# Mathematics

## (Chapter – 3) (Linear equations in two variables)

**(Class – X)**

## Exercise 3.1

**Question 1:**

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 Rs 50, whereas 7 pencils and 5 pens together cost Rs 46. Find the cost of one pencil and that of one pen.

**Answer 1:**

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

According to the question, the algebraic representation is $x + y = 10$ $x - y = 4$

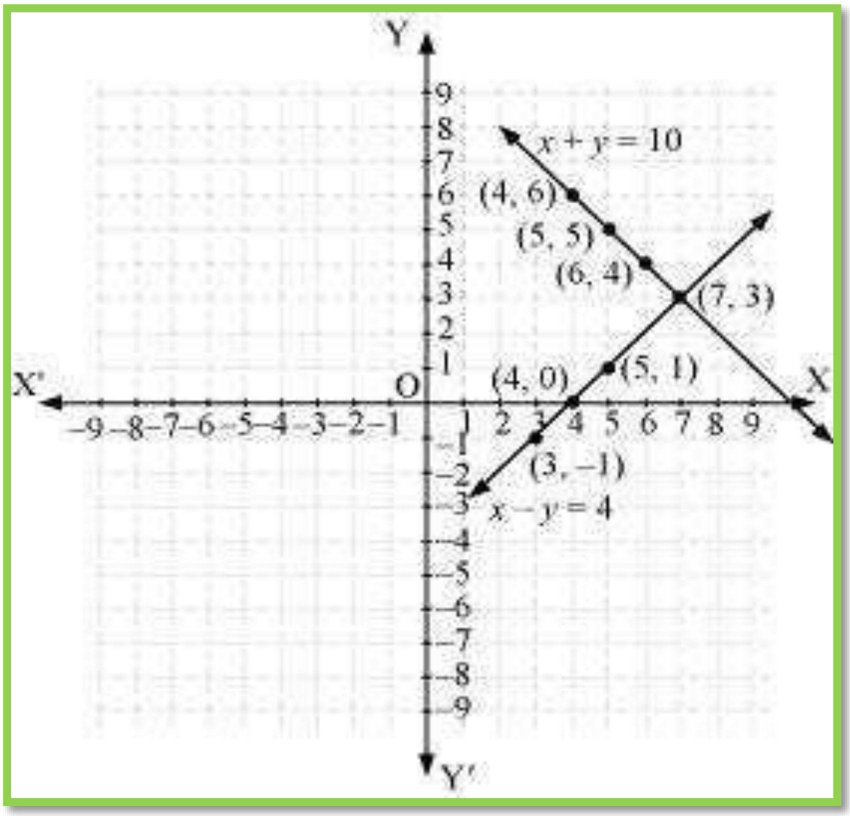
For $x + y = 10$, $x = 10 - y$

| | | | |
|---|---|---|---|
| $x$ | 5 | 4 | 6 |
| $y$ | 5 | 6 | 4 |

For $x - y = 4$, $x = 4 + y$

| | | | |
|---|---|---|---|
| $x$ | 5 | 4 | 3 |
| $y$ | 1 | 0 | −1 |

Hence, the graphic representation is as follows.




From the figure, it can be observed that these lines intersect each other at point (7, 3).

Therefore, the number of girls and boys in the class are 7 and 3 respectively.

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

According to the question, the algebraic representation is

$5x + 7y = 50$

$7x + 5y = 46$

For $5x + 7y = 50$,

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

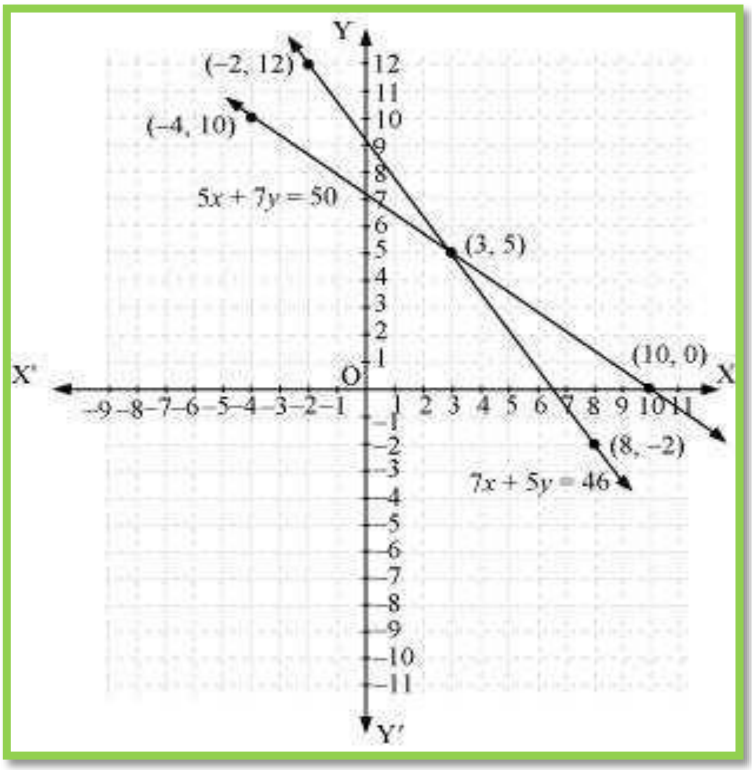
| | | | |
|---|---|---|---|
| $x$ | 3 | 10 | − 4 |
| $y$ | 5 | 0 | 10 |

