

LINEAR INEQUALITIES

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Inequalities

- Inequalities are statements where two quantities are unequal but a relationship exists between them.
- An inequation may contain one or more variables.
- Also, it may be linear or quadratic or cubic etc.
- A statement involving variable(s) and the sign of inequality

$>$, $<$, $\geq$ or $\leq$ is called an inequation or inequality.

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Inequalities

Example: Following are some examples of inequations:

- $3x - 2 < 0$

- $5x + 4y \leq 3$

- $5x - 3 > 0$

- $2x + 5y \geq 4$

- $4x + 5 \geq 0$

- $x^2 + 3x + 2 < 0$



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linear Inequations
in one variable

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linear inequation in one variable

- Let a be a non-zero real number and x be a variable. Then inequations of the form $ax + b < 0$, $ax + b \leq 0$, $ax + b > 0$ and $ax + b \geq 0$

Are known as linear inequations in one variable x .

Example

$$9x + 15 > 0$$

$$2x - 3 \leq 0$$

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Solution space of an inequation

- A solution Space of an inequation is the value(s) of the variable(s) that makes it a true statement.
- Consider the inequation $30x < 200$,x belong to whole number

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Solving linear inequations in one variable

Rule 1: Equal numbers may be added to (or subtracted from) both sides of an inequality without affecting the sign of inequality



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Solving linear inequations in one variable

Rule 2: Both sides of an inequality can be multiplied (or divided) by the same positive number without changing the sign of inequality



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Solving linear inequations in one variable

Rule 3. when both sides are multiplied or divided by a negative number, then the sign of inequality is reversed.

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Inequalities on Number line



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Example Solve the following linear inequations:

(i) $2x - 4 \leq 0$

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Example Solve the following linear inequations:

(ii) $4x - 12 \geq 0$

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Solution of linear
Inequations
in two variables

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linear inequations in two variable

- Let a, b be a non-zero real number and x, y be variables. Then inequations of the form $ax + by < c$, $ax + by \leq c$, $ax + by > c$ and $ax + by \geq c$ are known as linear inequations in two variables x and y .

