LINEAR PROGRAMMING

BASIC CONCEPTS

Arrow diagram for bounded/unbounded region.

Feasible region (having largest and smallest values M and m of $Z = ax + by$ at corner points)

Bounded

M is maximum and m is minimum value of Z.

Unbounded

Open half plane is determined by $ax + by > M$ and $ax + by < m$ obtained.

If no common point in the half plane determined by $ax + by > M$ and feasible region, then M is maximum value of Z, otherwise Z has no maximum value.

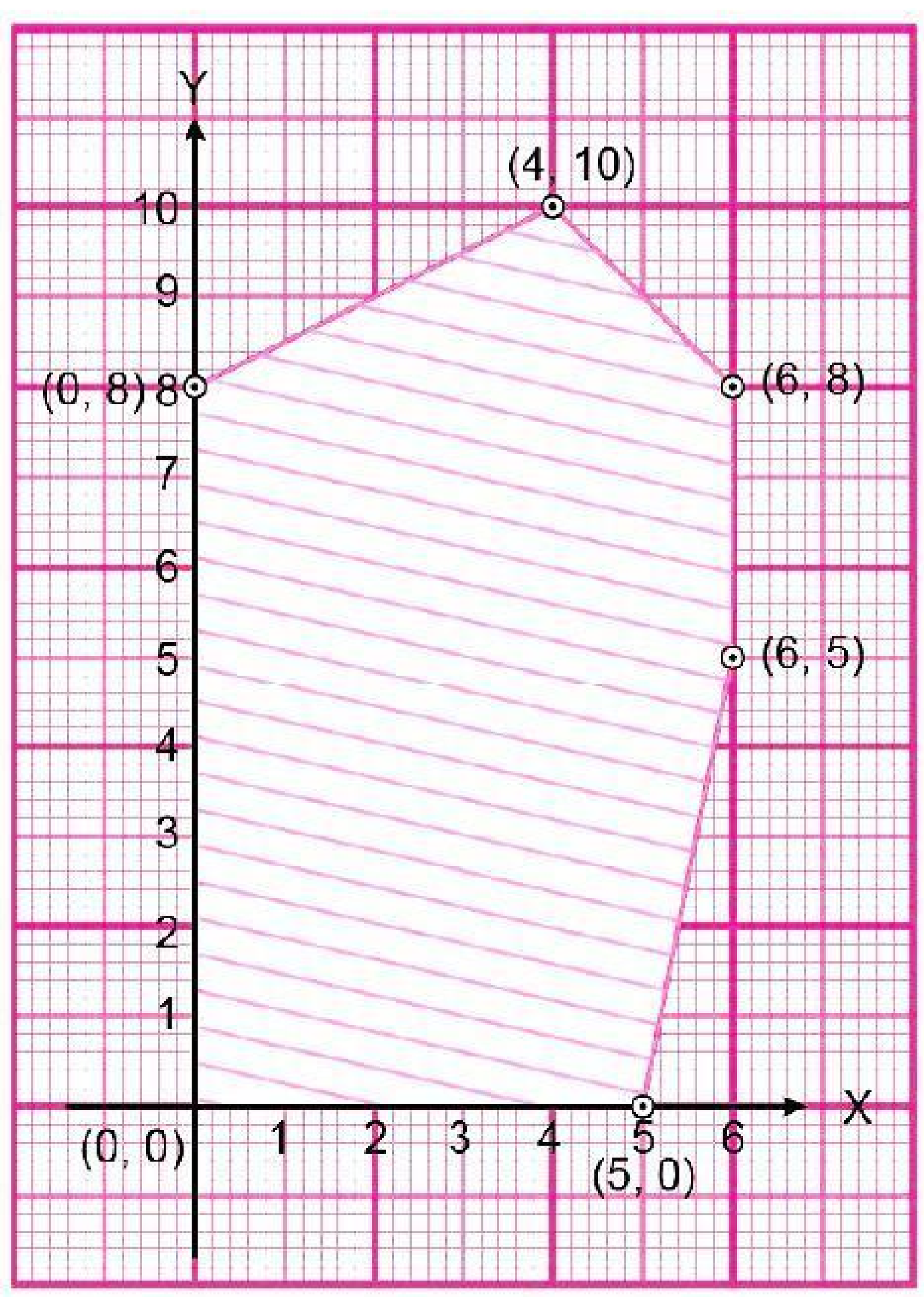
If no common point in the half plane determined by $ax + by < m$ and feasible region, then m is minimum value of Z, otherwise Z has no minimum value.

MULTIPLE CHOICE QUESTIONS

Choose and write the correct option in the following questions.

1. **The feasible region for an LPP is shown below:** *[NCERT Exemplar, CBSE 2020 (65/3/1)]*

   Let $Z = 3x - 4y$ be the objective function. Minimum of Z occurs at



(*a*) (0, 0) (*b*) (0, 8) (*c*) (5, 0) (*d*) (4, 10)

2. **Corner points of the feasible region determined by the system of linear constraints are (0, 3), (1, 1) and (3, 0). Let $Z = px + qy$, where $p, q > 0$. Condition on p and q so that the minimum of Z occurs at (3, 0) and (1, 1) is**

(a) $p = 2q$ (b) $p = \frac{q}{2}$ (c) $p = 3q$ (d) $p = q$

3. **Which of the following is a convex set?**

(a) $\{(x, y) : x^2 + y^2 \geq 5\}$ (b) $\{(x, y) : y^2 \geq x\}$

(c) $\{(x, y) : 3x^2 + 4y^2 \geq 5\}$ (d) $\{(x, y) : 0 \leq x \leq 1, 0 \leq y \leq 1\}$

4. **Let Z_1 and Z_2 are two optimal solution of a LPP, then**

(a) $Z = \lambda Z_1 + (1 - \lambda) Z_2, \lambda \in \mathbb{R}$ is also on optimal solution

(b) $Z = \lambda Z_1 + (1 - \lambda) Z_2, \lambda \in [0, 1]$ gives optimal solution

(c) $Z = \lambda Z_1 + (1 + \lambda) Z_2, \lambda \in [0, 1]$ gives optimal solution

(d) $Z = \lambda Z_1 + (1 + \lambda) Z_2, \lambda \in \mathbb{R}$ gives optimal solution

5. **The maximum value of $Z = 4x + 3y$ subject to constraint $x + y \leq 10$, $x, y \geq 0$** is

(a) 36 (b) 40 (c) 20 (d) none of these

6. **Consider a LPP given by**

Min $Z = 6x + 10y$

subject to $x \geq 6$; $y \geq 2$; $2x + y \geq 10$; $x, y \geq 0$

Redundant constraints in this LPP are

(a) $x \geq 0, y \geq 0$ (b) $x \geq 6, 2x + y \geq 10$ (c) $2x + y \geq 10$ (d) none of these

7. **Which of the following statements is correct?**

(a) Every LPP admits an optimal selection

(b) A LPP admits unique optimal solution

(c) If a LPP admits two optimal solutions it has an infinite solution.

(d) The set of all feasible solutions of a LPP is not a convex set.

8. **Which of the following is not a convex set?**

(a) $\{(x, y) \mid 2x + 5y < 7\}$ (b) $\{(x, y) \mid x^2 + y^2 \leq 4\}$

(c) $\{x : |x| = 5\}$ (d) $\{(x, y) \mid 3x^2 + 2y^2 \leq 6\}$

9. **The corner points of the feasible region determined by the following system of linear inequalities**

$2x + y \leq 10$, $x + 3y \leq 15$, $x, y \geq 0$ are (0, 0), (5, 0),

(3, 4) and (0, 5). Let $Z = px + qy$, where $p, q > 0$.

Condition on p and q so that the maximum of Z occurs at both (3, 4) and (0, 5) is

(a) $p = q$ (b) $p = 2q$ (c) $p = 3q$ (d) $q = 3p$

10. **The maximum value of $Z = x + 3y$ such that $2x + y \leq 20$, $x + 2y \leq 20$, $x \geq 0$, $y \geq 0$ is**

(a) 10 (b) 30 (c) 60 (d) $\frac{80}{3}$

11. **By graphical method solution of LLP maximize**

$Z = x + y$ subject to

$x + y \leq 2$

$x ; y \geq 0$

obtained at

(a) only one point (b) only two points

(c) at infinite number of points (d) none of these

12. Objective function of a LPP is

(*a*) constraint
(*b*) a function to be optimized
(*c*) a relation between the variables
(*d*) none of these

13. The objective function $Z = 4x + 3y$ can be maximised subject to constraints $3x + 4y \leq 24, 8x + 6y \leq 48,\ x \leq 5, y \leq 6, x, y \geq 0$

(*a*) at only one point
(*b*) at two points only
(*c*) at an infininte number of points
(*d*) none of these

14. The point at which the maximum value of $Z = x + y$, subject to constraints $x + 2y \leq 70$, $2x + y \leq 95$, $x, y \geq 0$ is obtained, is

(*a*) (30, 25) (*b*) (20, 35) (*c*) (35, 20) (*d*) (40, 15)

15. By the graphical method, the solution of LPP
Maximize $Z = 3x_1 + 5x_2$
subject to $3x_1 + 2x_2 \leq 18$
$x_1 \leq 4$
$x_2 \leq 6$
$x_1, x_2 \geq 0$ **is**

(*a*) $x_1 = 2, x_2 = 0, z = 6$
(*b*) $x_1 = 2, x_2 = 6, z = 36$
(*c*) $x_1 = 4, x_2 = 3, z = 27$
(*d*) $x_1 = 4, x_2 = 6, z = 42$

16. Solution of LPP maximize $Z = 2x - y$
subject to $x + y \leq 2$
$x, y \geq 0$

(*a*) 0 (*b*) 4 (*c*) 2 (*d*) none of these

17. The corner points of the feasible region determined by the system of linear inequalities are (0, 0), (4, 0), (2, 4) and (0, 5). If the maximum value of $Z = ax + by$, where $a, b > 0$ occurs at both (2, 4) and (4, 0), then

(*a*) $a = 2b$ (*b*) $2a = b$ (*c*) $a = b$ (*d*) $3a = b$

18. The graph of the inequality $2x + 3y > 6$ is

(*a*) half plane that contains the origin.
(*b*) half plane that neither contains the origin nor the points of the line $2x + 3y = 6$.
(*c*) whole *XOY*- plane excluding the points on the line $2x + 3y = 6$.
(*d*) entire *XOY* plane.