$7x + 5y = 46$

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

| | | | |
|---|---|---|---|
| ***x*** | **8** | **3** | **− 2** |
| ***y*** | **− 2** | **5** | **12** |

Hence, the graphic representation is as follows.




From the figure, it can be observed that these lines intersect each other at point (3, 5).

Therefore, the cost of a pencil and a pen are Rs 3 and Rs 5 respectively.

**Question 2:**

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

**Answer 2:**

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

$7x + 6y - 9 = 0$

Comparing these equations with $a_1x+b_1y+c_1=0$ and $a_2x+b_2y+c_2=0$, we obtain

$a_1=5, \quad b_1=-4, \quad c_1=8$

$a_2=7, \quad b_2=6, \quad c_2=-9$

$\frac{a_1}{a_2}=\frac{5}{7}$

$\frac{b_1}{b_2}=\frac{-4}{6}=\frac{-2}{3}$

Since $\frac{a_1}{a_2}\neq\frac{b_1}{b_2}$,

Hence, the lines representing the given pair of equations have a unique solution and the pair of lines intersects at exactly one point.

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

$18x + 6y + 24 = 0$

Comparing these equations with $a_1x+b_1y+c_1=0$

and $a_2x+b_2y+c_2=0$

We obtain, $a_1=9, \quad b_1=3, \quad c_1=12$

$a_2=18, \quad b_2=6, \quad c_2=24$

$\frac{a_1}{a_2}=\frac{9}{18}=\frac{1}{2}$

$\frac{b_1}{b_2}=\frac{3}{6}=\frac{1}{2}$

$\frac{c_1}{c_2}=\frac{12}{24}=\frac{1}{2}$

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

Hence, the lines representing the given pair of equations are coincident and there are infinite possible solutions for the given pair of equations.

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

$2x - y + 9 = 0$

Comparing these equations with $a_1x + b_1y + c_1 = 0$

and $a_2x + b_2y + c_2 = 0$ , we obtain

$a_1 = 6, \quad b_1 = -3, \quad c_1 = 10$

$a_2 = 2, \quad b_2 = -1, \quad c_2 = 9$

$\frac{a_1}{a_2} = \frac{6}{2} = \frac{3}{1}$

$\frac{b_1}{b_2} = \frac{-3}{-1} = \frac{3}{1}$

$\frac{c_1}{c_2} = \frac{10}{9}$

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

Hence, the lines representing the given pair of equations are parallel to each other and hence, these lines will never intersect each other at any point or there is no possible solution for the given pair of equations.

**Question 3:**

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 pair of linear equations are consistent, or inconsistent.

(i) $3x + 2y = 5; \quad 2x - 3y = 7$ (ii) $2x - 3y = 8; \quad 4x - 6y = 9$

(iii) $\frac{3}{2}x + \frac{5}{3}y = 7; \quad 9x - 10y = 14$ (iv) $5x - 3y = 11; -10x + 6y = -22$

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

**Answer 3:**

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

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

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

These linear equations are intersecting each other at one point and thus have only one possible solution. Hence, the pair of linear equations is consistent.

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

$4x - 6y = 9$

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

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

Therefore, these linear equations are parallel to each other and thus have no possible solution. Hence, the pair of linear equations is inconsistent.

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

$9x - 10y = 14$

$$\frac{a_1}{a_2} = \frac{\frac{3}{2}}{9} = \frac{1}{6}, \quad \frac{b_1}{b_2} = \frac{\frac{5}{3}}{-10} = \frac{-1}{6}, \quad \frac{c_1}{c_2} = \frac{7}{14} = \frac{1}{2}$$

Since $\frac{a_1}{a_2} \neq \frac{b_1}{b_2'}$

Therefore, these linear equations are intersecting each other at one point and thus have only one possible solution. Hence, the pair of linear equations is consistent.

(iv)$5x - 3y = 11$

$-10x + 6y = -22$

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

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

Therefore, these linear equations are coincident pair of lines and thus have infinite number of possible solutions. Hence, the pair of linear equations is consistent.