Example

$$2x + 3y > 6$$

$$2x - 39y \leq 12$$

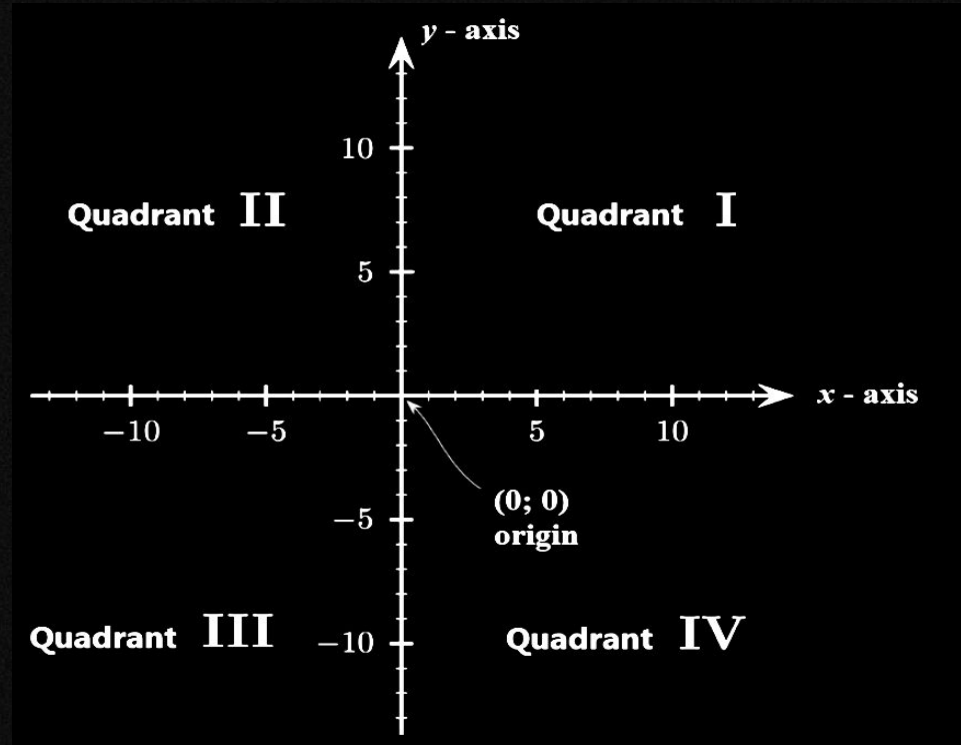
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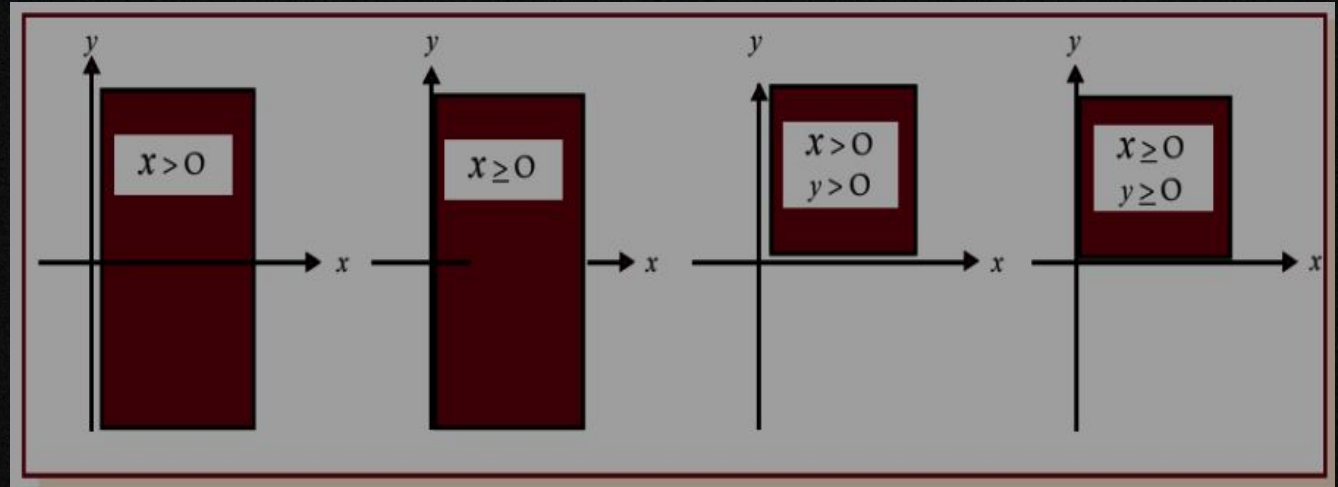


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Shading in a plane



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Steps to solve linear inequations in two variables

Step 1: Convert the given inequation, say $ax + by \leq c$, into the equation which represents a straight line in $ax + by = c$ which represents a straight line in xy -plane.

Step 2: Put $y=0$ in the equation obtained in step 1 to get the point where the line meets with x -axis. Similarly, put $x = 0$ to obtain a point where the line meets with y - axis.

Step 3: Join the points obtained in step 2 to obtain the graph of the line obtained from the given inequation. In case of a strict inequality i.e, $ax + by < c$ or $ax + by > c$, draw the dotted line, otherwise make it thick line.

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Steps to solve linear inequations in two variables

Step 4 : Choose a point , if possible $(0, 0)$, not lying on this line : Substitute its coordinates in the inequation . If the inequation is satisfied , then shade the portion of the plane which contains the chosen point ; otherwise shade the portion which does not contain the chosen point .

Step 5 : The shaded region obtained in step 4 represents the desired solution set .

Remark : In case of the inequalities $ax + by \leq c$ and $ax + by \geq c$ points on the line are also a part of the shaded region while in the case of inequalities $ax + by < c$ and $ax + by > c$ points on the line $ax + by = c$ are not in the shaded region .