19. The point which does not lie in the half plane $2x + 3y - 12 \leq 0$ is

(*a*) (1, 2) (*b*) (2, 1) (*c*) (2, 3) (*d*) (–3, 2)

20. The value of objective function $Z = 2x + 3y$ at corner point (3, 2) is

(*a*) 5 (*b*) 9 (*c*) 12 (*d*) none of these

21. The corner points of the feasible region determined by the system of linear constraints are (0, 10), (5, 5), (15, 15), (0, 20). Let $Z - px + qy$, where $p, q > 0$. Condition on p and q so that the maximum of Z occurs at both the points (15, 15) and (0, 20) is

(*a*) $p = q$ (*b*) $p = 2q$ (*c*) $q = 2p$ (*d*) $q = 3p$

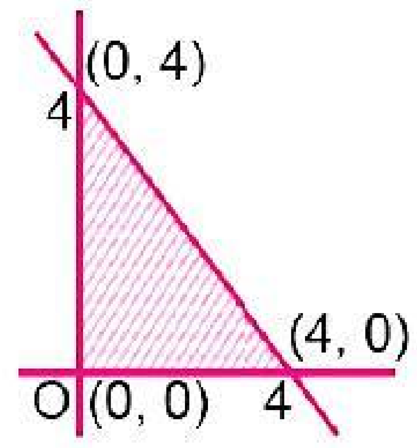
22. The position of origin (0, 0) w.r.t. feasible region represented by $x + y \geq 1$ is

(*a*) in the region
(*b*) not in the region
(*c*) on the line $x + y = 0$
(*d*) none of these

23. The feasible region for an LPP is always a

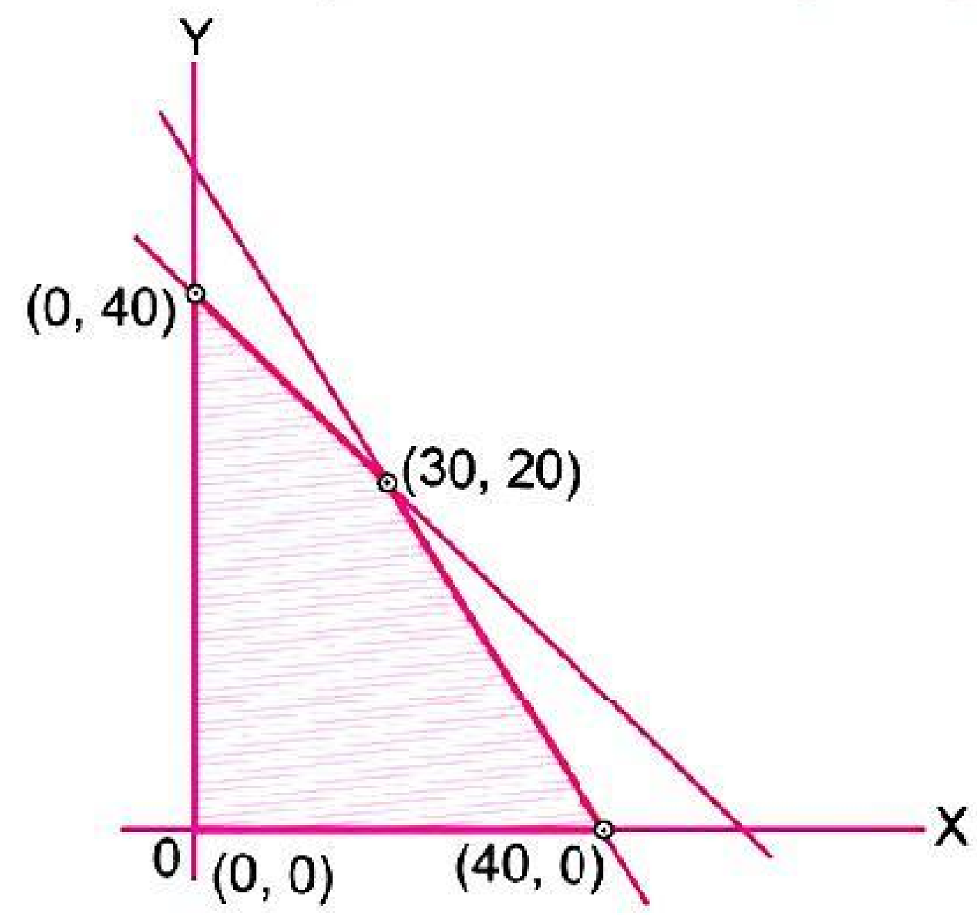
(*a*) type of polygon (*b*) concave polygon (*c*) convex polygon (*d*) none of these

24. **Feasible region shaded for a LPP is shown in figure. Maximum of $Z = 2x + 3y$ occurs at the point**



(*a*) (0, 0) (*b*) (4, 0) (*c*) (0, 4) (*d*) none of these

25. **The maximum value of $Z = 0.7x + y$ for feasible region given below is**



(*a*) 45 (*b*) 40 (*c*) 50 (*d*) 41

26. **A point out of following points lie in plane represented by $2x + 3y \leqslant 12$ is**

(*a*) (0, 3) (*b*) (3, 3) (*c*) (4, 3) (*d*) (0, 5)

27. **Feasible region is the set of points which satisfy**

(*a*) the objective functions (*b*) some of the given constraints
(*c*) all of the given constraints (*d*) None of these

28. **Objective function of a LPP is**

(*a*) a quadratic function (*b*) a constant
(*c*) a linear function to be optimised (*d*) None of these

Answers

1. (*b*)	**2.** (*b*)	**3.** (*d*)	**4.** (*b*)	**5.** (*b*)	**6.** (*c*)
7. (*c*)	**8.** (*c*)	**9.** (*d*)	**10.** (*b*)	**11.** (*c*)	**12.** (*b*)
13. (*c*)	**14.** (*d*)	**15.** (*b*)	**16.** (*b*)	**17.** (*a*)	**18.** (*b*)
19. (*c*)	**20.** (*c*)	**21.** (*d*)	**22.** (*b*)	**23.** (*c*)	**24.** (*c*)
25. (*d*)	**26.** (*a*)	**27.** (*d*)	**28.** (*c*)		

CASE-BASED QUESTIONS

Choose the correct option in the following questions.

1. **Read the following and answer any four questions from (*i*) to (*v*).**

A share is referred to as a unit of ownership which represents an equal proportion of a company's capital. A share entities the shareholders to an equal claim on profit and loss of the company.

Dr. Ritam wants to invest at most ₹12,000 in two type of shares A and B. According to the rules, she has to invest at least ₹2000 in share A and at least ₹4000 in share B. If the rate of interest on share A is 8% per annum and on share B is 10% per annum.

Answer the questions given below.

(*i*) If Dr. Ritam invests ₹x in share *A*, then which of the following is correct?

(*a*) $x = 2000$ (*b*) $x < 2000$ (*c*) $x \leqslant 2000$ (*d*) $x \geqslant 2000$

(*ii*) If she invest ₹y in share *B*, then which of the following is correct?

(*a*) $y = 4000$ (*b*) $y \geqslant 4000$ (*c*) $y > 4000$ (*d*) $y \leqslant 4000$

(*iii*) If total interest received by Dr. Ritam from both type of shares is represented by *Z*, then *Z* is equal to

(*a*) $Z = ₹(2x + y)$ (*b*) $Z = ₹(x + 2y)$ (*c*) $Z = ₹\left(\frac{2x}{25} + \frac{y}{10}\right)$ (*d*) $Z = ₹\left(\frac{2x}{10} + \frac{y}{25}\right)$

(*iv*) To maximise interest on both types of share, the invested amount on both shares *A* & *B* by her should be respectively

(*a*) ₹10,000, ₹2000 (*b*) ₹2,000, ₹10000 (*c*) ₹8,000, ₹4000 (*d*) ₹2,000, ₹4000

(*v*) The maximum interest received by her is

(*a*) ₹1040 (*b*) ₹3000 (*c*) ₹1160 (*d*) ₹1200

Sol. (*i*) Since, she has to invest at least ₹2000 in share *A*.