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

$2x+3y=12$

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

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

Therefore, these linear equations are coincident pair of lines and thus have infinite number of possible solutions. Hence, the pair of linear equations is consistent.

**Question 4:**

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

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

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

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

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

**Answer 4:**

(i) $x + y = 5$

$2x + 2y = 10$

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

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

Therefore, these linear equations are coincident pair of lines and thus have infinite number of possible solutions. Hence, the pair of linear equations is consistent.

$x + y = 5$, $x = 5 - y$

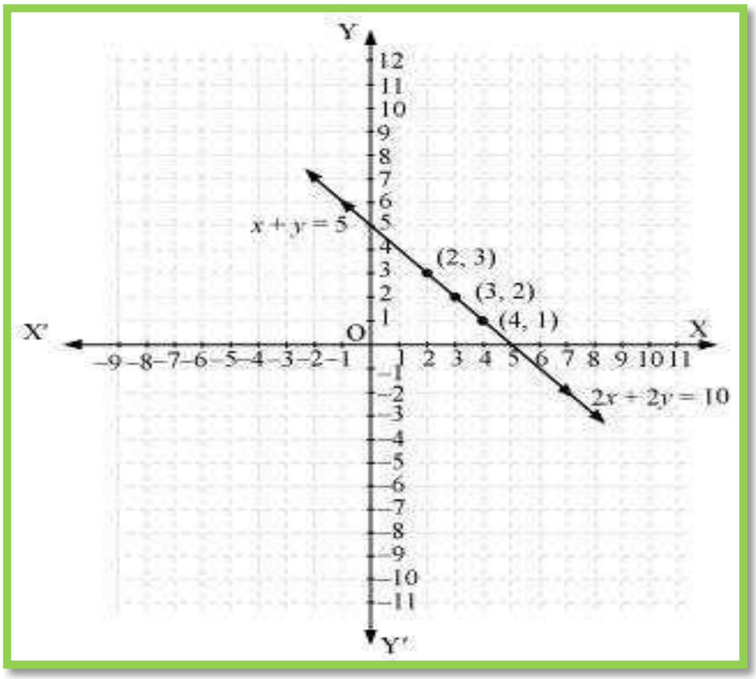
| ***x*** | **4** | **3** | **2** |
|---|---|---|---|
| ***y*** | **1** | **2** | **3** |

And, $2x + 2y = 10$

$x = \frac{10 - 2y}{2}$

| ***x*** | **4** | **3** | **2** |
|---|---|---|---|
| ***y*** | **1** | **2** | **3** |

Hence, the graphic representation is as follows.



From the figure, it can be observed that these lines are overlapping each other. Therefore, infinite solutions are possible for the given pair of equations.

(ii)$x - y = 8$

$3x - 3y = 16$

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

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

Therefore, these linear equations are parallel to each other and thus have no possible solution. Hence, the pair of linear equations is inconsistent.

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

$4x - 2y - 4 = 0$

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

Since $\frac{a_1}{a_2} \neq \frac{b_1}{b_2}$ ,

Therefore, these linear equations are intersecting each other at one point and thus have only one possible solution. Hence, the pair of linear equations is consistent.

$2x + y - 6 = 0$, $\quad y = 6 - 2x$

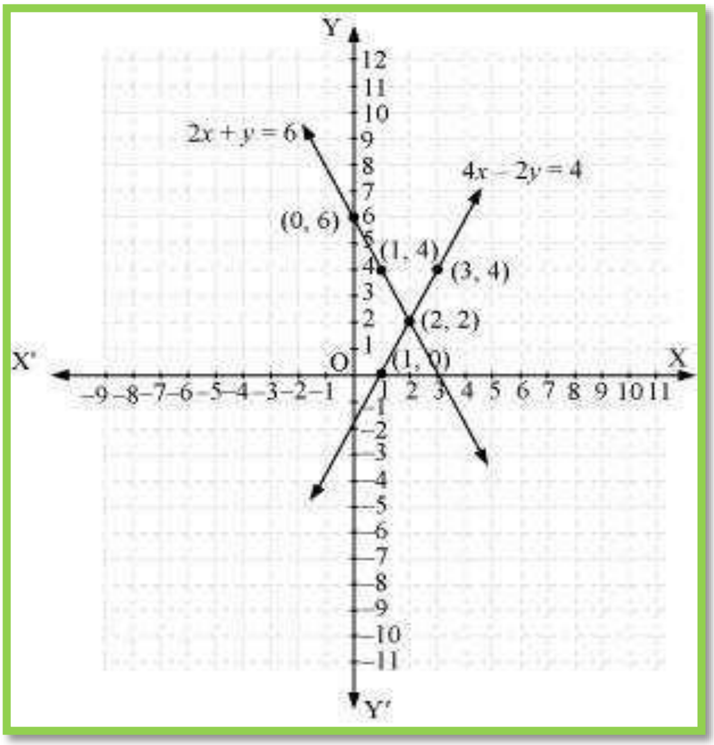
| | | | |
|---|---|---|---|
| ***x*** | **0** | **1** | **2** |
| ***y*** | **6** | **4** | **2** |