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Solve the following :

- $2x + 3y \leq 6$

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Solve the following :

- $3x + y < 6$

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Solve

$$x - y \leq -2$$



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Solve

$$2x - y \geq 1$$



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Solve

$$x \geq 2$$



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Solve

$$y \leq -3$$



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Solve

$$y \leq x / 2$$



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Solution of
Simultaneous linear
Inequations
in two variables

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Example: We now consider the problem of drawing graphs of the following inequalities $x \geq 0$, $y \geq 0$, $x \leq 6$, $y \leq 7$, $x + y \leq 12$ and shading the common region.



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EXERCISE : 3 (A)

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Choose the correct answer/answers

Ques 1 (i) An employer recruits experienced (x) and fresh workmen (y) for his firm under the condition that he cannot employ more than 9 people. x and y can be related by the inequality

- a. $x + y \neq 9$
- b. $x + y \leq 9, x \geq 0, y \geq 0$
- c. $x + y \geq 9, x \geq 0, y \geq 0$
- d. None of these

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Choose the correct answer/answers

(ii) On the average experienced person does 5 units of work while a fresh one 3 units of work daily but the employer has to maintain an output of at least 30 units of work per day. This situation can be expressed as

- a. $5x + 3y \leq 30$
- b. $5x + 3y > 30$
- c. $5x + 3y \geq 30$ $x \geq 0, y \geq 0$
- d. None of these

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Choose the correct answer/answers

(iii) The rules and regulations demand that the employer should employ not more than 5 experienced hands to 1 fresh one and this fact can be expressed as

- a. $y \geq x/5$
- b. $5y \leq x$
- c. $5y \geq x$
- d. None of these

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Choose the correct answer/answers

(iv) The union however forbids him to employ less than 2 experienced person to each fresh person. This situation can be expressed as

- a. $x \leq y/2$
- b. $y \leq x/2$
- c. $y \geq x/2$
- d. $x > 2y$

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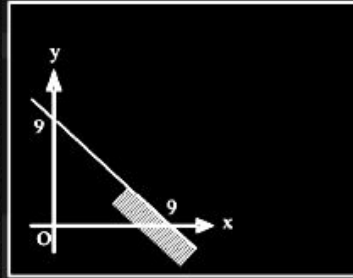
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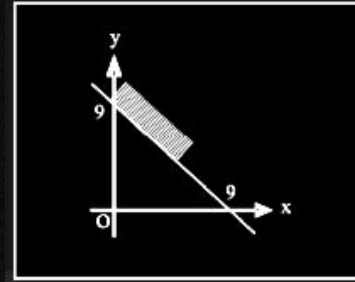
Choose the correct answer/answers

(v) The graph to express the inequality $x + y \leq 9$ is

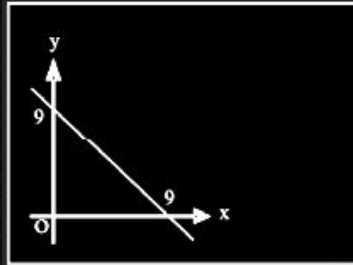
a.



b.



c.



d. None of these



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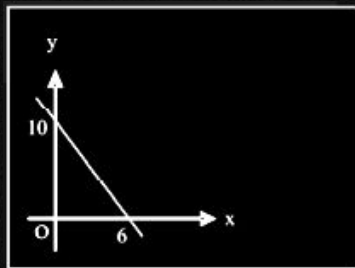
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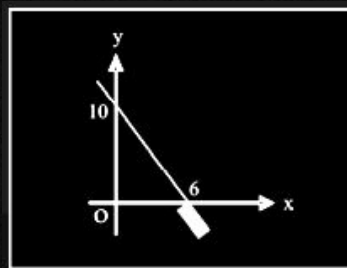
Choose the correct answer/answers

(vi) The graph to express the inequality $5x + 3y \geq 30$ is

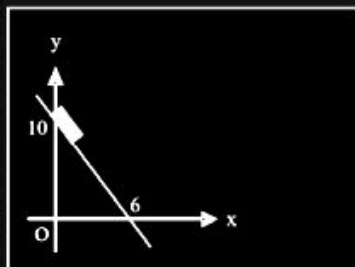
a.