$\therefore\ x \geqslant 2000$

Option (*d*) is correct.

(*ii*) Since, she has to invest atleast ₹4000 in share *B*.

$\therefore\ y \geqslant 4000$

Option (*b*) is correct.

(*iii*) Interest on share $A = x \times \frac{8}{100} = ₹\frac{2x}{25}$

Interest on share $B = y \times \frac{10}{100} = ₹\frac{y}{10}$

$\therefore$ Her total interest $= Z = ₹\left(\frac{2x}{25} + \frac{y}{10}\right)$

Option (*c*) is correct.

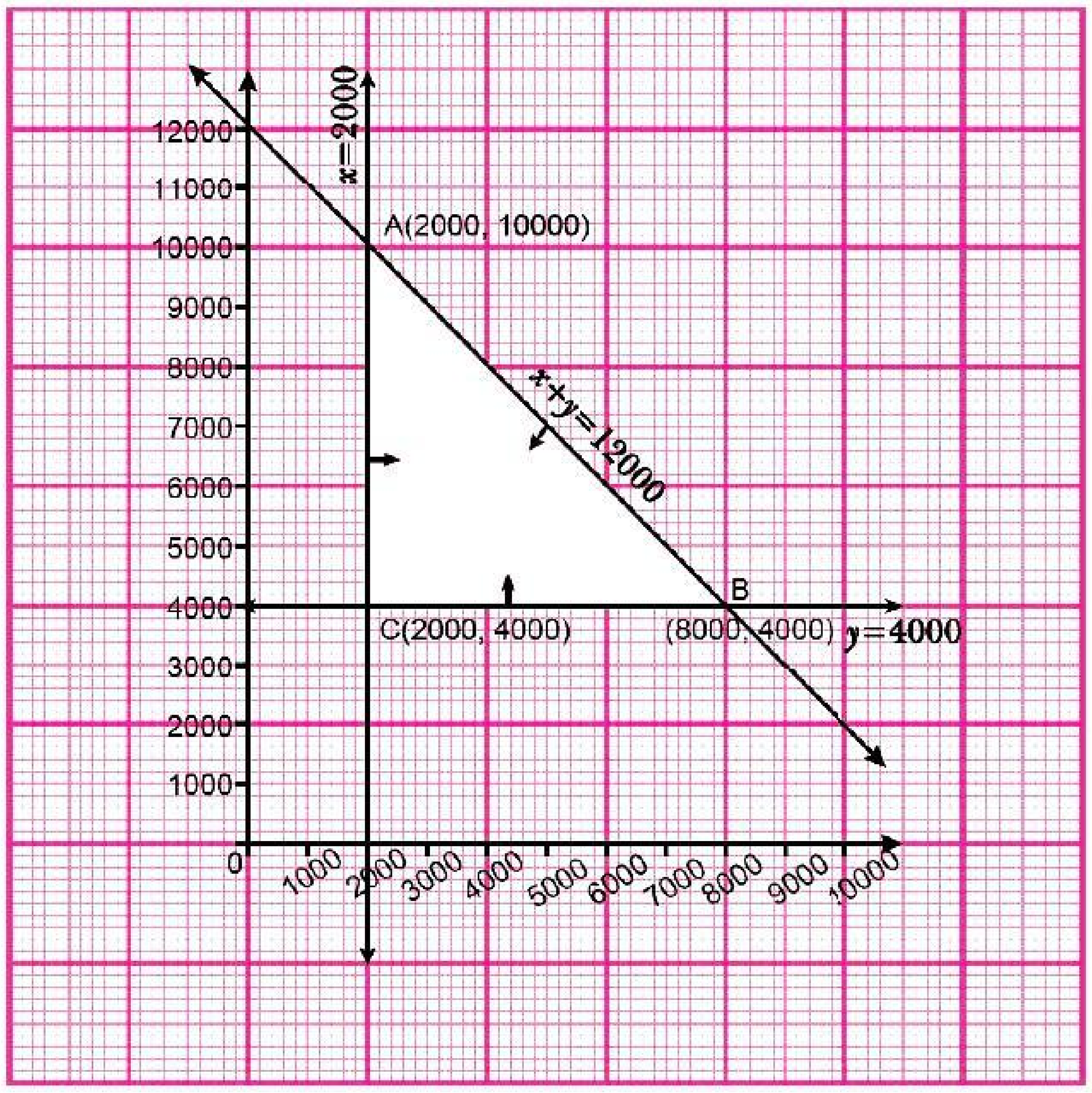
(*iv*) We have

$Z = \left(\frac{2x}{25} + \frac{y}{10}\right)$ which is to be maximised under constraints

$x \geqslant 2000$

$y \geqslant 4000$

and $x + y \leqslant 12000$



Here, ABC be bounded feasible region with corner points $A(2,000, 10000)$, B (8000, 4000), $C(2,000, 4000)$.

Now we evaluate Z at each corner points.

Corner Point	$Z = \left(\frac{2x}{25} + \frac{y}{10}\right)$
A (2,000, 10000)	1160
B (8000, 4000)	1040
C (2,000, 4000)	560

i.e. for maximum interest $x = ₹2000$, $y = ₹10000$

Option (*b*) is correct.

(*v*) Obviously

For $x = ₹2000$, $y = ₹10000$

$$Z = \frac{2 \times 2000}{25} + \frac{10000}{10}$$

$$= 160 + 1000 = ₹1160$$

Option (*c*) is correct.

2. Read the following and answer any four questions from (*i*) to (*v*).

A dealer Ramprakash residing in a rural area opens a shop to start his business. He wishes to purchase a number of ceiling fans and table fans. A ceiling fan costs him ₹360 and table fan costs ₹240.

Answer the questions given below.

(*i*) If Ramprakash purchases x ceiling fans, y table fans. He has space in his store for at most 20 items, then which of the following is correct

(*a*) $x + y = 20$ (*b*) $x + y > 20$ (*c*) $x + y < 20$ (*d*) $x + y \leq 20$

(*ii*) If Ramprakash has only ₹5760 to invest on both type of fans, then which of the following is correct

(*a*) $x + y \leq 5760$ (*b*) $360x + 240y \leq 5760$

(*c*) $360x + 240y \geq 5760$ (*d*) $3x + 2y \leq 48$

(*iii*) If he expects to sell ceiling fan at a profit of ₹22 and table fan for a profit of ₹18, then the profit Z is expressed as

(*a*) $Z = 18x + 22y$ (*b*) $Z = 22x + 18y$ (*c*) $Z = x + y$ (*d*) $Z \leq 22x + 18y$

(*iv*) If he sells all the fans that he buys, then the number x, y of both the type fans in stock to get maximum profit is

(*a*) $x = 10, y = 12$ (*b*) $x = 12, y = 8$ (*c*) $x = 16, y = 0$ (*d*) $x = 8, y = 12$

(*v*) The maximum profit after selling all fans is

(*a*) ₹360 (*b*) ₹560 (*c*) ₹1000 (*d*) ₹392

Sol. (*i*) From question

He has space in store for atmost 20 items

$\therefore \quad x + y \leq 20$

Option (*d*) is correct.

(*ii*) From question

Maximum investment = ₹5760

Total cost for him to purchase both type of fans = $360x + 240y$

$\therefore \quad 360x + 240y \leq 5760 \quad \Rightarrow 3x + 2y \leq 48$

Option (*d*) is correct.

(*iii*) Profit on ceiling fans = ₹$22x$

Profit on table fans = ₹$18y$

$\therefore \quad Z = 22x + 18y$

Option (*b*) is correct.

(*iv*) We have

(Profit) $Z = 22x + 18y$, which is to be maximized under constraints

$3x + 2y \leq 48$

$x + y \leq 20$

$x, y \geq 0$ [$\because$ Number of fans can never be negative]

3. Read the following and answer any four questions from (*i*) to (*v*).

Aeroplane is an important invention for three reasons. It shortens travel time, is more comfortable and facilitates the transport of heavy cargo.

An aeroplane can carry a maximum of 200 passengers.

A profit of ₹400 is made on each executive class ticket and a profit of ₹300 is made on each economy class ticket. The airline reserves at least 20 seats for executive class. However at least 4 times as many passenger prefer to travel by economy class than by executive class.

Answer the questions given below.

(*i*) If there be x tickets of executive class and y tickets of economy class be sold, then which of the following is correct?

(*a*) $x + y = 200$ (*b*) $x + y \geqslant 200$ (*c*) $x + y > 200$ (*d*) $x + y \leqslant 200$

(*ii*) Which pair of constraints are correct?

(*a*) $x \geqslant 40$ and $x \leqslant 20$ (*b*) $x \leqslant 40$ and $x \geqslant 20$

(*c*) $x < 40$ and $x > 20$ (*d*) $x = 40$ and $x \geqslant 40$

(*iii*) If profit earned by airlines is represented by Z, then Z is given by

(*a*) $Z = 300x + 400y$ (*b*) $Z = 400x + 300y$

(*c*) $Z = x + y$ (*d*) $Z = 4x + 3y$

(*iv*) Airlines are interested to maximise the profit. For this to happen the value of x and y *i.e.* number of executive class ticket and economy class ticket to be sold should be respectively.