And $4x - 2y - 4 = 0$

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

| | | | |
|---|---|---|---|
| ***x*** | **1** | **2** | **3** |
| ***y*** | **0** | **2** | **4** |

Hence, the graphic representation is as follows.




From the figure, it can be observed that these lines are intersecting each other at the only point i.e., (2, 2) and it is the solution for the given pair of equations.

(iv)$2x - 2y - 2 = 0$

$4x - 4y - 5 = 0$

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

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

Therefore, these linear equations are parallel to each other and thus have no possible solution. Hence, the pair of linear equations is inconsistent.

**Question 5:**

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.

**Answer 5:**

Let the width of the garden be *x* and length be *y*.

According to the question,

$y - x = 4$ ………………. (1)
$y + x = 36$ ……………..(2)

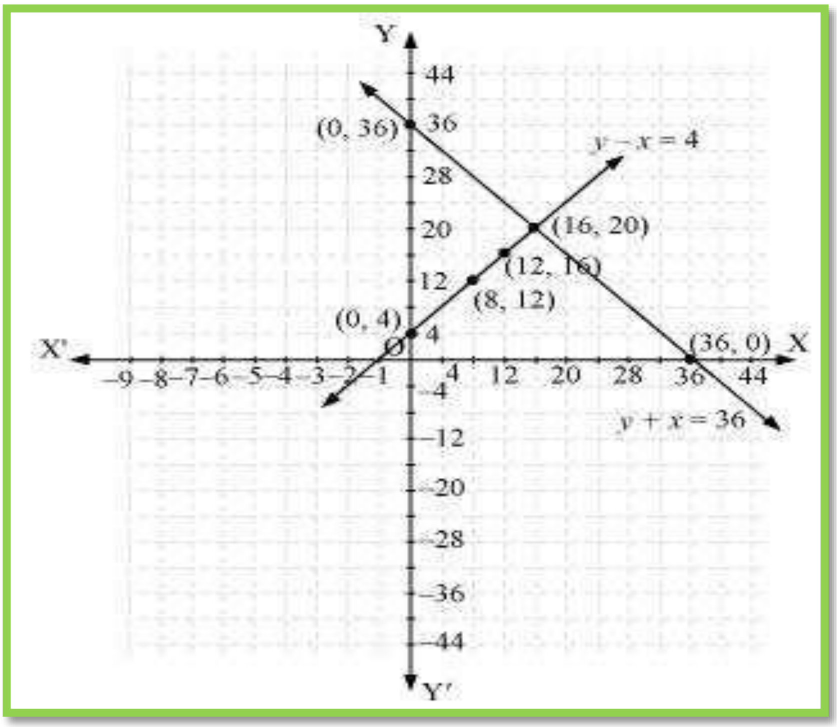
$y - x = 4$

| | | | |
|---|---|---|---|
| ***x*** | **0** | **8** | **12** |
| ***y*** | **4** | **12** | **16** |

$y + x = 36$

| | | | |
|---|---|---|---|
| ***x*** | **0** | **36** | **16** |
| ***y*** | **36** | **0** | **20** |

Hence, the graphic representation is as follows.



From the figure, it can be observed that these lines are intersecting each other at only point i.e., (16, 20). Therefore, the length and width of the given garden is 20 m and 16 m respectively.

**Question 6:**

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

(i) Intersecting lines (ii) Parallel lines

(iii) Coincident lines

**Answer 6:**

(i)**Intersecting lines:**

For this condition,

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

The second line such that it is intersecting the given line is

$$2x + 4y - 6 = 0 \quad \text{as} \quad \frac{a_1}{a_2} = \frac{2}{2} = 1, \quad \frac{b_1}{b_2} = \frac{3}{4} \text{ and } \frac{a_1}{a_2} \neq \frac{b_1}{b_2}.$$

(ii) **Parallel lines:**

For this condition,

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

Hence, the second line can be

$4x + 6y - 8 = 0$

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

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

(iii)**Coincident lines**:

For coincident lines,

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

Hence, the second line can be

$6x + 9y - 24 = 0$

as $\frac{a_1}{a_2} = \frac{2}{6} = \frac{1}{3}, \quad \frac{b_1}{b_2} = \frac{3}{9} = \frac{1}{3}, \frac{c_1}{c_2} = \frac{-8}{-24} = \frac{1}{3}$

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

**Question 7:**

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.