b.



c.



d. None of these

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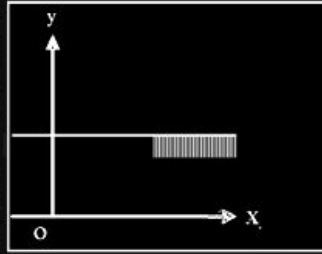
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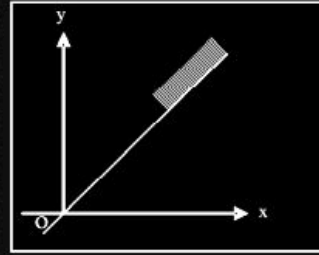
Choose the correct answer/answers

(vii) The graph to express the inequality $y \leq \left(\frac{1}{2}\right)x$ is indicated by

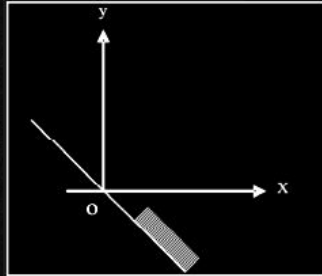
a.



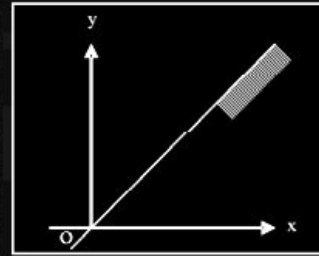
b.



c.



d.



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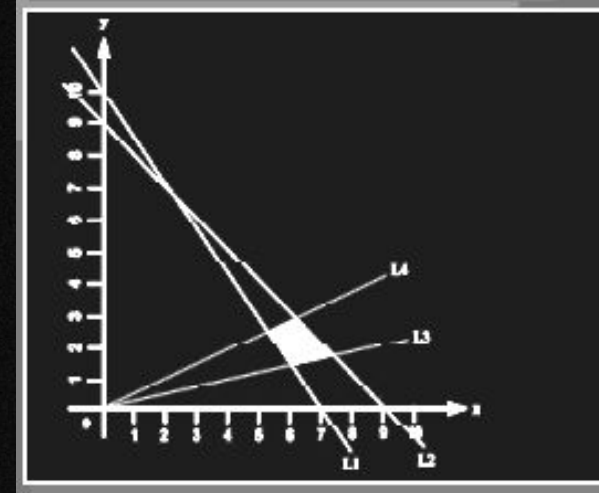
Choose the correct answer/answers

(viii) $L_1: 5x + 3y = 30$ $L_2: x + y = 9$ $L_3: y = x/3$ $L_4: y = x/2$

The common region (shaded part) shown in the diagram refers to

- a. $5x + 3y \leq 30$
 $x + y \leq 9$
 $y \leq 1/5 x$
 $y \leq x/2$
- b. $5x + 3y \geq 30$
 $x + y \leq 9$
 $y \geq x/3$
 $y \leq x/2$
 $x \geq 0, y \geq 0$
- c. $5x + 3y \geq 30$
 $x + y \geq 9$
 $y \leq x/3$
 $y \geq x/2$
 $x \geq 0, y \geq 0$

d. None of these



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Ques 2 A dietitian wishes to mix together two kinds of food so that the vitamin content of the mixture is at least 9 units of vitamin A, 7 units of vitamin B, 10 units of vitamin C and 12 units of vitamin D. The vitamin content per Kg. of each food is shown below:

	A	B	C	D
Food I :	2	1	1	2
Food II:	1	1	2	3

Assuming x units of food I is to be mixed with y units of food II the situation can be expressed as

a. $2x + y \leq 9$

$$x + y \leq 7$$

$$x + 2y \leq 10$$

$$2x + 3y \leq 12$$

$$x > 0, y > 0$$

b. $2x + y \geq 30$

$$x + y \leq 7$$

$$x + 2y \geq 10$$

$$x + 3y \geq 12$$

c. $2x + y \geq 9$

$$x + y \geq 7$$

$$x + y \leq 10$$

$$x + 3y \geq 12$$

d. $2x + y \geq 9$

$$x + y \geq 7$$

$$x + 2y \geq 10$$

$$2x + 3y \geq 12$$

$$x \geq 0, y \geq 0,$$

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Ques 3 Graph of inequalities drawn below:

$$L_1: 2x + y = 9 \quad L_2: x + y = 7 \quad L_3: x + 2y = 10 \quad L_4: x + 3y = 12$$

