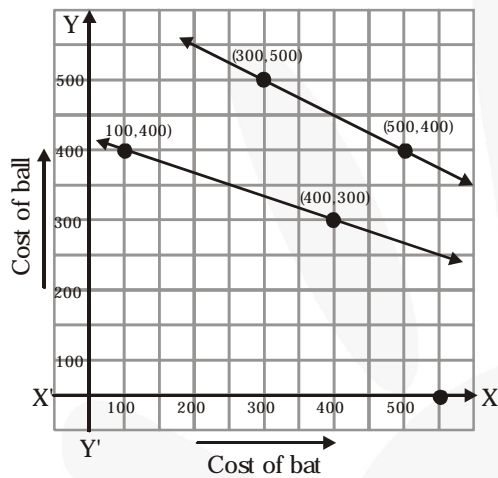
Sol. Let the cost of 1 bat be ₹ x
and the cost of 1 ball be ₹ y

So, $3x + 6y = 3900$ and $x + 3y = 1300$

x	300	500
y	500	400

and

x	400	100
y	300	400

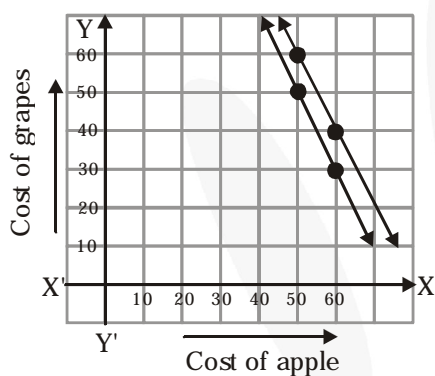


Q3. The cost of 2 kg of apples and 1 kg of grapes on a day was found to be ₹ 160. After a month, the cost of 4 kg of apples and 2 kg of grapes is ₹ 300. Represent the situation algebraically and geometrically.

Sol. Let the cost of 1 kg of apple be ₹ x
and the cost of 1 kg of grapes be ₹ y

$$\text{So, } 2x + y = 160$$

$$4x + 2y = 300$$



x	50	60
y	60	40

and

x	50	60
y	50	30

Ex - 3.2

Q1. Form the pair of linear equations in the following problems, and find their solutions graphically.

- (i) 10 students of class X took part in a Mathematics quiz. If the number of girls is 4 more than the number of boys, find the number of boys and girls who took part in the quiz.
 (ii) 5 pencils and 7 pens together cost ₹ 50, whereas 7 pencils and 5 pens together cost 46.

Find the cost of one pencil and that of one pen.

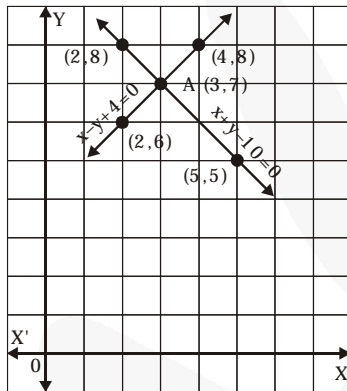
Sol. (i) Let the number of boys be x and the number of girls be y .

According to the given conditions

$$x + y = 10 \text{ and } y = x + 4$$

We get the required pair of linear equations as

$$x + y - 10 = 0, x - y + 4 = 0$$



Graphical Solution

$$x + y - 10 = 0 \dots(i)$$

x	2	5
$y = 10 - x$	8	5

$$x - y + 4 = 0 \dots(ii)$$

x	2	4
$y = x + 4$	6	8

From the graph, we have : $x = 3, y = 7$ common solution of the two linear equations.

Hence, the number of boys = 3 and the number of girls = 7.

(ii) Let the cost of 1 pencil be Rs x and cost of 1 pen be Rs. y .

$$5x + 7y = 50$$

$$7x + 5y = 46$$

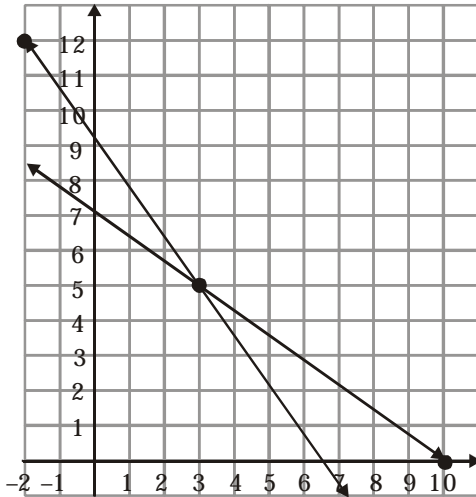
Graphical solution

$$5x + 7y = 50 \quad 7x + 5y = 46$$

$$y = \frac{50 - 5x}{7} \quad y = \frac{46 - 7x}{5}$$

x	3	10
y	5	0

x	3	-2
y	5	12



From the graph we have $x = 3$, $y = 5$.

Hence, cost of one pencil = Rs.3 and cost of one pen = Rs.5

Q2. On comparing the ratios $\frac{a_1}{a_2}$, $\frac{b_1}{b_2}$ and $\frac{c_1}{c_2}$, find out whether the lines representing the following pairs of linear equations intersect at a point, are parallel or coincident.

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

(ii) $9x + 3y + 12 = 0$; $18x + 6y + 24 = 0$

(iii) $6x - 3y + 10 = 0$; $2x - y + 9 = 0$

Sol. (i) $5x - 4y + 8 = 0$ (i)

$7x + 6y - 9 = 0$ (ii)

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

\Rightarrow Lines represented by (i) and (ii) intersect at a point

(ii) $9x + 3y + 12 = 0$ (i)

$18x + 6y + 24 = 0$ (ii)

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

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

\therefore Lines represented by (i) and (ii) are coincident.

(iii) $6x - 3y + 10 = 0$ (i)

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

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

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

\therefore Lines represented by (i) and (ii) are parallel

Q3. On comparing the ratios $\frac{a_1}{a_2}$, $\frac{b_1}{b_2}$ and $\frac{c_1}{c_2}$, find out whether the following pairs of linear equations are consistent, or inconsistent.

(i) $3x + 2y = 5$; $2x - 3y = 7$

(ii) $2x - 3y = 8$; $4x - 6y = 9$

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

(iv) $5x - 3y = 11$; $-10x + 6y = -22$

(v) $\frac{4}{3}x + 2y = 8$; $2x + 3y = 12$

Sol. (i) $3x + 2y - 5 = 0$... (i)

$2x - 3y - 7 = 0$... (ii)

$$\frac{a_1}{a_2} = \frac{3}{2}, \frac{b_1}{b_2} = \frac{2}{-3} = -\frac{2}{3}$$

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

\Rightarrow The equations have a unique solution.

Hence, consistent.