**Answer 7:**

$x - y + 1 = 0$ or $x = y - 1$

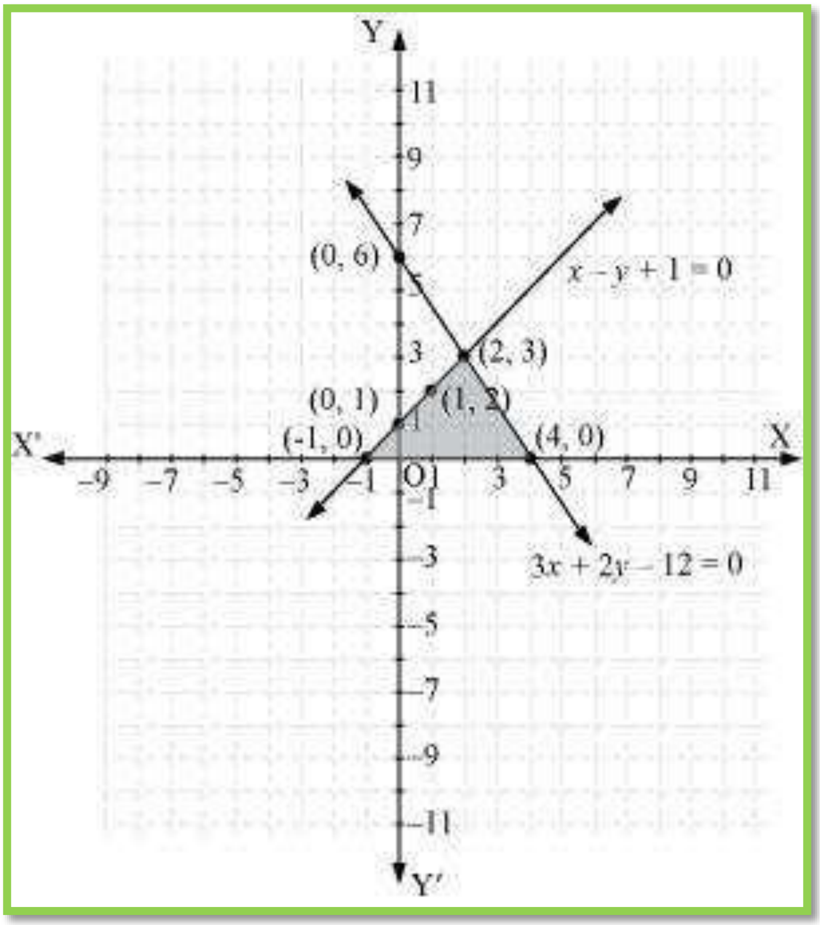
| ***x*** | **0** | **1** | **2** |
|---|---|---|---|
| ***y*** | **1** | **2** | **3** |

$3x + 2y - 12 = 0$

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

| ***x*** | **4** | **2** | **0** |
|---|---|---|---|
| ***y*** | **0** | **3** | **6** |

Hence, the graphic representation is as follows.




From the figure, it can be observed that these lines are intersecting each other at point (2, 3) and *x*-axis at (−1, 0) and (4, 0). Therefore, the vertices of the triangle are (2, 3), (−1, 0), and (4, 0).

# Mathematics

## (Chapter – 3) (Linear equations in two variables)

**(Class – X)**

## Exercise 3.2

**Question 1:**

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) $\frac{3x}{2}-\frac{5y}{3}=-2$

$\frac{x}{3}+\frac{y}{2}=\frac{13}{6}$

**Answer 1:**

(i) $x + y = 14$ ……………………..(1)

$x - y = 4$ ………………………..(2)

From (1), we obtain $x = 14 - y$ (3)

Substituting this value in equation (2), we obtain

$$(14-y)-y=4$$
$$14-2y=4$$
$$10=2y$$
$$y=5 \qquad (4)$$

Substituting this in equation (3), we obtain

$$x=9$$
$$\therefore x=9, y=5$$

(ii) $s-t=3 \qquad (1)$

$$\frac{s}{3}+\frac{t}{2}=6 \qquad (2)$$

From (1), we obtain

$$s=t+3 \qquad (3)$$

Substituting this value in equation (2), we obtain

$$\frac{t+3}{3}+\frac{t}{2}=6$$
$$2t+6+3t=36$$
$$5t=30$$
$$t=6 \qquad (4)$$

Substituting in equation (3), we obtain $s$
$= 9$

$\therefore s = 9, t = 6$

(iii)$3x - y = 3$ (1)

$9x - 3y = 9$ (2) From (1), we obtain $y = 3x - 3$ (3)

Substituting this value in equation (2), we obtain

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

$9 = 9$

This is always true.