(*a*) 40, 160 (*b*) 160, 40 (*c*) 20, 180 (*d*) 180, 20

(*v*) The maximum profit earned by airlines is

(*a*) ₹68000 (*b*) ₹70000 (*c*) ₹64000 (*d*) ₹62000

Sol. (*i*) Since, Aeroplane can carry a maximum of 200 passengers

$\therefore\ x + y \leqslant 200$

Option (*d*) is correct.

(*ii*) Since, Airline reserves at least 20 seats for executive class

$\Rightarrow\ x \geqslant 20$

Also atleast four times as many passengers prefer to travel by economy class than by executive class.

$\Rightarrow\ y = 4x$

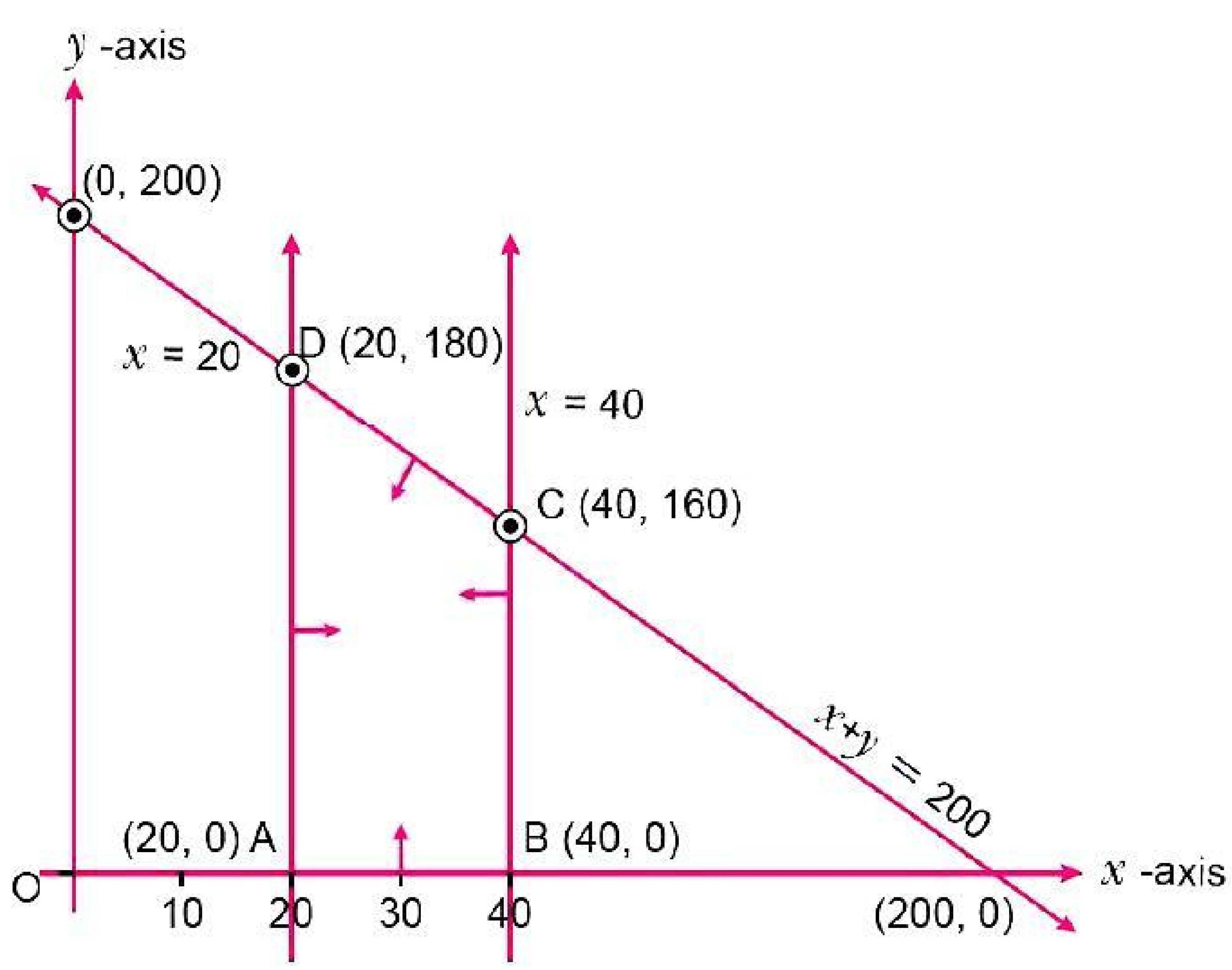
$\Rightarrow$

$x + 4x \leqslant 200 \quad [\because x + y \leqslant 200]$

$\Rightarrow\ 5x \leqslant 200 \qquad \Rightarrow\ x \leqslant 40$

$\Rightarrow\ x \geqslant 20$ and $x \leqslant 40$

Option (*b*) is correct.



(*iii*) Profit on executive class = $400x$

Profit on executive class = $300y$

$\therefore$ Total profit $Z = 400x + 300y$

Option (*b*) is correct.

(*iv*) We have

$Z = 400x + 300y$ which is to be maximise under constraints

$x + y \leqslant 200$

$x \leqslant 40$

$x \geqslant 20, y \geqslant 0$

Here, *ABCD* in bounded feasible region with corner points A(20, 0), B(40, 0), C(40, 160), D(20, 180).

Now we evaluate Z at each corner points.

Corner Point	$Z = 400x + 300y$
A(20, 0)	8000
B (40, 0)	16000
C(40, 160)	64000
D(20, 180)	62000

For maximum profit $x = 40, y = 160$

Option (*a*) is correct.

(*v*) We have

$Z = 400x + 300y$

$= 400 \times 40 + 300 \times 160$

$= 16000 + 48000$

$=$ ₹64000 $\quad [\because \text{For maximum } profit\ x = 40, y = 160]$

Option (*c*) is correct.

ASSERTION-REASON QUESTIONS

In the following questions, a statement of Assertion (A) is followed by a statement of Reason (R). Choose the correct answer out of the following choices.

(a) Both A and R are true and R is the correct explanation of A.

(b) Both A and R are true but R is not the correct explanation of A.

(c) A is true but R is false.

(d) A is false and R is also false.

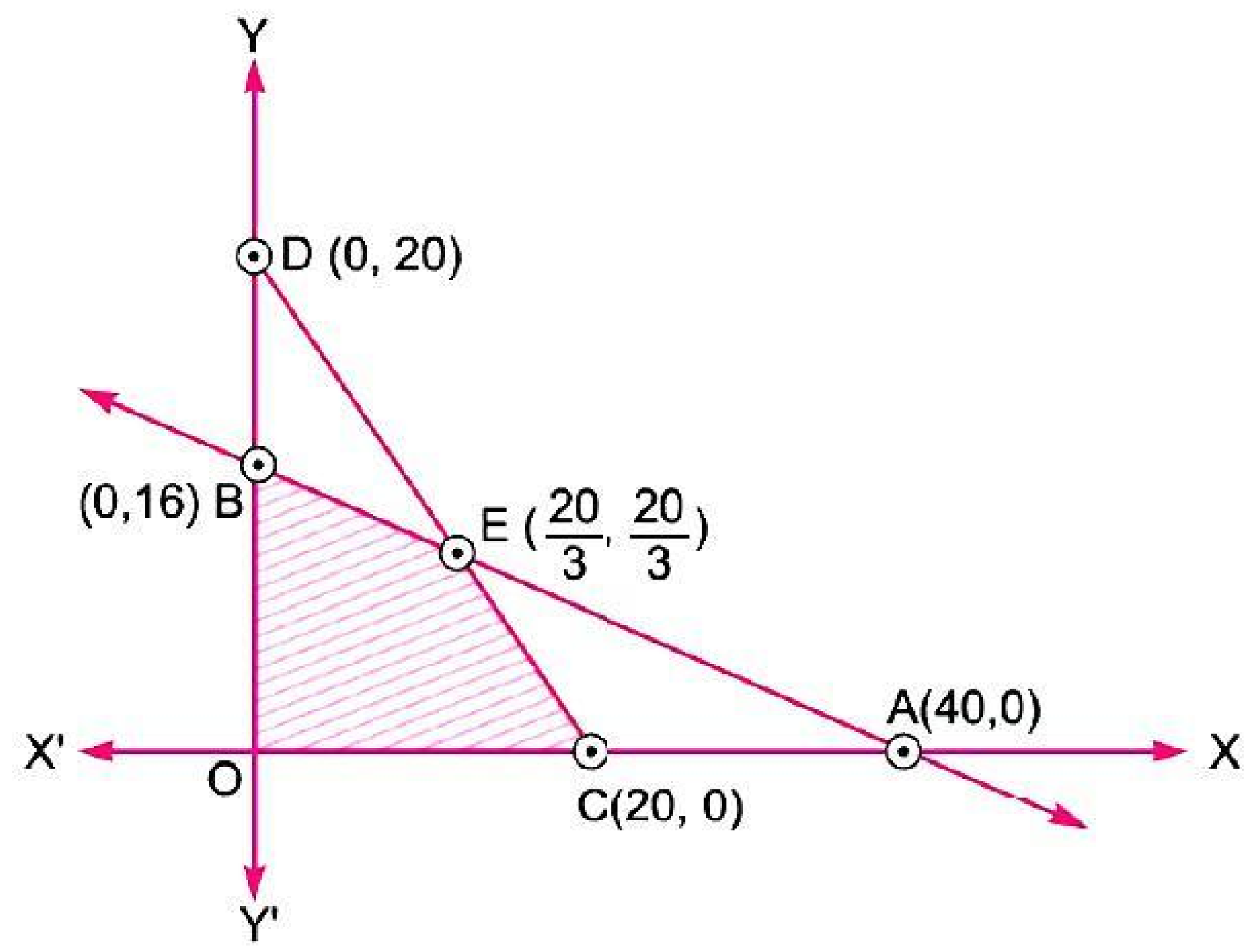
1. Assertion (A) : The maximum value of $Z = 5x + 3y$, satisfying the conditions $x \geq 0$, $y \geq 0$ and $5x + 2y \leq 10$, is 15.