(ii) $2x - 3y = 8$ (i)

$4x - 6y = 9$ (ii)

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

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

\therefore The equations have no solution. Hence inconsistent.

$$(iii) \quad \frac{3}{2}x + \frac{5}{3}y = 7 \quad \dots\dots(i)$$

$$9x - 10y = 14 \quad \dots\dots(ii)$$

$$\frac{a_1}{a_2} = \frac{\frac{3}{2}}{9} = \frac{1}{6}, \frac{b_1}{b_2} = \frac{\frac{5}{3}}{-10} = \frac{-1}{6}$$

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

\Rightarrow The equations have a unique solutions

Hence, consistent.

$$(iv) \quad 5x - 3y = 11 \quad \dots\dots(i)$$

$$-10x + 6y = -22 \quad \dots\dots(ii)$$

$$\frac{a_1}{a_2} = \frac{5}{-10} = \frac{-1}{2}, \frac{b_1}{b_2} = \frac{-3}{6} = \frac{-1}{2},$$

$$\frac{c_1}{c_2} = \frac{11}{-22} = \frac{-1}{2}$$

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

The equations have infinite solutions.

Hence, consistent.

$$(v) \quad \frac{4}{3}x + 2y = 8 \quad \dots\dots(i)$$

$$2x + 3y = 12 \quad \dots\dots(ii)$$

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

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

The equations have infinite solutions.

Hence, consistent.

Q4. Which of the following pairs of linear equations are consistent/inconsistent? If consistent, obtain the solution graphically :

(i) $x + y = 5$, $2x + 2y = 10$

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

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

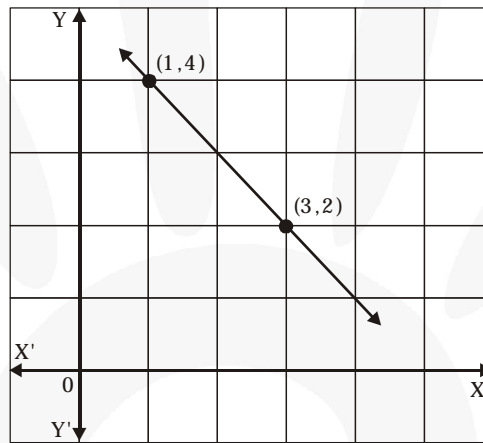
(iv) $2x - 2y - 2 = 0$, $4x - 4y - 5 = 0$

Sol. (i) $x + y = 5$ (i)

$2x + 2y = 10$ (ii)

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

i.e., $\frac{a_1}{a_2} = \frac{b_1}{b_2} = \frac{c_1}{c_2}$



Hence, the pair of linear equations is consistent.

(i) and (ii) are same equations and hence the graph is coincident straight line.

x	1	3
y = 5 - x	4	2

(ii) $x - y = 8$ (i)

$3x - 3y = 16$ (ii)

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

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

Therefore, lines have no solution

Hence, inconsistent.

(iii) $2x + y = 6$ (i)
 $4x - 2y = 4$ (ii)
 $\frac{a_1}{a_2} = \frac{2}{4} = \frac{1}{2}, \frac{b_1}{b_2} = \frac{1}{-2} = -\frac{1}{2}, \frac{c_1}{c_2} = \frac{6}{4} = \frac{3}{2}$
 $\Rightarrow \frac{a_1}{a_2} \neq \frac{b_1}{b_2}$

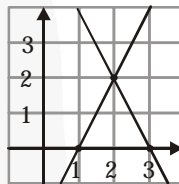
Therefore, lines have unique solution.

Hence, consistent

from (i) from (ii)

x	2	3
y	2	0

x	2	1
y	2	0



from graph $x = 2, y = 2$

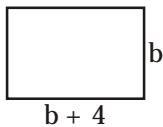
(iv) $2x - 2y = 2$ (i)
 $4x - 4y = 5$ (ii)
 $\frac{a_1}{a_2} = \frac{2}{4} = \frac{1}{2}, \frac{b_1}{b_2} = \frac{-2}{-4} = \frac{1}{2}, \frac{c_1}{c_2} = \frac{2}{5}$
 $\Rightarrow \frac{a_1}{a_2} = \frac{b_1}{b_2} \neq \frac{c_1}{c_2}$

Therefore, lines have no solution.

Hence, Inconsistent.

Q5. Half the perimeter of a rectangular garden, whose length is 4 m more than its width, is 36 m. Find the dimensions of the garden

Sol.



Length, $\ell = b + 4$ and Breadth = b

Perimeter of rectangle = $2 (\ell + b)$

$$\frac{1}{2} [2 (\ell + b)] = 36$$

$$(\ell + b) = 36 \quad \text{.....(i)}$$

As, $\ell = b + 4$, so putting the value of ℓ

in equation (i), we get

$$\Rightarrow b + 4 + b = 36$$

$$2b + 4 = 36$$

$$2b = 32$$

$$b = 16\text{m}, \ell = b + 4 = 16 + 4 = 20\text{m}$$

Thus, length of garden = 20m and breadth of garden = 16 m

Q6. Given the linear equation $2x + 3y - 8 = 0$, write another linear equation in two variables such that the geometrical representation of the pair so formed is :

(i) Intersecting lines

(ii) Parallel lines

(iii) Coincident lines

Sol. (i) $2x + 3y - 8 = 0$ (Given equation)

$$3x + 2y + 4 = 0 \quad (\text{New equation})$$

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

Hence, the graph of the two equations will be two intersecting lines.

(ii) $2x + 3y - 8 = 0$ (given equation)

$$4x + 6y - 10 = 0 \quad (\text{New equation})$$

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

Hence, the graph of the two equations will be two parallel lines.

(iii) $2x + 3y - 8 = 0$ (given equation)

$$4x + 6y - 16 = 0 \quad (\text{New equation})$$

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

Hence, the graph of the two equations will be two coincident lines.

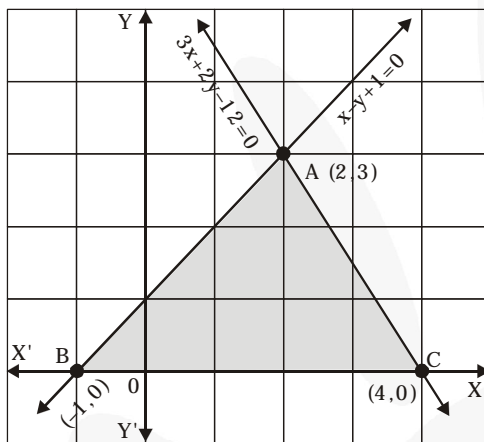
Q7. Draw the graphs of the equations $x - y + 1 = 0$ and $3x + 2y - 12 = 0$. Determine the coordinates of the vertices of the triangle formed by these lines and the x-axis, and shade the triangular region.

Sol. $x - y + 1 = 0$... (i)

x	-1	2
$y = x + 1$	0	3

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

x	2	4
$y = \frac{12 - 3x}{2}$	3	0



The vertices of the triangle are
A (2, 3), B (-1, 0) and C (4, 0)

Ex - 3.3

Q1. Solve the following pair of linear equations by the substitution method.