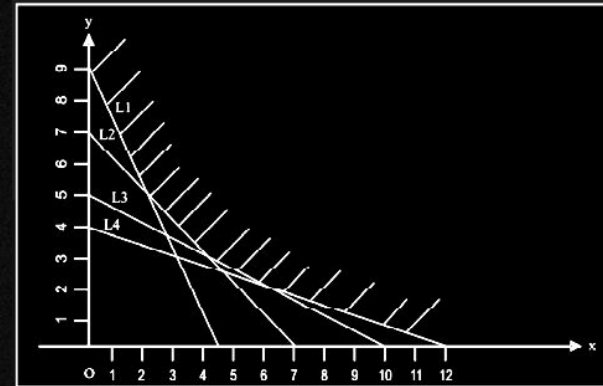
The common region (shaded part) indicated on the diagram is expressed by the set of inequalities

a. $2x + y \leq 9$
 $x + y \geq 7$
 $x + 2y \geq 10$
 $x + 3y \geq 12$

b. $2x + y \geq 9$
 $x + y \leq 7$
 $x + 2y \geq 10$
 $x + 3y \geq 12$

c. $2x + y \geq 9$
 $x + y \geq 7$
 $x + 2y \geq 10$
 $x + 3y \geq 12$
 $x \geq 0, y \geq 0$

d. None of these



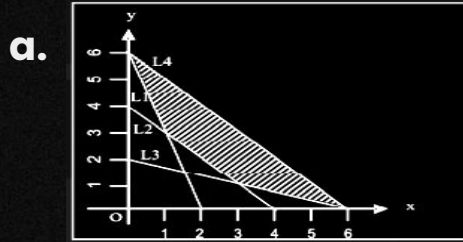
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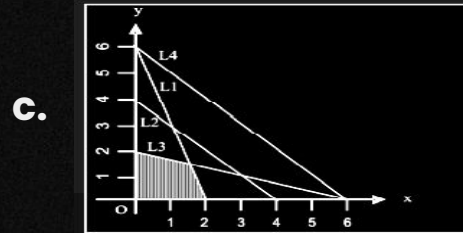
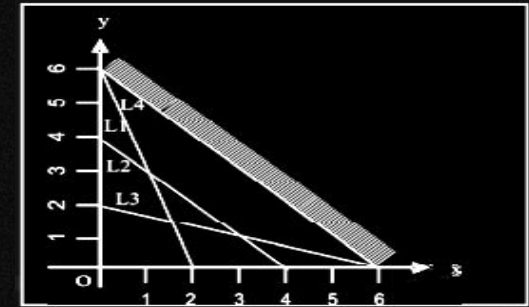
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Choose the correct answer/answers

Que. 4 The common region satisfied by the inequalities $L_1: 3x + y \geq 6$, $L_2: x + y \geq 4$, $L_3: x + 3y \geq 6$, and $L_4: x + y \leq 6$ is indicated by



b.



d. None of these

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Choose the correct answer/answers

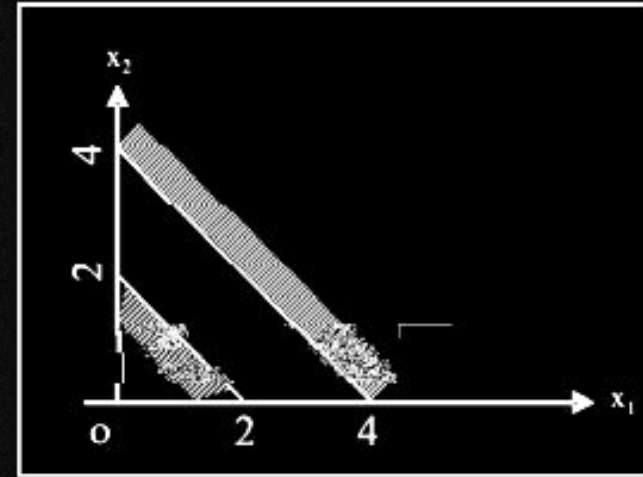
Que. 5 The region indicated by the shading in the graph is expressed by inequalities