Reason (R) : A feasible region may be bounded or unbounded.

2. Assertion (A) : The maximum value of $Z = x + 3y$. Such that $2x + y \leq 20$, $x + 2y \leq 20$, $x, y \geq 0$ is 30.

Reason (R) : The variables that enter into the problem are called decision variables.

3. Assertion (A) : Shaded region represented by $2x + 5y \geq 80$, $x + y \leq 20$, $x \geq 0, y \geq 0$ is



Reason (R) : A region or a set of points is said to be convex if the line joining any two of its points lies completely in the region.

Answers

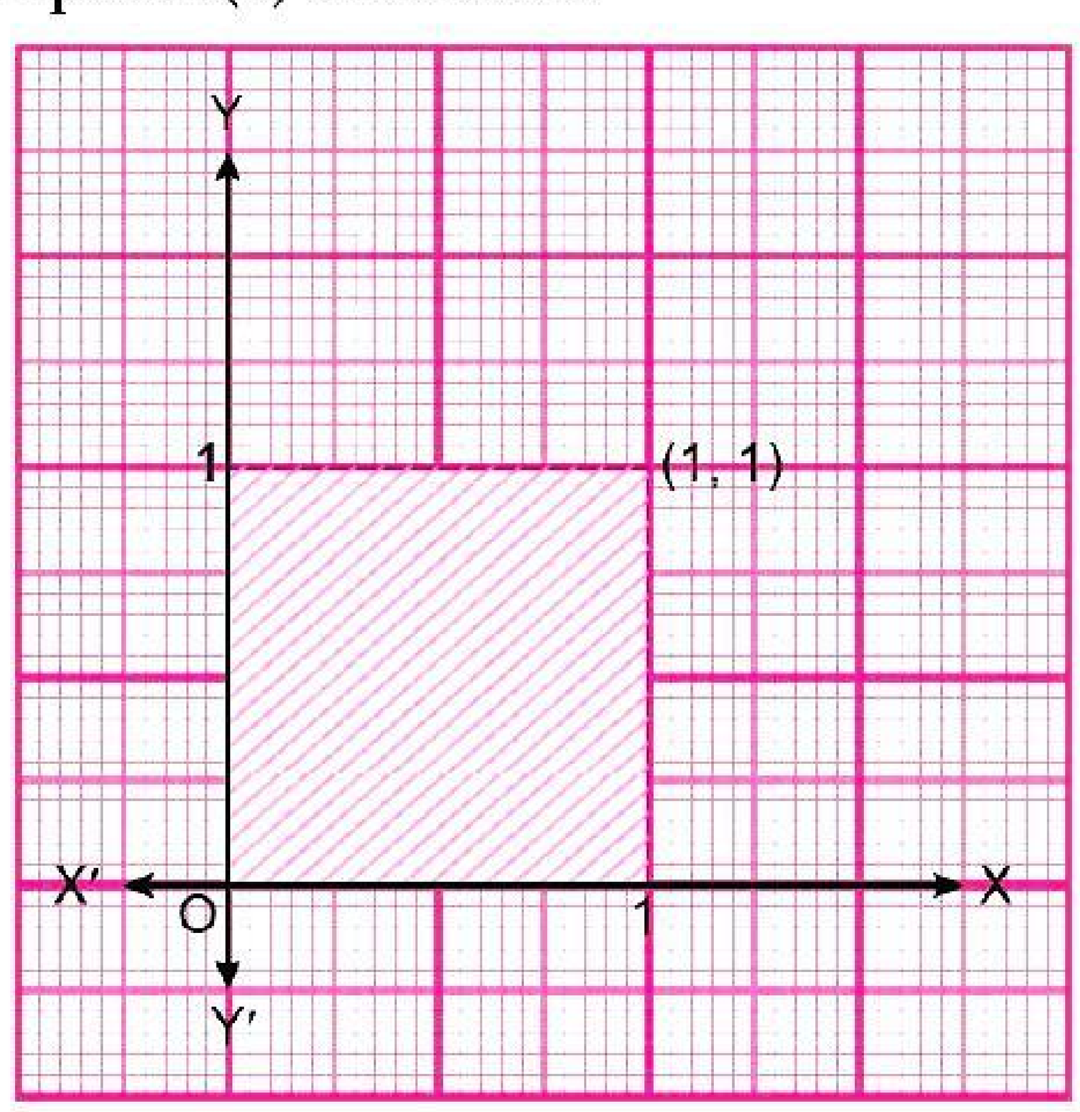
1. (*b*) **2.** (*b*) **3.** (*d*)

HINTS/SOLUTIONS OF SELECTED MCQS

1. Given objective function $Z = 3x - 4y$
on putting the corner points, we get
$Z_{min} = -32$ at (0, 8)
Option (*b*) is correct.

2. At (3, 0), $Z_{min} = 3p + q \times 0 = 3p$
and, at (1, 1), $Z_{min} = p \times 1 + q + 1 = p + q$
$\therefore\ 3p = p + q$
$\Rightarrow\ 2p = q\ \Rightarrow\ p = \frac{q}{2}$
Option (*b*) is correct.

3.

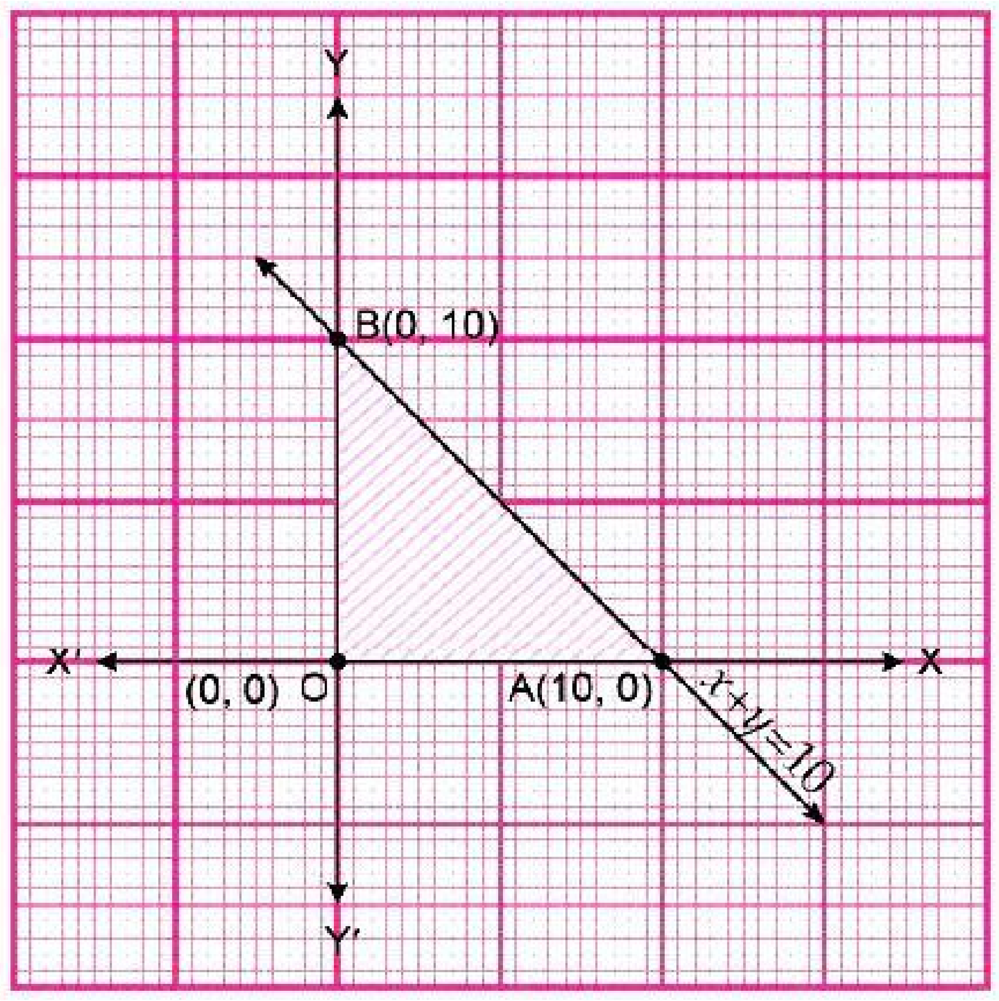


For any two point in this square region $\exists$ a line sigment joining them.
Hence it is a convex set.
Option (*d*) is correct.