(i) $x + y = 14, x - y = 4$

(ii) $s - t = 3, \frac{s}{3} + \frac{t}{2} = 6$

(iii) $3x - y = 3, 9x - 3y = 9$

(iv) $0.2x + 0.3y = 1.3, 0.4x + 0.5y = 2.3$

(v) $\sqrt{2}x + \sqrt{3}y = 0, \sqrt{3}x - \sqrt{8}y = 0$

(vi) $\frac{3x}{2} - \frac{5y}{3} = -2, \frac{x}{3} + \frac{y}{2} = \frac{13}{6}$

Sol. (i) $x + y = 14$ (i)
 $x - y = 4$ (ii)
 From (ii) $y = x - 4$ (iii)
 Substituting y from (iii) in (i), we get
 $x + x - 4 = 14$
 $\Rightarrow 2x = 18$
 $\Rightarrow x = 9$
 Substituting $x = 9$ in (iii), we get
 $y = 9 - 4 = 5$,
 i.e, $y = 5$
 $x = 9, y = 5$

(ii) $s - t = 3$ (i)
 $\frac{s}{3} + \frac{t}{2} = 6$ (ii)
 From (i) $s = t + 3$ (iii)
 Substituting s from (iii) in (ii), we get
 $\frac{t+3}{3} + \frac{t}{2} = 6$
 $\Rightarrow 2(t+3) + 3t = 36$
 $\Rightarrow 5t + 6 = 36$
 $\Rightarrow t = 6$
 From (iii), $s = 6 + 3 = 9$,
 Hence, $s = 9, t = 6$

(iii) $3x - y = 3$ (i)
 $9x - 3y = 9$ (ii)
 From (i) $y = 3x - 3$ (iii)
 Substituting y from (iii) in (ii), we get
 $9x - 3(3x - 3) = 9$
 $9x - 9x + 9 = 9$
 $9 = 9$
 It means, equation have infinite solutions.

(iv) $0.2x + 0.3y = 1.3$ (i)
 $0.4x + 0.5y = 2.3$ (ii)
 From (i) $y = \frac{1.3 - 0.2x}{0.3}$ (iii)
 Substituting y from (iii) in (ii), we get
 $0.4x + 0.5 \left(\frac{1.3 - 0.2x}{0.3} \right) = 2.3$

$$\Rightarrow 0.4x + \frac{13}{6} - \frac{x}{3} = 2.3$$

$$\Rightarrow \frac{2}{5}x - \frac{x}{3} = 2.3 - \frac{13}{6}$$

$$\Rightarrow \frac{x}{15} = \frac{4}{30}$$

$$\Rightarrow x = 2$$

Substituting $x = 2$ in (iii)

$$y = 3 \times 2 - 3$$

Hence, $y = 3$

$$(v) \quad \sqrt{2}x + \sqrt{3}y = 0 \quad \dots\dots(i)$$

$$\sqrt{3}x - \sqrt{8}y = 0 \quad \dots\dots(ii)$$

$$\text{From (ii) } y = \frac{\sqrt{3}x}{\sqrt{8}} \quad \dots\dots(iii)$$

Substituting y from (iii) in (i), we get

$$\sqrt{2}x + \sqrt{3} \times \frac{\sqrt{3}x}{\sqrt{8}} = 0$$

$$\Rightarrow \frac{4x + 3x}{\sqrt{8}} = 0 \Rightarrow 7x = 0$$

$$x = 0$$

Substituting $x = 0$ in (iii)

Hence, $y = 0$

$$(vi) \quad \frac{3x}{2} - \frac{5y}{3} = -2 \quad \dots\dots(i)$$

$$\frac{x}{3} + \frac{y}{2} = \frac{13}{6} \quad \dots\dots(ii)$$

$$\text{From (i) } y = \frac{\frac{3x}{2} + 2}{\frac{5}{3}} = \frac{9x + 12}{10} \quad \dots\dots(iii)$$

Substituting y from (iii) in (ii), we get

$$\frac{x}{3} + \frac{9x + 12}{10 \times 2} = \frac{13}{6}$$

$$\Rightarrow \frac{x}{3} + \frac{9x}{20} + \frac{3}{5} = \frac{13}{6}$$

$$\Rightarrow \frac{47x}{60} = \frac{47}{30}$$

$$x = 2$$

Substituting $x = 2$ in (iii)

$$y = \frac{9 \times 2 + 12}{10}$$

Hence, $y = 3$.

Q2. Solve $2x + 3y = 11$ and $2x - 4y = -24$ and hence find the value of 'm' for which $y = mx + 3$

Sol. $2x + 3y = 11$ (i)
 $2x - 4y = -24$ (ii)
 Subtract equation (ii) from (i), we get
 $2x + 3y - 2x + 4y = 11 + 24$
 $7y = 35$
 $y = 5$
 Substituting value of y in equation (i), we get
 $2x + 3 \times 5 = 11$
 $2x = 11 - 15$
 $x = -\frac{4}{2} = -2$
 Now, $x = -2$, $y = 5$
 Putting value of x & y in $y = mx + 3$
 $5 = -2m + 3$
 $\Rightarrow 2 = -2m$
 $\Rightarrow m = -1$

Q3. From the pair of linear equations for the following problems and find their solution by substitution method.

- The difference between two numbers is 26 and one number is three times the other. Find them.
- The larger of two supplementary angles exceeds the smaller by 18 degrees. Find them.
- The coach of a cricket team buys 7 bats and 6 balls for Rs. 3800. Later, she buys 3 bats and 5 balls for Rs. 1750. Find the cost of each bat and each ball.
- The taxi charges in a city consist of a fixed charge together with the charge for the distance covered. For a distance of 10 km, the charge paid is Rs. 105 and for a journey of 15 km, the charge paid is Rs. 155. What are the fixed charges and the charge per kilometer? How much does a person have to pay for travelling a distance of 25 km?
- A fraction becomes $\frac{9}{11}$, if 2 is added to both the numerator and the denominator. If, 3 is added to both the numerator and the denominator it becomes $\frac{5}{6}$. Find the fraction.
- Five years hence, the age of jacob will be three times that of his son. Five years ago, Jacob's age was seven times that of his son. What are their present ages?

Sol. (i) Let the two numbers be x and y ($x > y$). Then,
 $x - y = 26$... (i)
 $x = 3y$... (ii)
 Substituting value of x from (ii) in (i)
 $3y - y = 26$
 $2y = 26$
 $y = 13$
 Substituting value of y in (ii) $x = 3 \times 13 = 39$
 Thus, two numbers are 13 and 39.

- (ii) Let the supplementary angles be x and y ($x > y$) Then,

$$x + y = 180 \quad \dots(i)$$

$$x - y = 18 \quad \dots(ii)$$

$$\text{from (i) } x = 18 + y \quad \dots(iii)$$

Substituting value of x from (iii) in (i)

$$18 + y + y = 180$$

$$2y = 180 - 18$$

$$y = \frac{162}{2} = 81$$

$$\text{from (iii) } x = 18 + 81 = 99$$

Thus, the angles are 99° and 81

- (iii) Let the cost price of 1 bat is Rs x and the cost price of 1 ball is Rs y

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

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

From (i)

$$7x = 3800 - 6y$$

$$x = \frac{3800 - 6y}{7} \quad \dots(iii)$$

Substituting value of x from (iii) in (ii), we get

$$3\left(\frac{3800 - 6y}{7}\right) + 5y = 1750$$

$$11400 - 18y + 35y = 12250$$

$$17y = 850$$

$$y = 50$$

$$\text{From (iii) } x = \frac{3800 - 300}{7} = 500$$

Thus, cost price of 1 bat is Rs. 500 and 1 ball is Rs. 50

- (iv) Let fixed charge be Rs x and charge per km be Rs y . Then,

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

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

From equation (i)