a. $x_1 + x_2 \leq 2$
 $2x_1 + 2x_2 \geq 8$
 $x_1 \geq 0, x_2 \geq 0,$

b. $x_1 + x_2 \leq 2$
 $x_2 x_1 + x_2 \leq 4$

c. $x_1 + x_2 \geq 2$
 $2x_1 + 2x_2 \geq 8$

d. $x_1 + x_2 \leq 2$
 $2x_1 + 2x_2 > 8$



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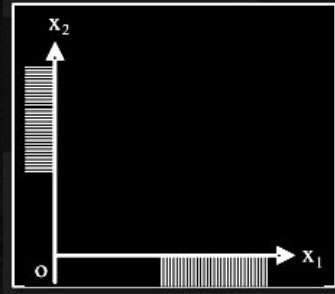
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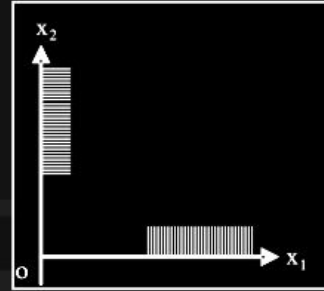
Choose the correct answer/answers

Que. 6 (i) The inequalities $x_1 \geq 0$, $x_2 \geq 0$, are: represented by one of the graphs shown below:

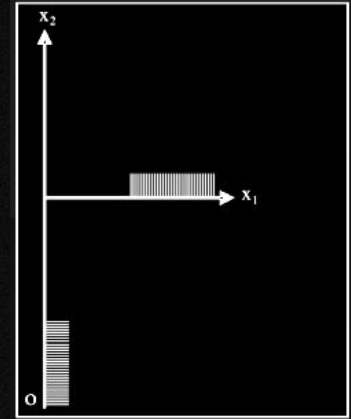
a.



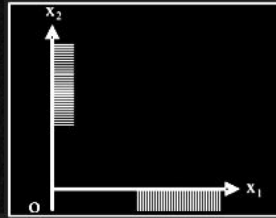
b.



c.



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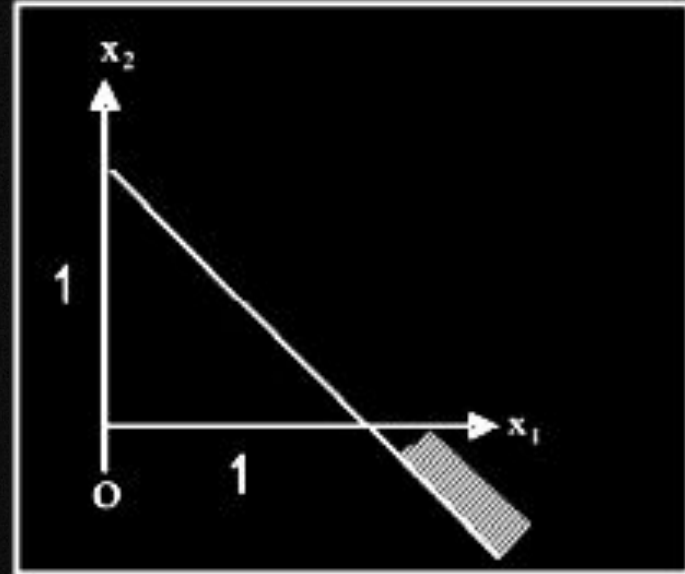


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Choose the correct answer/answers

(ii) The region is expressed as

- a. $x_1 - x_2 \geq 1$
- b. $x_1 + x_2 \leq 1$
- c. $x_1 + x_2 \geq 1$
- d. None of these