Hence, the given pair of equations has infinite possible solutions and the relation between these variables can be given by $y = 3x - 3$

Therefore, one of its possible solutions is $x = 1$, $y = 0$.

( iv ) $0.2x+0.3y=1.3 \qquad (1)$

$$0.4x+0.5y=2.3 \qquad (2)$$

From equation (1), we obtain

$$x=\frac{1.3-0.3y}{0.2} \qquad (3)$$

Substituting this value in equation (2), we obtain

$$0.4\left(\frac{1.3-0.3y}{0.2}\right)+0.5y=2.3$$
$$2.6-0.6y+0.5y=2.3$$
$$2.6-2.3=0.1y$$
$$0.3=0.1y$$
$$y=3 \qquad (4)$$

Substituting this value in equation (3), we obtain

$$x = \frac{1.3 - 0.3 \times 3}{0.2}$$
$$= \frac{1.3 - 0.9}{0.2} = \frac{0.4}{0.2} = 2$$
$$\therefore x = 2,\ y = 3$$

(v) $\sqrt{2}x + \sqrt{3}y = 0 \qquad (1)$

$\sqrt{3}x - \sqrt{8}y = 0 \qquad (2)$

From equation (1), we obtain

$$x = \frac{-\sqrt{3}y}{\sqrt{2}} \qquad (3)$$

Substituting this value in equation (2), we obtain

$$\sqrt{3}\left(-\frac{\sqrt{3}y}{\sqrt{2}}\right) - \sqrt{8}y = 0$$
$$-\frac{3y}{\sqrt{2}} - 2\sqrt{2}y = 0$$
$$y\left(-\frac{3}{\sqrt{2}} - 2\sqrt{2}\right) = 0$$
$$y = 0 \qquad (4)$$

Substituting this value in equation (3), we obtain

$x = 0$

$\therefore x = 0,\ y = 0$

(vi) $\frac{3}{2}x - \frac{5}{3}y = -2 \qquad (1)$

$\frac{x}{3} + \frac{y}{2} = \frac{13}{6} \qquad (2)$

From equation (1), we obtain

$$9x - 10y = -12$$
$$x = \frac{-12 + 10y}{9} \qquad (3)$$

Substituting this value in equation (2), we obtain

$$\frac{\frac{-12+10y}{9}}{3}+\frac{y}{2}=\frac{13}{6}$$

$$\frac{-12+10y}{27}+\frac{y}{2}=\frac{13}{6}$$

$$\frac{-24+20y+27y}{54}=\frac{13}{6}$$

$$47y=117+24$$

$$47y=141$$

$$y=3 \qquad (4)$$

Substituting this value in equation (3), we obtain

$$x=\frac{-12+10\times3}{9}=\frac{18}{9}=2$$

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

**Question 2:**

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

**Answer 2:**

$$2x+3y=11 \qquad (1)$$

$$2x-4y=-24 \qquad (2)$$

From equation (1), we obtain

$$x=\frac{11-3y}{2} \qquad (3)$$

Substituting this value in equation (2), we obtain

$$2\left(\frac{11-3y}{2}\right)-4y=-24$$

$$11-3y-4y=-24$$

$$-7y=-35$$

$$y=5 \qquad (4)$$

Putting this value in equation (3), we obtain

$$x=\frac{11-3\times5}{2}=-\frac{4}{2}=-2$$

Hence, $x$ = −2, $y$ = 5

Also,

$y = mx + 3$

$5 = -2m + 3$

$-2m = 2$

$m = -1$

**Question 3:**

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

**(i)** The difference between two numbers is 26 and one number is three times the other. Find them.

**(ii)** The larger of two supplementary angles exceeds the smaller by 18 degrees. Find them.

**(iii)** 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.

**(iv)** 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 km? How much does a person have to pay for travelling a distance of 25 km.

**(v)** A fraction becomes 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 5/6. Find the fraction.

**(vi)** 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?

**Answer 3:**

(i) Let the first number be $x$ and the other number be $y$ such that $y > x$.

According to the given information,

$y = 3x \quad (1)$

$y - x = 26 \quad (2)$

On substituting the value of $y$ from equation (1) into equation (2), we obtain

$3x - x = 26$

$x = 13 \quad (3)$

Substituting this in equation (1), we obtain $y = 39$

Hence, the numbers are 13 and 39.

(ii) Let the larger angle be $x$ and smaller angle be $y$.

We know that the sum of the measures of angles of a supplementary pair is always 180º.