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

Substituting value of x from (iii) in (ii)

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

$$105 + 5y = 155$$

$$5y = 50$$

$$y = 10$$

$$\text{from (iii) } x = 105 - 10 \times 10 = 5$$

Thus, fixed charge is Rs. 10 and charge per km is Rs. 5

- (v) Let $\frac{x}{y}$ be the fraction where x and y are positive integers.

$$\frac{x+2}{y+2} = \frac{9}{11}$$

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

$$11x - 9y = -4 \quad \dots(i)$$

$$\frac{x+3}{y+3} = \frac{5}{6}$$

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

$$6x - 5y = -3 \quad \dots(ii)$$

From (i)

$$11x = 9y - 4$$

$$x = \frac{9y-4}{11} \quad \dots(iii)$$

Substituting value of x from (iii) in (ii)

$$6\left(\frac{9y-4}{11}\right) - 5y = 3$$

$$54y - 24 - 55y = -33$$

$$y = 33 - 24$$

$$y = 9$$

$$\text{From (iii) } x = \frac{9 \times 9 - 4}{11} = 7$$

Thus, fraction is $7/9$.

- (vi) Let x (in years) be the present age of Jacob's son and y (in years) be the present age of Jacob. Then,

$$y + 5 = 3(x + 5)$$

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

$$y - 5 = 7(x - 5)$$

$$7x - y = 30 \quad \dots(ii)$$

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

Substituting value of y from (iii) in (ii)

$$7x - (3x + 10) = 30$$

$$4x = 40$$

$$x = 10$$

$$\text{From (iii) } y = 40$$

Thus, Jacob's present age is 40 years and his son's the age is 10 years.

Ex - 3.4

Q1. Solve the following pair of equations by the elimination method and the substitution method :

(i) $x + y = 5$ and $2x - 3y = 4$

(ii) $3x + 4y = 10$ and $2x - 2y = 2$

(iii) $3x - 5y - 4 = 0$ and $9x = 2y + 7$

(iv) $\frac{x}{2} + \frac{2y}{3} = -1$ and $x - \frac{y}{3} = 3$

Sol. (i) Solution By Elimination Method:

$$x + y = 5 \quad \dots(i)$$

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

Multiplying (i) by 3 and (ii) by 1 and adding we get $3(x + y) + 1(2x - 3y) = 3 \times 5 + 1 \times 4$

$$\Rightarrow 3x + 3y + 2x - 3y = 19$$

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

From (i), substituting $x = \frac{19}{5}$, we get

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

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

(i) Solution By Substitution Method :

$$x + y = 5 \quad \dots(i)$$

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

$$\text{From (i), } y = 5 - x \quad \dots(iii)$$

Substituting y from (iii) in (ii), $2x - 3(5 - x) = 4$

$$\Rightarrow 2x - 15 + 3x = 4$$

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

$$\text{Then from (iii), } y = 5 - \frac{19}{5} \Rightarrow y = \frac{6}{5}$$

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

(ii) Solution by elimination method

$$3x + 4y = 10 \quad \dots(i)$$

$$2x - 2y = 2 \quad \dots(ii)$$

multiplying (ii) equation by 2, we get

$$4x - 4y = 4 \quad \dots(iii)$$

Add equation (i) and (iii), we get

$$7x = 14$$

$$\Rightarrow x = 2$$

Substituting, $x = 2$ in (i), we get

$$3 \times 2 + 4 \times y = 10$$

$$\Rightarrow 4y = 4$$

$$\Rightarrow y = 1$$

$$\text{Hence, } x = 2, y = 1$$

(ii) Solution by substitution method

$$3x + 4y = 10 \quad \dots(i)$$

$$2x - 2y = 2 \quad \dots(ii)$$

From (ii), $y = \frac{2x-2}{2} = x - 1 \quad \dots(\text{iii})$

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

$$3x + 4(x - 1) = 10$$

$$\Rightarrow 3x + 4x - 4 = 10$$

$$\Rightarrow 7x = 14$$

$$x = 2$$

Then from (iii)

$$y = 2 - 1 = 1$$

Hence, $x = 2, y = 1$

(iii) Solution by elimination method

$$3x - 5y = 4 \quad \dots(\text{i})$$

$$9x = 2y + 7 \quad \dots(\text{ii})$$

Multiplying (i) equation by 3, we get

$$9x - 15y = 12 \quad \dots(\text{iii})$$

Subtracting (iii) from (ii), we get

$$9x - 9x + 15y = 2y + 7 - 12$$

$$\Rightarrow 15y - 2y = 7 - 12$$

$$13y = -5$$

$$y = \frac{-5}{13}$$

From (i) substituting value of $y = \frac{-5}{13}$

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

$$\Rightarrow 3x = \frac{-25}{13} + 7$$

$$\Rightarrow 3x = \frac{-25 + 52}{13}$$

$$3x = \frac{27}{13}$$

$$x = \frac{9}{13}$$

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

(iii) Solution by substitution method

$$3x - 5y = 4 \quad \dots(i)$$

$$9x = 2y + 7 \quad \dots(ii)$$

From (i)

$$x = \frac{4+5y}{3} \quad \dots(iii)$$

Substuting $x = \frac{4+5y}{3}$ in (ii)

$$9 \times \frac{4+5y}{3} = 2y + 7$$

$$12 + 15y = 2y + 7$$

$$y = \frac{-5}{13}$$

from (iii)

$$x = \frac{4+5\left(\frac{-5}{13}\right)}{3} = \frac{27}{39}$$

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

(iv) Solution by elimination method

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

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

Multiplying (ii), we get

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

Adding (i) and (iii), we get

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

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

$$\Rightarrow x = 2$$

From (ii) substituting $x = 2$, in equation (ii), we get

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

$$\Rightarrow -1 = \frac{y}{3}$$

$$\Rightarrow y = -3$$

$$\text{Hence, } x = 2, y = -3$$

(iv) Solution by substitution method

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

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

$$\text{from (ii), } x = 3 + \frac{y}{3} \quad \dots(iii)$$

Substituting x from (iii) in (i), we get

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

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

$$\Rightarrow \frac{y + 4y}{6} = -1 - \frac{3}{2}$$

$$\Rightarrow \frac{5y}{6} = \frac{-5}{2}$$

$$\Rightarrow y = -3$$

Substituting $y = -3$ in equation (ii), we get

$$\Rightarrow x - \frac{(-3)}{3} = 3$$

$$\Rightarrow x + 1 = 3$$

$$\Rightarrow x = 2$$

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

Q2. Form the pair of linear equations in the following problems, and find their solutions (if they exist) by the elimination method :

(i) If we add 1 to the numerator and subtract 1 from the denominator, a fraction reduces to 1.

It becomes $\frac{1}{2}$ if we only add 1 to the denominator. What is the fraction?

(ii) Five years ago Nuri was thrice as old as Sonu. Ten years later, Nuri will be twice as old as Sonu. How old are Nuri and Sonu?

(iii) The sum of the digits of a two-digit number is 9. Also, nine times this number is twice the number obtained by reversing the order of the digits. Find the number.