4. For any two optimal solution Z_1, and Z_2, their linear combination also gives optimal solution of LPP.

i.e., $Z = \lambda Z_1 + (1-\lambda)Z_2 \ \lambda \in [0,1]$
gives optimal solution.
Option (*b*) is correct.

5.



Feasible region is shaded region shown in figure with corner points $O(0, 0)$, $A(10, 0)$, $B(0, 10)$

$Z(0, 0) = 0$

$Z(10, 0) = 40 \longrightarrow$ maximum

$Z(0, 10) = 30$

Option (*b*) is correct.

6. $2x + y \geq 10$

Option (*c*) is correct.

7. If a LPP admits two optimal solutions it has an infinite solution.

Option (*c*) is correct.

8. $\because \{x : |x| = 5\} = \{-5, 5\}$

Which is not a convex set.

Option (*c*) is correct.

9. Z at $(3, 4) = 3p + 4q$

$Z(0, 5) = 5q$

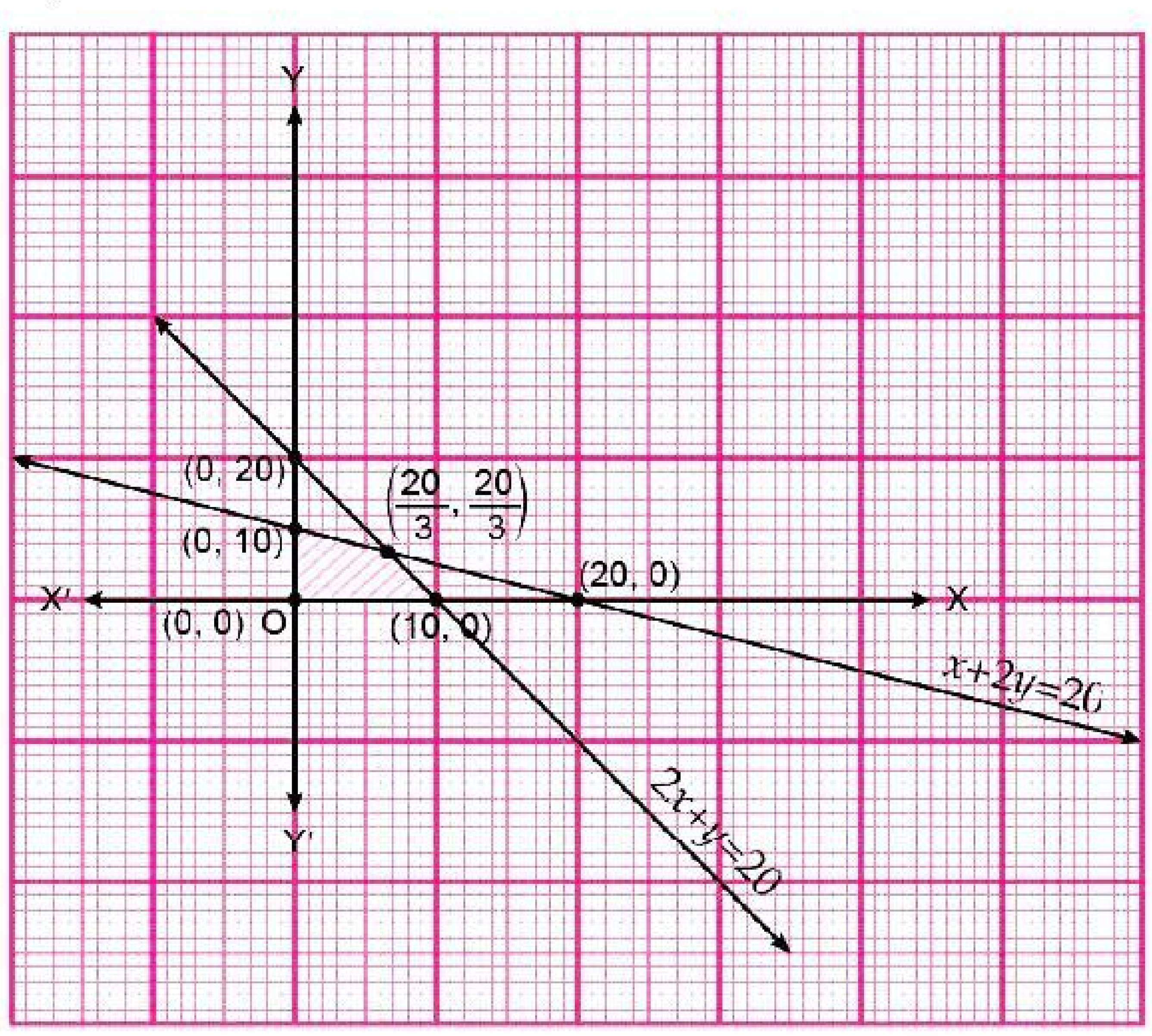
$\therefore Z(3, 4) = Z(0, 5) \Rightarrow 3p + 4q = 5q$

$\Rightarrow 3p = q$

i.e., $q = 3p$

Option (*d*) is correct.

10.



Feasible region is shaded region which is shown in the figure with corner points (0, 0), (10, 0), $\left(\frac{20}{3}, \frac{20}{3}\right)$, and (0, 10)

$Z(0, 0) = 0$

$Z(10, 0) = 10$

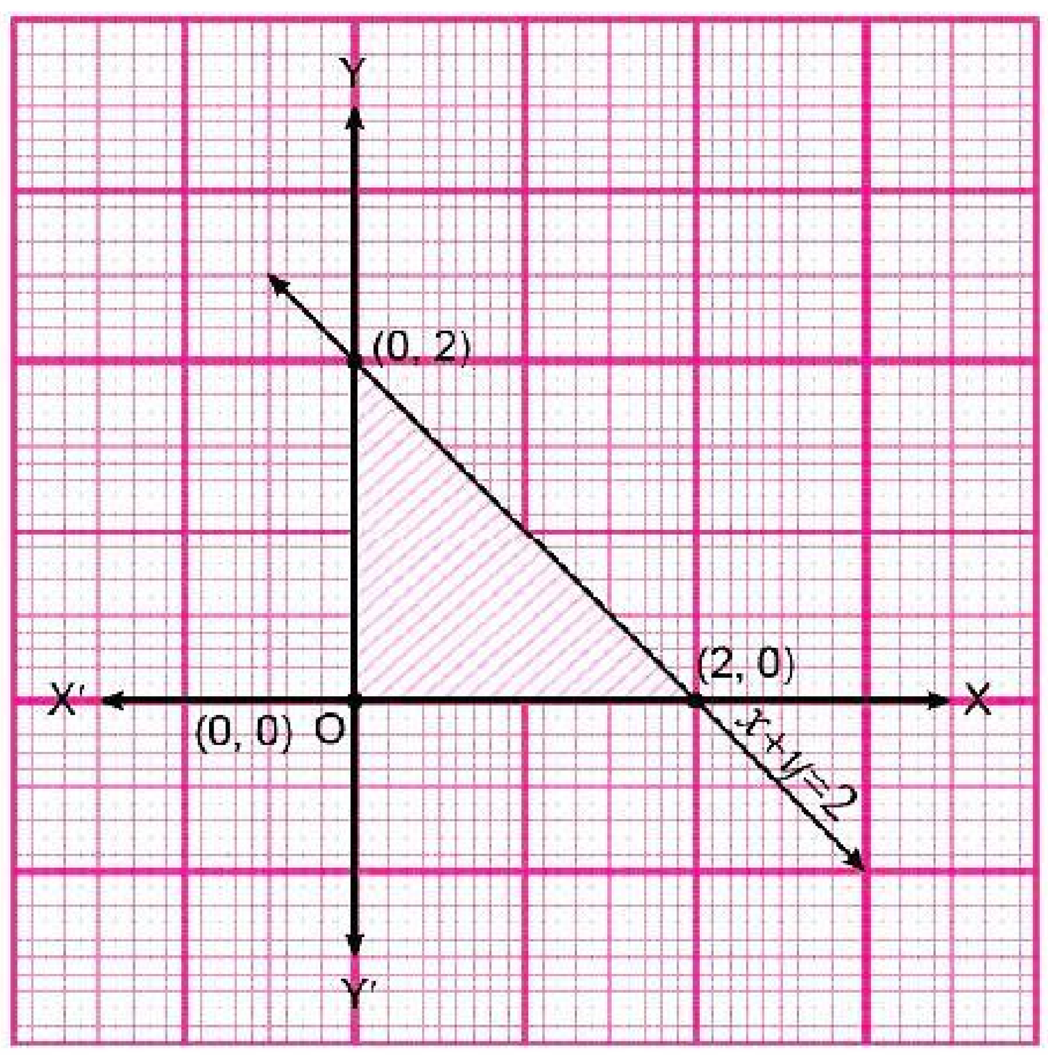
$Z\left(\frac{20}{3}, \frac{20}{3}\right) = \frac{20}{3} + 20 = \frac{80}{3}$

$Z(0, 10) = 30 \longleftarrow$ Maximum

$Z_{max} = 30$ obtained at (0, 10).

Option (*b*) is correct.

11.