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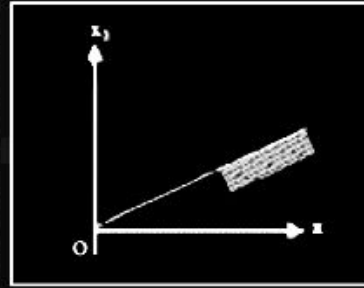
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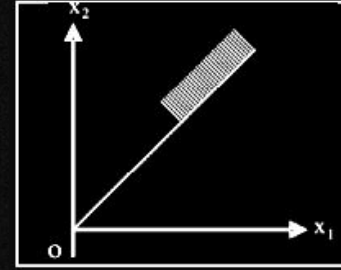
Choose the correct answer/answers

(iii) The inequality $-x_1 + 2x_2 \leq 0$ is indicated on the graph as

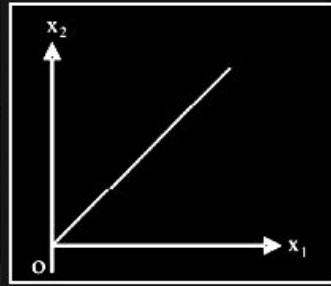
a.



b.



c.



d. None of these

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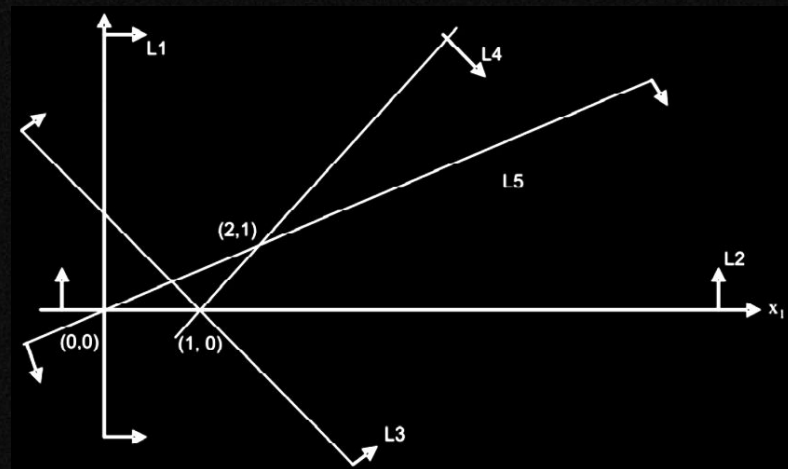
Que. 7 The common region indicated on the graph is expressed by the set of five inequalities

a. $L1 : x_1 \geq 0$
 $L2 : x_2 \geq 0$
 $L3 : x_1 + x_2 \leq 1$
 $L4 : x_1 - x_2 \geq 1$
 $L5 : -x_1 + 2x_2 \leq 0$

b. $L1 : x_1 \geq 0$
 $L2 : x_2 \geq 0$
 $L3 : x_1 + x_2 \geq 1$
 $L4 : x_1 - x_2 \geq 1$
 $L5 : -x_1 + 2x_2 \leq 0$

c. $L1 : x_1 \leq 0$
 $L2 : x_2 \leq 0$
 $L3 : x_1 + x_2 \geq 1$
 $L4 : x_1 - x_2 \geq 1$
 $L5 : -x_1 + 2x_2 \leq 0$

d. None of these



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Choose the correct answer/answers

Que. 8 A firm makes two types of products: Type A and Type B. The profit on product A is ₹ 20 each and that on product B is ₹ 30 each. Both types are processed on three machines M_1 , M_2 and M_3 . The time required in hours by each product and total time available in hours per week on each machine are as follows:

Machine	Product A	Product B	Available Time
M1	3	3	36
M2	5	2	50
M3	2	6	60

The constraints can be formulated taking x_1 = number of units A and x_2 = number of unit of B as