(iv) Meena went to a bank to withdraw Rs. 2000. She asked the cashier to give her Rs. 50 and Rs. 100 notes only. Meena got 25 notes in all. Find how many notes of Rs. 50 and Rs. 100 she received.

(v) A lending library has a fixed charge for the first three days and an additional charge for each day thereafter. Saritha paid Rs. 27 for a book kept for seven days, while Susy paid Rs. 21 for the book she kept for five days. Find the fixed charge and the charge for each extra day.

Sol. (i) Let fraction = $\frac{x}{y}$

$$\frac{x+1}{y-1} = 1,$$

$$x + 1 = y - 1$$

$$x - y = -2 \quad \dots(i)$$

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

$$2x = y + 1$$

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

Multiplying (i) by 2 and (ii) by 1 and subtracting we get

$$2x - 2y = -4$$

Subtracting, $\frac{2x - y = 1}{-y = -5}$

$$y = 5$$

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

$$2x - 5 = 1 \Rightarrow x = 3$$

$$\text{Fraction} = \frac{x}{y} = \frac{3}{5}$$

(ii) Let present age of Nuri = x years

Let present age of Sonu = y years

Five years ago,

$$x - 5 = 3(y - 5)$$

$$x - 5 = 3y - 15$$

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

Ten years later,

$$(x + 10) = 2(y + 10)$$

$$x + 10 = 2y + 20$$

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

Subtracting (ii) from (i)

$$x - 3y = -10$$

$$x - 2y = +10$$

$$-y = -20$$

$$\Rightarrow y = 20$$

Substituting $y = 20$ in (ii), we get

$$x - 2 \times 20 = 10$$

$$\Rightarrow x = 50$$

So, present age of Nuri is 50 years

present age of Sonu is 20 years

(iii) Let unit digit = x , ten's digit = y

So, original number = $10y + x$

$$9(10y + x) = 2(10x + y)$$

$$90y + 9x = 20x + 2y$$

$$88y = 11x$$

$$x = 8y \quad \dots(i)$$

Also given sum of digits = 9

$$x + y = 9 \quad \dots(ii)$$

from (i) and (ii)

$$9y = 9$$

$$y = 1 \Rightarrow x = 8$$

$$\text{So, number} = 10 \times 1 + 8 = 18$$

- (iv) Let number of Rs.50 notes = x
 and number of Rs.100 notes = y
 total notes = $x + y = 25$... (i)

Also value of notes = Rs. 2000

$$50x + 100y = 2000$$

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

From (i) and (ii)

Number of Rs.50 notes = 10

Number of Rs.100 notes = 15

- (v) Let fixed charge be Rs. x
 and charge for each extra day by Rs. y

$$\text{Then } x + 4y = 27 \quad \dots (i)$$

$$x + 2y = 21 \quad \dots (ii)$$

Subtracting (ii) from (i)

$$2y = 6$$

$$y = 3$$

Substituting $y = 3$ in (i)

$$\Rightarrow x = 15$$

So fixed charge = Rs. 15

and charge for each extra day = Rs.3

Ex - 3.5

Q1. Which of the following pairs of linear equations has unique solution, no solution, or infinitely many solutions. In case there is a unique solution, find it by using cross multiplication method.

(i) $x - 3y - 3 = 0$

$3x - 9y - 2 = 0$

(iii) $3x - 5y = 20$

$6x - 10y = 40$

(ii) $2x + y = 5$

$3x + 2y = 8$

(iv) $x - 3y - 7 = 0$

$3x - 3y - 15 = 0$

Sol. (i) $x - 3y - 3 = 0$, $3x - 9y - 2 = 0$

$$\frac{a_1}{a_2} = \frac{1}{3}, \frac{b_1}{b_2} = \frac{-3}{-9} = \frac{1}{3}, \frac{c_1}{c_2} = \frac{-3}{-2} = \frac{3}{2}$$

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

Hence, no solution.

(ii) $2x + y = 5$... (i) and $3x + 2y = 8$... (ii)

$$\frac{a_1}{a_2} \neq \frac{b_1}{b_2} \left(\frac{a_1}{a_2} = \frac{2}{3}, \frac{b_1}{b_2} = \frac{1}{2} \right)$$

Here, we have a unique solution. By cross multiplication, we have

$$\frac{x}{\begin{vmatrix} 1 & -5 \\ 2 & -8 \end{vmatrix}} = \frac{y}{\begin{vmatrix} -5 & 2 \\ -8 & 3 \end{vmatrix}} = \frac{1}{\begin{vmatrix} 2 & 1 \\ 3 & 2 \end{vmatrix}}$$

$$\Rightarrow \frac{x}{\{(1)(-8) - (2)(-5)\}} = \frac{y}{\{(-5)(3) - (-8)(2)\}}$$

$$= \frac{1}{\{(2)(2) - (3)(1)\}}$$

$$\Rightarrow \frac{x}{(-8 + 10)} = \frac{y}{(-15 + 16)} = \frac{1}{(4 - 3)}$$

$$\Rightarrow \frac{x}{2} = \frac{y}{1} = \frac{1}{1} \Rightarrow \frac{x}{2} = \frac{1}{1} \text{ and } \frac{y}{1} = \frac{1}{1}$$

$$\Rightarrow x = 2 \text{ and } y = 1$$

(iii) $3x - 5y = 20$ (i)

$6x - 10y = 40$ (ii)

$$\frac{a_1}{a_2} = \frac{3}{6} = \frac{1}{2}, \frac{b_1}{b_2} = \frac{-5}{-10} = \frac{1}{2}, \frac{c_1}{c_2} = \frac{20}{40} = \frac{1}{2}$$

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

Hence, infinite solutions

$$(iv) \quad x - 3y - 7 = 0 \quad \dots\dots(i)$$

$$3x - 3y - 15 = 0 \quad \dots\dots(ii)$$

$$\frac{a_1}{a_2} = \frac{1}{3}, \frac{b_1}{b_2} = 1, \frac{c_1}{c_2} = \frac{7}{15}$$

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

Hence, unique solution.

$$\frac{x}{(-3)(-15) - (-3)(-7)} = \frac{y}{3 \times (-7) - 1 \times (-15)}$$

$$= \frac{1}{1 \times (-3) - 3(-3)}$$

$$\Rightarrow \frac{x}{45 - 21} = \frac{y}{-21 + 15} = \frac{1}{-3 + 9}$$

$$\Rightarrow \frac{x}{24} = \frac{y}{-6} = \frac{1}{6}$$

$$x = \frac{24}{6} = 4, \quad y = \frac{-6}{6} = -1$$

- Q2.** (i) For which values of a and b does the following pair of linear equations have an infinite number of solutions? $2x + 3y = 7$ $(a - b)x + (a + b)y = 3a + b - 2$
- (ii) For which value of k will the following pair of linear equations have no solution? $3x + y = 1$ $(2k - 1)x + (k - 1)y = 2k + 1$.