Feasible region is shaded region with corner points (0, 0), (2, 0) and (0, 2)

$Z(0, 0) = 0$

$Z(2, 0) = 2 \longleftarrow$ maximise

$Z(0, 2) = 2 \longleftarrow$ maximise

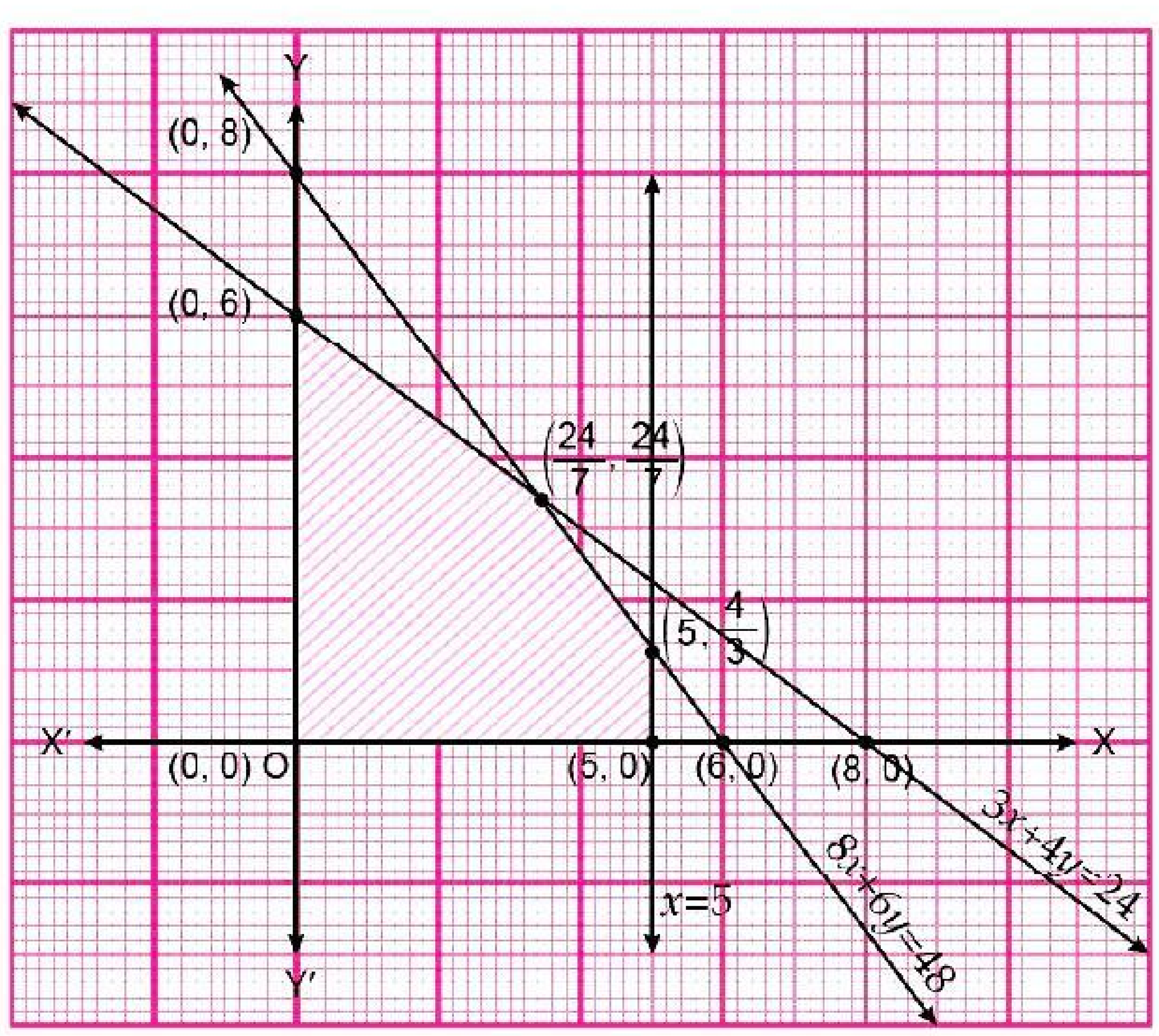
$Z_{max} = 2$ obtained at (2, 0) and (0, 2) so is obtained at any point on line segment joining (2, 0) and (0, 2).

Option (*c*) is correct.

12. By objective functions of a LPP is a function to be optimised.

Option (*b*) is correct.

13.



Feasible region is shaded region shown in figure, with corner point (0, 0), (0, 6), $\left(\frac{24}{7}, \frac{27}{7}\right)$, $\left(5, \frac{4}{3}\right)$, (5, 0)

$Z(0, 0) = 0$

$Z(0, 6) = 18$

$Z\left(\frac{24}{7}, \frac{24}{7}\right) = \frac{96}{7}, \frac{72}{7} = \frac{168}{7} = 24 \longleftarrow$ Maximum

$Z\left(5, \frac{4}{3}\right) = 20 + 4 = 24 \longleftarrow$ Maximum

$Z(5, 0) = 20$

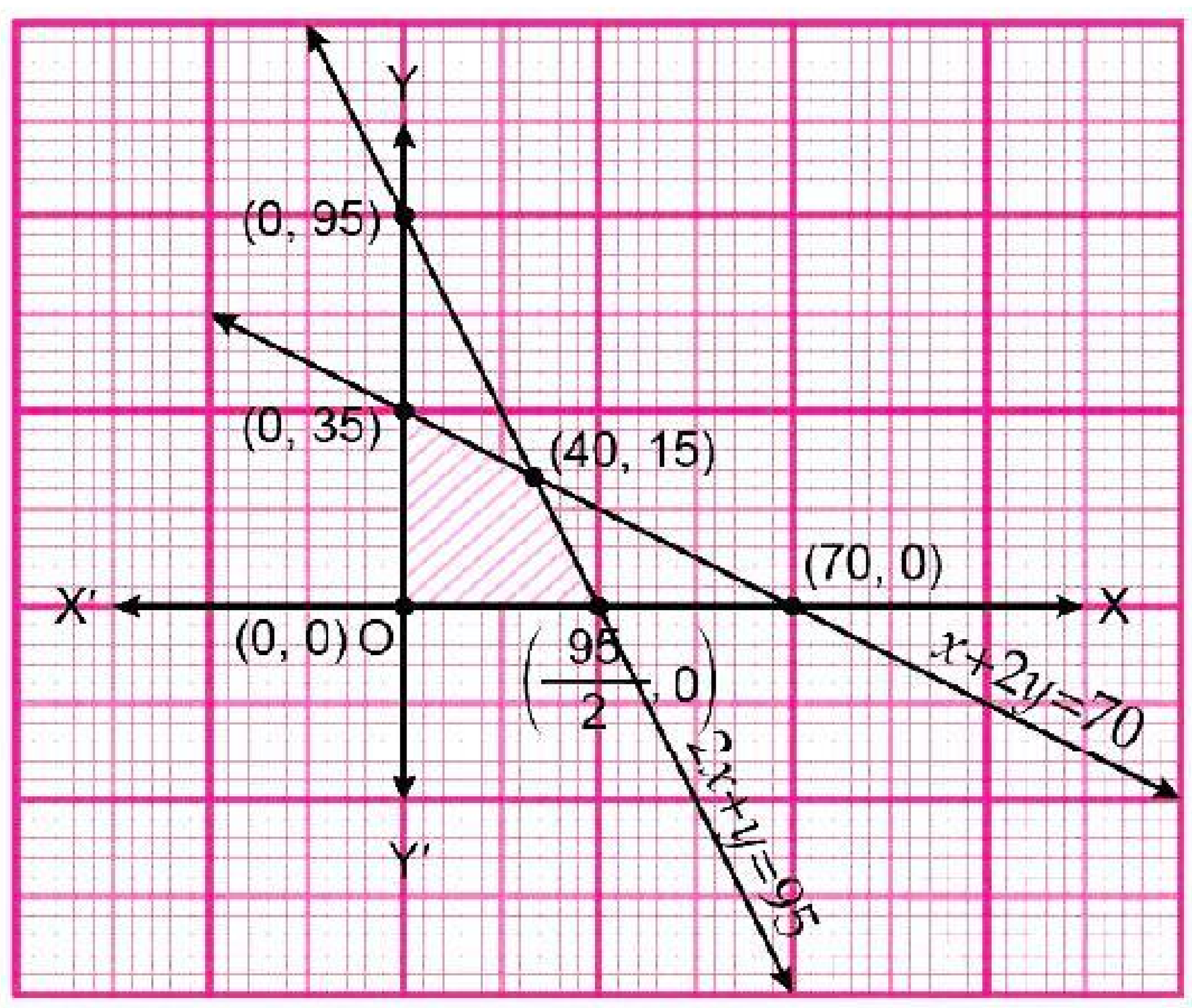
As Z has maximum value 24 at $\left(\frac{24}{7}, \frac{24}{7}\right)$ and $\left(5, \frac{4}{3}\right)$

So at any line segment joining $\left(\frac{24}{7}, \frac{24}{7}\right)$ and $\left(5, \frac{4}{3}\right)$

Hence there are infinitely many points.

Hence option (*c*) is correct.

14.