According to the given information,

$$x + y = 180^\circ \quad (1)$$

$$x - y = 18^\circ \quad (2)$$

From (1), we obtain $x = 180^\circ - y$ (3)

Substituting this in equation (2), we obtain

$$180^\circ - y - y = 18^\circ$$

$$162^\circ = 2y$$

$$81^\circ = y \quad (4)$$

Putting this in equation (3), we obtain $x$

$= 180^\circ - 81^\circ$

$= 99^\circ$

Hence, the angles are 99º and 81º.

(iii) Let the cost of a bat and a ball be $x$ and $y$ respectively.

According to the given information,

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

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

From (1), we obtain

$$y = \frac{3800 - 7x}{6} \quad (3)$$

Substituting this value in equation (2), we obtain

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

$$3x + \frac{9500}{3} - \frac{35x}{6} = 1750$$

$$3x - \frac{35x}{6} = 1750 - \frac{9500}{3}$$

$$\frac{18x-35x}{6}=\frac{5250-9500}{3}$$
$$-\frac{17x}{6}=\frac{-4250}{3}$$
$$-17x=-8500$$
$$x=500 \qquad (4)$$

Substituting this in equation (3), we obtain

$$y=\frac{3800-7\times500}{6}$$
$$=\frac{300}{6}=50$$

Hence, the cost of a bat is Rs 500 and that of a ball is Rs 50.

(iv)Let the fixed charge be Rs *x* and per km charge be Rs *y*.

According to the given information,

$$x+10y=105 \qquad (1)$$
$$x+15y=155 \qquad (2)$$

From (3), we obtain

$$x=105-10y \qquad (3)$$

Substituting this in equation (2), we obtain

$$105-10y+15y=155$$
$$5y=50$$
$$y=10 \qquad (4)$$

Putting this in equation (3), we obtain

$$x=105-10\times10$$
$$x=5$$

Hence, fixed charge = Rs 5

And per km charge = Rs 10

Charge for 25 km = *x* + 25*y*

= 5 + 250 = Rs 255

(v) Let the fraction be x/y.

According to the given information,

$$\frac{x+2}{y+2}=\frac{9}{11}$$
$$11x+22=9y+18$$
$$11x-9y=-4 \qquad (1)$$
$$\frac{x+3}{y+3}=\frac{5}{6}$$
$$6x+18=5y+15$$
$$6x-5y=-3 \qquad (2)$$

From equation (1), we obtain $x=\frac{-4+9y}{11}$ (3)

Substituting this in equation (2), we obtain

$$6\left(\frac{-4+9y}{11}\right)-5y=-3$$
$$-24+54y-55y=-33$$
$$-y=-9$$
$$y=9 \qquad (4)$$

Substituting this in equation (3), we obtain

$$x=\frac{-4+81}{11}=7$$

Hence, the fraction is 7/9.

(vi) Let the age of Jacob be *x* and the age of his son be *y*.

According to the given information,

$$(x+5)=3(y+5)$$
$$x-3y=10 \qquad (1)$$
$$(x-5)=7(y-5)$$
$$x-7y=-30 \qquad (2)$$

From (1), we obtain

$$x=3y+10 \qquad (3)$$

Substituting this value in equation (2), we obtain

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

Substituting this value in equation (3), we obtain

$$x=3\times 10+10$$
$$=40$$

Hence, the present age of Jacob is 40 years whereas the present age of his son is 10 years.

# Mathematics

## (Chapter – 3) (Linear equations in two variables)

**(Class – X)**

## Exercise 3.3

**Question 1:**

Solve the following pair of linear 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 $x-\frac{y}{3}=3$

**Answer 1:**

**(i)** ***By elimination method***

X + y = 5 ...............(1)

2x – 3y = 4 ............(2)

Multiplying equation (1) by 2, we obtain

$2x+2y=10 \quad (3)$

Subtracting equation (2) from equation (3), we obtain

$5y=6$

$y=\frac{6}{5} \qquad (4)$

Substituting the value in equation (1), we obtain

$x=5-\frac{6}{5}=\frac{19}{5}$

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

***By substitution method***

From equation (1), we obtain

$x=5-y$ (5)

Putting this value in equation (2), we obtain

$2(5-y)-3y=4$

$-5y = -6$

$y=\frac{6}{5}$

Substituting the value in equation (5), we obtain

$x = 5 - \frac{6}{5} = \frac{19}{5}$

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

**(ii)** ***By elimination method***

$3x + 4y = 10 \quad (1)$

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

Multiplying equation (2) by 2, we obtain

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

Adding equation (1) and (3), we obtain

$7x = 14$

$x = 2 \quad (4)$

Substituting in equation (1), we obtain

$6 + 4y = 10$

$4y = 4$

$y = 1$

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

***By substitution method***

From equation (2), we obtain

$x = 1 + y$ (5)