Sol. (i) $2x + 3y - 7 = 0 \quad \dots(i)$

$(a - b)x + (a + b)y - (3a + b - 2) = 0 \quad \dots(ii)$

For infinite number of solutions, we have

$$\frac{a - b}{2} = \frac{a + b}{3} = \frac{3a + b - 2}{7}$$

For first and second, we have

$$\frac{a - b}{2} = \frac{a + b}{3} \quad \text{or} \quad 3a - 3b = 2a + 2b$$

$$\text{or } a = 5b \quad \dots(i)$$

From second and third, we have

$$\frac{a + b}{3} = \frac{3a + b - 2}{7}$$

$$\text{or } 7a + 7b = 9a + 3b - 6 \quad \text{or } 4b = 2a - 6$$

$$\text{or } 2b = a - 3 \quad \dots(ii)$$

From (i) and (ii), eliminating a,

$$2b = 5b - 3 \quad \Rightarrow b = 1$$

Substituting $b = 1$ in (i), we get $a = 5$

$$(ii) \quad 3x + y = 1$$

$$(2k - 1)x + (k - 1)y = 2k + 1$$

For no, solution, $\frac{a_1}{a_2} = \frac{b_1}{b_2} \neq \frac{c_1}{c_2}$

$$\frac{3}{2k-1} = \frac{1}{k-1} \neq \frac{1}{2k+1}$$

So, $\frac{3}{2k-1} = \frac{1}{k-1}$ & $\frac{1}{k-1} \neq \frac{1}{2k+1}$

$$3(k - 1) = 2k - 1 \quad 2k + 1 \neq k - 1$$

$$k = 2 \quad k \neq -2$$

Q3. Solve the following pair of linear equations by the substitution and cross-multiplication methods: $8x + 5y = 9$, $3x + 2y = 4$

Sol. By substitution method,

$$8x + 5y = 9 \quad \dots(i)$$

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

From (ii), we get

$$x = \frac{4 - 2y}{3}$$

Substituting x from (iii) in (i), we get

$$8 \left(\frac{4 - 2y}{3} \right) + 5y = 9$$

$$\Rightarrow 32 - 16y + 15y = 27$$

$$\Rightarrow 5 = y$$

Substituting $y = 5$ in (ii) we get

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

$$\Rightarrow 3x = -6$$

$$\Rightarrow x = -2$$

Hence, $x = -2$, $y = 5$

By cross multiplication method

$$8x + 5y = 9 \quad \dots(i)$$

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

$$\frac{x}{5 \times (-4) - 2(-9)} = \frac{y}{3 \times (-9) - 8(-4)} = \frac{1}{8 \times 2 - 3 \times 5}$$

$$\Rightarrow x = \frac{-20 + 18}{1} = -2$$

$$\Rightarrow y = \frac{-27 + 32}{1} = 5$$

Hence, $x = -2$, $y = 5$

Q4. Form the pair of linear equations in the following problems and find their solutions (if they exist) by any algebraic method.

- (i) A part of monthly hostel charges is fixed and the remaining depends on the number of days one has taken food in the mess. When a student A takes food for 20 days she has to pay Rs. 1000 as hostel charges whereas a student B, who takes food for 26 days, pays Rs. 1180 as hostel charges. Find the fixed charges and the cost of food per day.
- (ii) A fraction becomes $\frac{1}{3}$ when 1 is subtracted from the numerator and it becomes $\frac{1}{4}$ when 8 is added to its denominator. Find the fraction.
- (iii) Yash scored 40 marks in a test, getting 3 marks for each right answer and losing 1 mark for each wrong answer. Had 4 marks been awarded for each correct answer and 2 marks been deducted for each incorrect answer, then Yash would have scored 50 marks. How many questions were there in the test?
- (iv) Places A and B are 100 km apart on a highway. One car starts from A and another from B at the same time. If the cars travel in the same direction at different speeds, they meet in 5 hours. If they travel towards each other, they meet in 1 hour. What are the speeds of the two cars?
- (v) The area of a rectangle gets reduced by 9 square units if its length is reduced by 5 units and breadth is increased by 3 units. If we increase the length by 3 units and the breadth by 2 units, the area increases by 67 square units. Find the dimensions of the rectangle.

Sol. (i) Let the fixed charge be x
and charges of food for 1 day be y .
So, $x + 20y = 1000$ (i)
 $x + 26y = 1180$ (ii)
Subtracting (i) from (ii), we get
 $6y = 180$; $y = 30$
Substituting y in (i), we get
 $x + 20 \times 30 = 1000$
 $x = 1000 - 600$
 $x = 400$
So, fixed charge = Rs.400 and charges of food
for 1 day = Rs.30

(ii) Let the fraction be $\frac{x}{y}$

Then, $\frac{x-1}{y} = \frac{1}{3}$ (i)

 $\frac{x}{y+8} = \frac{1}{4}$ (ii)
From (i) and (ii), we get
 $3x - 3 = y$ or $3x - y = 3$ (iii)
 $4x = y + 8$ or $4x - y = 8$ (iv)
Subtracting (iii) from (iv), we get

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

$$x = 5$$

Substituting x in (iii), we get

$$3 \times 5 - y = 3$$

$$y = 12$$

So the required fraction is $\frac{5}{12}$

- (iii) Number of right answers = x . Number of wrong answers = y

$$\text{Then, } 3x - y = 40 \quad \dots(i)$$

$$4x - 2y = 50 \quad \dots(ii)$$

Multiplying (i) by 2, we get

$$6x - 2y = 80 \quad \dots(iii)$$

Subtracting (ii) from (iii), we get

$$2x = 30$$

$$\Rightarrow x = 15$$

Substituting $x = 15$, in (i), we get

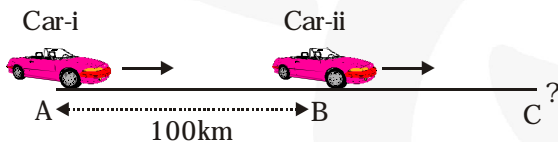
$$45 - y = 40$$

$$\Rightarrow y = 5$$

$$\text{Total questions} = x + y = 15 + 5 = 20$$

- (iv) Speed of car i = x km/hr
Speed of car ii = y km/hr

First case :

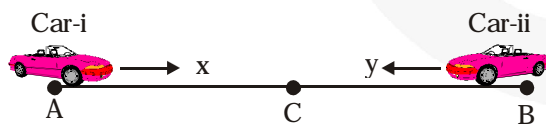


Two cars meet at C after 5 hrs.

$$AC - BC = AB$$

$$\Rightarrow 5x - 5y = 100 \quad \dots(i)$$

Second case :



Two cars meet at C after one hour

$$x + y = 100 \quad \dots(ii)$$

Multiplying (ii) by 5, we get

$$5x + 5y = 500 \quad \dots(iii)$$

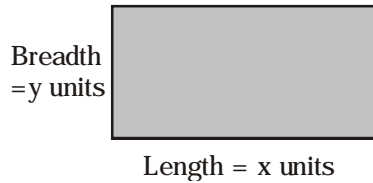
Adding (i) and (iii), we get

$$10x = 600$$

$$\Rightarrow x = 60 \text{ km/hr}$$

Substituting $x = 60$ km/hr in (ii), we get
 $y = 40$ km/hr
 Speed of car (i) = 60 km/hr
 Speed of car (ii) 40 km/hr

- (v) In first case, area is reduced by 9 square units.