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$$x_1 + x_2 \leq 12$$

a. $5x_1 + 2x_2 \leq 50$

$$2x_1 + 6x_2 \leq 60$$

c. $3x_1 + 3x_2 \leq 36$

$$5x_1 + 2x_2 \leq 50$$

$$2x_1 + 6x_2 \leq 60$$

$$x_1 \geq 0, x_2 \geq 0$$

$$3x_1 + 3x_2 \geq 36$$

b. $5x_1 + 2x_2 \leq 50$

$$2x_1 + 6x_2 \geq 60$$

$$x_1 \geq 0, x_2 \geq 0$$

d. None of these

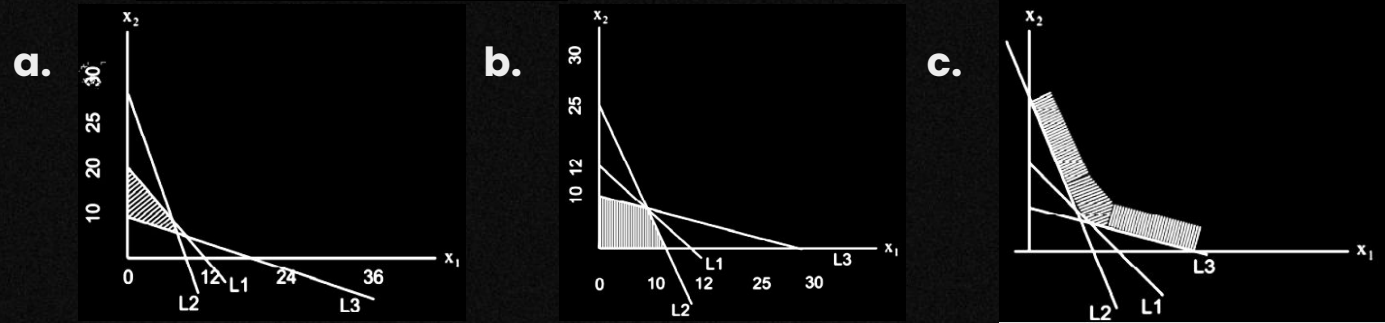
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Choose the correct answer/answers

Ques. 9 The set of inequalities $L1: x_1 + x_2 \leq 12$, $L2: 5x_1 + 2x_2 \leq 50$, $L3: x_1 + 3x_2 \leq 30$, $x_1 \geq 0$, and $x_2 \geq 0$ is represented by



d. None of these

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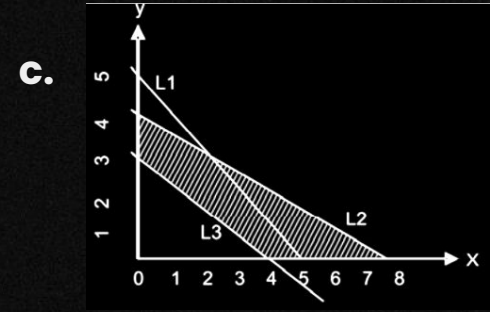
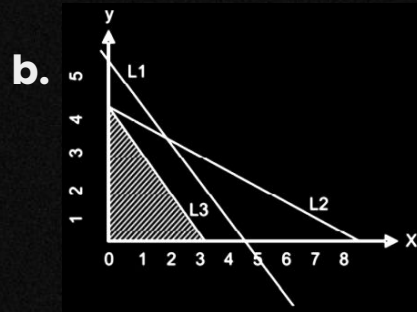
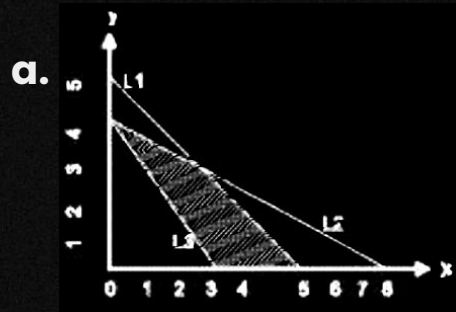
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Choose the correct answer/answers

Que.10

The common region satisfying the set of inequalities $x \geq 0$, $y \geq 0$, $L1: x+y \leq 5$, $L2: x+2y \leq 8$ and $L3: 4x+3y \geq 12$ is indicated by



d. None of these

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