Putting this value in equation (1), we obtain

$3(1 + y) + 4y = 10$

$7y$ = 7

$y = 1$

Substituting the value in equation (5), we obtain

$x = 1 + 1 = 2$

$\therefore x = 2, y = 1$

**(iii)*****By elimination method***

$3x - 5y - 4 = 0 \quad (1)$

$9x = 2y + 7$

$9x - 2y - 7 = 0 \quad (2)$

Multiplying equation (1) by 3, we obtain

$$9x-15y-12=0 \qquad (3)$$

Subtracting equation (3) from equation (2), we obtain

$$13y=-5$$

$$y=\frac{-5}{13} \qquad (4)$$

Substituting in equation (1), we obtain

$$3x+\frac{25}{13}-4=0$$

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

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

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

***By substitution method***

From equation (1), we obtain

$$x=\frac{5y+4}{3} \qquad (5)$$

Putting this value in equation (2), we obtain

$$9\left(\frac{5y+4}{3}\right)-2y-7=0$$

$$13y=-5$$

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

Substituting the value in equation (5), we obtain

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

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

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

**(iv)** ***By elimination method***

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

$$3x+4y=-6 \quad (1)$$

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

$$3x-y=9 \qquad (2)$$

Subtracting equation (2) from equation (1), we obtain

$$5y=-15$$

$$y=-3 \qquad (3)$$

Substituting this value in equation (1), we obtain

$$3x-12=-6$$

$$3x=6$$

$$x=2$$

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

***By substitution method***

From equation (2), we obtain

$$x=\frac{y+9}{3} \quad (5)$$

Putting this value in equation (1), we obtain

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

$5y = -15$

$$y=-3$$

Substituting the value in equation (5), we obtain

$$x=\frac{-3+9}{3}=2$$

$\therefore x = 2, y = -3$

**Question 2:**

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 ½ 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 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.

**Answer 2:**

**(i)** Let the fraction be x/y.

According to the given information,

$$\frac{x+1}{y-1}=1 \qquad \Rightarrow x-y=-2 \qquad (1)$$

$$\frac{x}{y+1}=\frac{1}{2} \qquad \Rightarrow 2x-y=1 \qquad (2)$$

Subtracting equation (1) from equation (2), we obtain $x = 3$ …………(3)

Substituting this value in equation (1), we obtain

$$3-y=-2$$

$$-y=-5$$

$$y=5$$

Hence, the fraction is 3/5.

**(ii)**Let present age of Nuri = $x$

and present age of Sonu = $y$

According to the given information,

$$(x-5)=3(y-5)$$
$$x-3y=-10 \qquad (1)$$
$$(x+10)=2(y+10)$$
$$x-2y=10 \qquad (2)$$

Subtracting equation (1) from equation (2), we obtain $y$ = 20 (3)

Substituting it in equation (1), we obtain

$$x-60=-10$$
$$x=50$$

Hence, age of Nuri = 50 years

And, age of Sonu = 20 years

**(iii)**Let the unit digit and tens digits of the number be $x$ and $y$ respectively.

Then, number = 10$y$ + $x$

Number after reversing the digits = 10$x$ + $y$

According to the given information, $x$ + $y$ = 9 …………………(1)

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

88$y$ − 11$x$ = 0

− $x$ + 8$y$ =0 ………………….(2)

Adding equation (1) and (2), we obtain

9$y$ = 9 $y$

= 1 (3)

Substituting the value in equation (1), we obtain $x$ = 8

Hence, the number is 10$y$ + $x$ = 10 × 1 + 8 = 18

**(iv)**Let the number of Rs 50 notes and Rs 100 notes be $x$ and $y$ respectively.

According to the given information,

$$x+y=25 \qquad (1)$$
$$50x+100y=2000 \qquad (2)$$

Multiplying equation (1) by 50, we obtain

$$50x+50y=1250 \qquad (3)$$

Subtracting equation (3) from equation (2), we obtain

$$50y=750$$
$$y=15$$

Substituting in equation (1), we have $x$ = 10

Hence, Meena has 10 notes of Rs 50 and 15 notes of Rs 100.

**(v)**Let the fixed charge for first three days and each day charge thereafter be Rs *x* and Rs *y* respectively.

According to the given information,

$x+4y=27 \qquad (1)$

$x+2y=21 \qquad (2)$

Subtracting equation (2) from equation (1), we obtain

$2y=6$

$y=3 \qquad (3)$

Substituting in equation (1), we obtain

$x+12=27$

$x=15$

Hence,

fixed charge = Rs 15

And

Charge per day = Rs 3