When length = $x - 5$ units
 and breadth = $y + 3$ units

$$\Rightarrow xy - (x - 5) \times (y + 3) = 9 \quad \dots(i)$$

In second case area increases by 67 sq. units when length = $x + 3$ and breadth = $y + 2$.

$$\Rightarrow (x + 3) \times (y + 2) - xy = 67 \quad \dots(ii)$$

Solving both equations, we get

$$xy - xy - 3x + 5y + 15 = 9$$

$$3x - 5y = 6 \quad \dots(iii)$$

$$xy + 2x + 3y + 6 - xy = 67$$

$$2x + 3y = 61 \quad \dots(iv)$$

Multiplying (iii) by 3 and (iv) by 5, we get

$$9x - 15y = 18$$

$$10x + 15y = 305$$

Adding, we get

$$19x = 323$$

$$\Rightarrow x = 17$$

By putting $x = 17$, we get $y = 9$

Ex - 3.6

Q1. Solve the following pairs of equations by reducing them to a pair of linear equations :

(i) $\frac{1}{2x} + \frac{1}{3y} = 2$, $\frac{1}{3x} + \frac{1}{2y} = \frac{13}{6}$

(ii) $\frac{2}{\sqrt{x}} + \frac{3}{\sqrt{y}} = 2$, $\frac{4}{\sqrt{x}} - \frac{9}{\sqrt{y}} = -1$

(iii) $\frac{4}{x} + 3y = 14$, $\frac{3}{x} - 4y = 23$

(iv) $\frac{5}{(x-1)} + \frac{1}{(y-2)} = 2$, $\frac{6}{(x-1)} - \frac{3}{(y-2)} = 1$

(v) $\frac{7x-2y}{xy} = 5$, $\frac{8x+7y}{xy} = 15$

(vi) $6x + 3y = 6xy$, $2x + 4y = 5xy$

(vii) $\frac{10}{(x+y)} + \frac{2}{(x-y)} = 4$, $\frac{15}{(x+y)} - \frac{5}{(x-y)} = -2$

(viii) $\frac{1}{(3x+y)} + \frac{1}{(3x-y)} = \frac{3}{4}$, $\frac{1}{2(3x+y)} - \frac{1}{2(3x-y)} = \frac{-1}{8}$

Sol. (i) $\frac{1}{2x} + \frac{1}{3y} = 2$, $\frac{1}{3x} + \frac{1}{2y} = \frac{13}{6}$

Substituting $\frac{1}{x} = u$ and $\frac{1}{y} = v$

We get $\frac{1}{2}u + \frac{1}{3}v = 2$, $\frac{1}{3}u + \frac{1}{2}v = \frac{13}{6}$

Multiplying by 6 on both sides, we get

$\Rightarrow 3u + 2v = 12$... (i)

$2u + 3v = 13$... (ii)

Multiplying (i) by 3 and (ii) by 2, then subtracting later from first, we get

$3(3u + 2v) - 2(2u + 3v) = 3 \times 12 - 2 \times 13$

$\Rightarrow 9u - 4u = 36 - 26 \Rightarrow u = 2$

Then substituting $u = 2$ in (i), we get

$6 + 2v = 12$

$\Rightarrow v = 3$

Now, $u = 2$ and $v = 3$

$\Rightarrow \frac{1}{x} = 2$ and $\frac{1}{y} = 3 \Rightarrow x = \frac{1}{2}$ and $y = \frac{1}{3}$

$$(ii) \quad \frac{2}{\sqrt{x}} + \frac{3}{\sqrt{y}} = 2 \quad \dots(i)$$

$$\frac{4}{\sqrt{x}} - \frac{9}{\sqrt{y}} = -1 \quad \dots(ii)$$

Take $\frac{1}{\sqrt{x}} = a$, $\frac{1}{\sqrt{y}} = b$, we get

$$2a + 3b = 2 \quad \dots(iii)$$

$$4a - 9b = -1 \quad \dots(iv)$$

Multiplying (iii) by 3, we get

$$6a + 9b = 6 \quad \dots(v)$$

Adding (iv) and (v), we get

$$10a = 5$$

$$\Rightarrow a = \frac{1}{2} \text{ Substituting } a = \frac{1}{2} \text{ in (iii), we get}$$

$$3b = 1$$

$$\Rightarrow b = \frac{1}{3}$$

$$\text{Now, } \frac{1}{\sqrt{x}} = a = \frac{1}{2} \text{ and } \frac{1}{\sqrt{y}} = b = \frac{1}{3}$$

$$\Rightarrow \sqrt{x} = 2, \sqrt{y} = 3$$

Squaring, we get

$$x = 4, y = 9$$

$$(iii) \quad \frac{4}{x} + 3y = 14 \quad \dots(i)$$

$$\frac{3}{x} - 4y = 23 \quad \dots(ii)$$

$$\text{Take, } \frac{1}{x} = a$$

$$4a + 3y = 14 \quad \dots(iii)$$

$$3a - 4y = 23 \quad \dots(iv)$$

Multiplying (iii) by 4 and (iv) by 3

$$16a + 12y = 56$$

$$9a - 12y = 69$$

Adding both, we get

$$25a = 125$$

$$\Rightarrow a = 5$$

Substituting a in (iii), we get

$$20 + 3y = 14$$

$$\Rightarrow 3y = -6$$

$$\Rightarrow y = -2$$

$$\text{As, } \frac{1}{x} = a = 5$$

$$\Rightarrow x = \frac{1}{5}$$

$$\text{Hence, } x = \frac{1}{5} \text{ and } y = -2$$

$$(iv) \quad \frac{5}{(x-1)} + \frac{1}{(y-2)} = 2 \quad \dots(i)$$

$$\frac{6}{(x-1)} - \frac{3}{(y-2)} = 1 \quad \dots(ii)$$

Take, $\frac{1}{(x-1)} = a$ and $\frac{1}{(y-2)} = b$

$$5a + b = 2 \quad \dots(iii)$$

$$6a - 3b = 1 \quad \dots(iv)$$

Multiplying (iii) by 3, we get

$$15a + 3b = 6$$

$$6a - 3b = 1$$

Adding both we get

$$21a = 7$$

$$a = 1/3$$

So, by solving, $b = 1/3$

$$\text{As, } a = \frac{1}{3} = \frac{1}{x-1} \Rightarrow x - 1 = 3 \Rightarrow x = 4$$

$$\text{and } b = \frac{1}{3} = \frac{1}{y-2} \Rightarrow y - 2 = 3$$

$$\Rightarrow y = 5$$

$$(v) \quad \frac{7x-2y}{xy} = 5, \quad \frac{8x+7y}{xy} = 15$$

By solving, we get

$$\frac{7}{y} - \frac{2}{x} = 5 \quad \dots(i)$$

$$\frac{8}{y} + \frac{7}{x} = 15 \quad \dots(ii)$$

Taking $\frac{1}{y} = u$, $\frac{1}{x} = v$

$$7u - 2v = 5 \quad \dots(iii)$$

$$8u + 7v = 15 \quad \dots(iv)$$

Multiplying (iii) by 7 and (iv) by 2, we get

$$49u - 14v = 35$$

$$16u + 14v = 30$$

Adding, we get

$$65u = 65$$

$$u = 1$$

By solving, we get $v = 1$

$$\text{As, } u = 1 = \frac{1}{y} \Rightarrow y = 1$$

$$\text{and } v = 1 = \frac{1}{x} \Rightarrow x = 1$$

- (vi) $6x + 3y = 6xy$
 $2x + 4y = 5xy$
 By solving, we get

$$\frac{6}{y} + \frac{3}{x} = 6 \quad \dots(i)$$

$$\frac{2}{y} + \frac{4}{x} = 5 \quad \dots(ii)$$

Take, $\frac{1}{y} = u$, $\frac{1}{x} = v$, we get

$$6u + 3v = 6 \quad \dots(iii)$$

$$2u + 4v = 5 \quad \dots(iv)$$

Multiply (iv) by 3, we get

$$6u + 12v = 15 \quad \dots(v)$$

Subtract (iii) from (v), we get

$$9v = 9 \Rightarrow v = 1$$

By solving we get $u = 1/2$

$$\text{As, } \frac{1}{x} = v = 1 \Rightarrow x = 1$$

$$\text{and } \frac{1}{y} = u = \frac{1}{2} \Rightarrow y = 2$$

- (vii) $\frac{10}{(x+y)} + \frac{2}{(x-y)} = 4, \frac{15}{(x+y)} - \frac{5}{(x-y)} = -2$

Take $\frac{1}{x+y} = u$ and $\frac{1}{x-y} = v$

$$10u + 2v = 4 \quad \dots(i)$$

$$15u - 5v = -2 \quad \dots(ii)$$

Multiply (i) by 5 and (ii) by 2, we get

$$50u + 10v = 20$$

$$30u - 10v = -4$$

Adding, we get

$$80u = 16$$

$$u = 1/5$$

By solving, we get $v = 1$

$$\text{As, } \frac{1}{x+y} = u = \frac{1}{5}$$

$$\Rightarrow x + y = 5 \quad \dots(iii)$$

$$\text{and } \frac{1}{x-y} = v = 1$$

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

Adding (iii) and (iv), we get

$$2x = 6$$

$$\Rightarrow x = 3 \text{ and } y = 2$$

Hence, $x = 3, y = 2$

$$(viii) \frac{1}{3x+y} + \frac{1}{3x-y} = \frac{3}{4} \quad \dots\dots(i)$$

$$\frac{1}{2(3x+y)} - \frac{1}{2(3x-y)} = -\frac{1}{8} \quad \dots\dots(ii)$$

$$\text{Let, } \frac{1}{3x+y} = u, \quad \frac{1}{3x-y} = v$$

$$u + v = \frac{3}{4} \quad \dots\dots(iii)$$

$$\frac{u}{2} - \frac{v}{2} = -\frac{1}{8} \quad \dots\dots(iv)$$

From (iv), we get

$$u - v = -\frac{1}{4} \quad \dots\dots(v)$$

Solving (iii) and (v), we get

$$2u = \frac{1}{2}$$

$$u = \frac{1}{4}, \quad v = \frac{1}{2}$$

$$\text{So, } \frac{1}{3x+y} = \frac{1}{4} \Rightarrow 3x + y = 4$$

$$\frac{1}{3x-y} = \frac{1}{2} \Rightarrow 3x - y = 2$$

Solving, we get

$$x = 1, y = 1$$

Q2. Formulate the following problems as a pair of linear equations, and hence find their solutions:

- (i) Ritu can row downstream 20 km in 2 hours, and upstream 4 km in 2 hours. Find her speed of rowing in still water and the speed of the current.
- (ii) 2 women and 5 men can together finish an embroidery work in 4 days, while 3 women and 6 men can finish it in 3 days. Find the time taken by 1 woman alone to finish the work, and also that taken by 1 man alone.
- (iii) Roohi travels 300 km to her home partly by train and partly by bus. She takes 4 hours if she travels 60 km by train and the remaining by bus. If she travels 100 km by train and the remaining by bus, she takes 10 minutes longer. Find the speed of the train and the bus separately.

Sol. (i) Speed of Ritu in still water = x km/hr
 Speed of current = y km/hr
 Then speed downstream = $(x + y)$ km/hr
 speed upstream = $(x - y)$ km/hr

$$\frac{20}{x+y} = 2 \text{ and } \frac{4}{x-y} = 2$$

$$\Rightarrow x + y = 10 \quad \dots(i)$$

$$x - y = 2 \quad \dots(ii)$$

From (i) and (ii)

$$x + y = 10$$

$$x - y = 2$$

$$\hline 2x = 12$$

From (i)

$$6 + y = 10$$

$$y = 4$$

So speed of Ritu = 6 km/hr and speed of current = 4 km/hr.

- (ii) Let 1 woman finish the work in x days and let 1 man finish the work in y days.

$$\text{Work of 1 woman in 1 day} = \frac{1}{x}$$

$$\text{Work of 1 man in 1 day} = \frac{1}{y}$$

Work of 2 women and 5 men in one day

$$= \frac{2}{x} + \frac{5}{y} = \frac{5x+2y}{xy}$$

$$\text{The number of days required for complete work} = \frac{xy}{5x+2y}$$

$$\text{We are given that } \frac{xy}{5x+2y} = 4$$

$$\text{Similarly, in second case } \frac{xy}{6x+3y} = 3$$

$$xy = 4(5x + 2y) \quad \dots(i)$$

$$xy = 3(6x + 3y) \quad \dots(ii)$$

By solving, we get

$$xy = 20x + 8y$$

$$xy = 18x + 9y$$

$$\Rightarrow \frac{20}{y} + \frac{8}{x} = 1 \quad \dots(iii)$$

$$\frac{18}{y} + \frac{9}{x} = 1 \quad \dots(iv)$$

Putting $\frac{1}{y} = u, \frac{1}{x} = v$

$$20u + 8v = 1 \quad \dots(v)$$

$$18u + 9v = 1 \quad \dots(vi)$$

Multiply (v) by 9 and (vi) by 10

$$180u + 72v = 9$$

$$180u + 90v = 10$$

On subtracting, we get

$$18v = 1 \quad v = 1/18 \text{ and } u = 1/36$$

$$\text{As } u = \frac{1}{36} = \frac{1}{y} \Rightarrow y = 36 \text{ days}$$

$$\text{and } v = \frac{1}{18} = \frac{1}{x} \Rightarrow x = 18 \text{ days}$$

- (iii) Let the speed of train be x km/hr
and the speed of bus be y km/hr

$$\text{So, } \frac{60}{x} + \frac{240}{y} = 4 \quad \dots(i)$$

$$\frac{100}{x} + \frac{200}{y} = \frac{25}{6} \quad \dots(ii)$$

$$\text{Let } \frac{1}{x} = u, \quad \frac{1}{y} = v$$

$$60u + 240v = 4 \quad \dots(iii)$$

$$100u + 200v = \frac{25}{6} \quad \dots(iv)$$

Solving (iii) and (iv), we get

$$u = \frac{1}{60}, \quad v = \frac{1}{80}$$

$$\text{So, } \frac{1}{x} = \frac{1}{60} \quad \text{and} \quad \frac{1}{y} = \frac{1}{80}$$

$$\therefore x = 60 \text{ km/hr and } y = 80 \text{ km/hr}$$