Feasible region is shaded region with corner points (0, 0), $\left(\frac{95}{2}, 0\right)$, (40, 15), (0, 35)

$\therefore Z(0, 0) = 0$

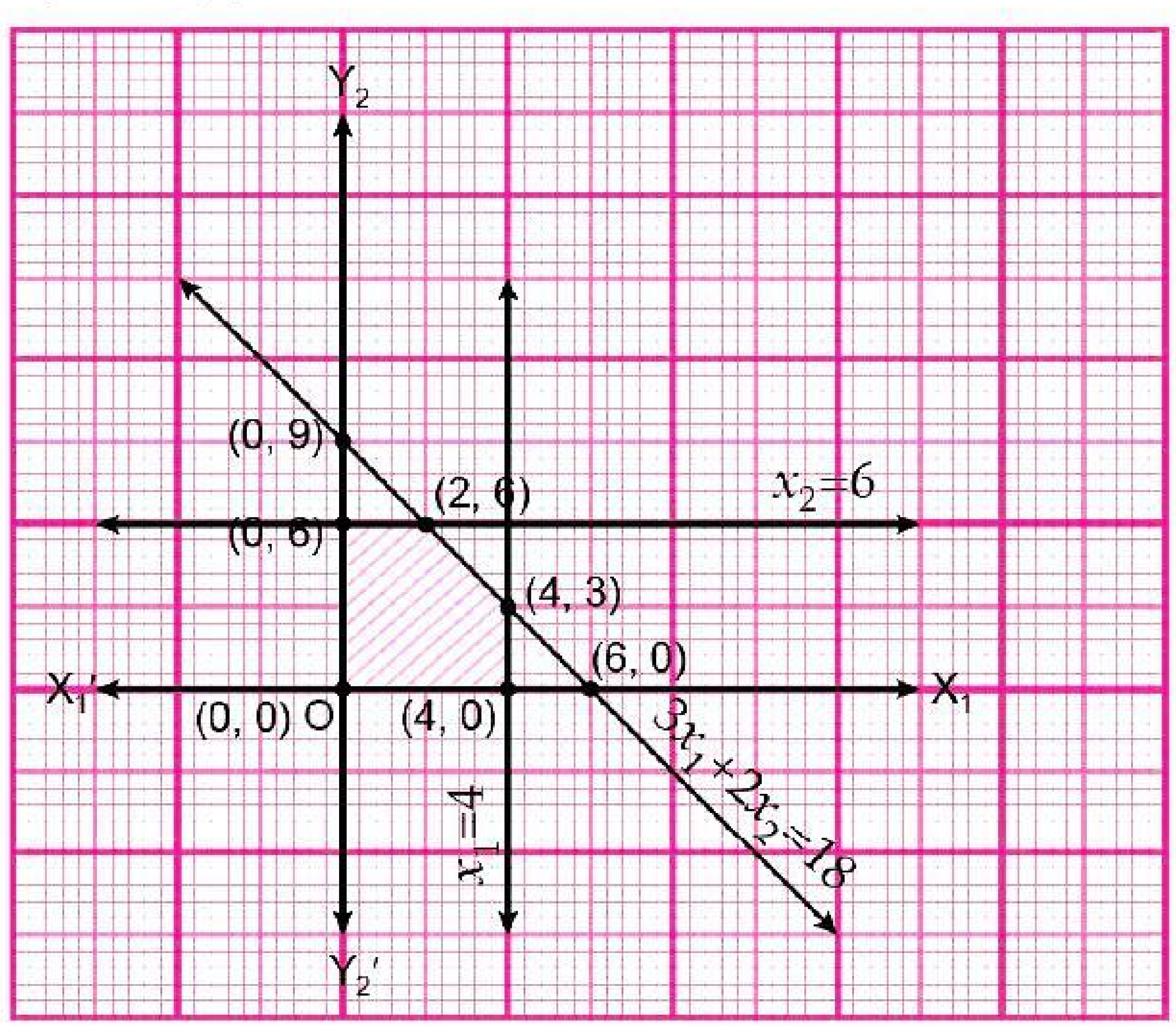
$Z\left(\frac{95}{2}, 0\right) = \frac{95}{2}$

$Z(40, 15) = 40 + 15 = 55 \longleftarrow$ Maximum

$Z(0, 35) = 0 + 35 = 35$

Option (*d*) is correct.

15.



Feasible region is shaded region shown in the figure with corner points (0, 0), (4, 0), (4, 3), (2, 6) and (0, 6).

$Z(0, 0) = 0$

$Z(4, 0) = 12$

$Z(4, 3) = 12 + 15 = 27$

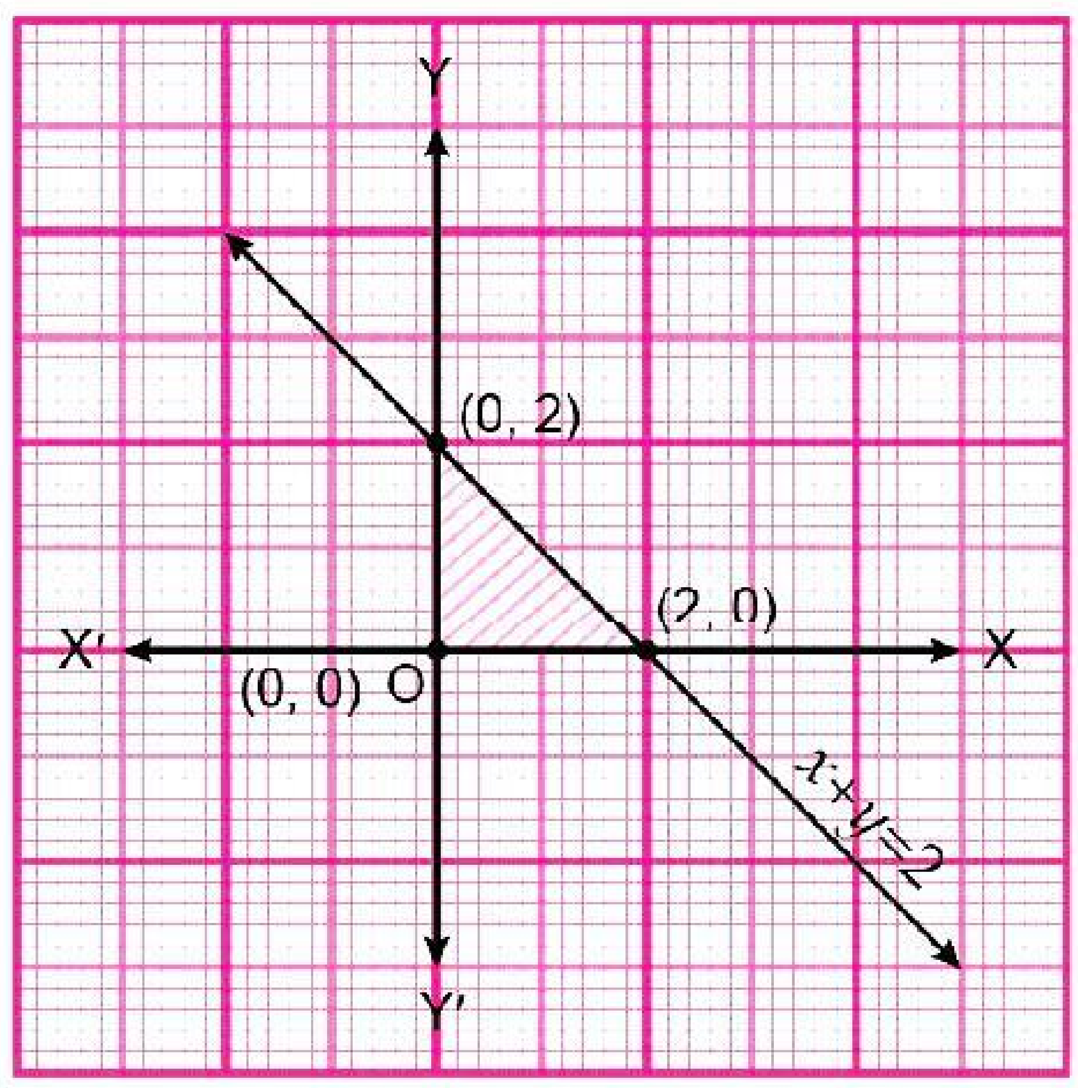
$Z(2, 6) = 6 + 30 = 36 \longleftarrow$ Maximum

$Z(0, 6) = 30$

Maximum value of Z is 36 obtained at $x_1 = 2, x_2 = 6$.

Option (*b*) is correct.

16.



Feasible region is shaded region with corner points (0, 0), (2, 0) and (0, 2).

$Z(0, 0) = 0$

$Z(2, 0) = 4 \longleftarrow$ maximum

$Z(0, 2) = -2$

$Z_{max} = 4$ and obtained at (2, 0)

Option (*b*) is correct.

17. Since maximum value of $Z = ax + by$, where $a, b > 0$ occurs at both points (2, 4) and (4, 0).

$\therefore$ $Z_{max} = 2a + 4b$ at (2, 4) will be same at (4, 0) *i.e.*, $Z_{max} = 4a + 0 = 4a$ at (4, 0)

$\Rightarrow$ $2a + 4b = 4a$ $\Rightarrow$ $2a = 4b$ $\quad a = 2b$

$\therefore$ Option (*a*) is the correct choice.

18. Given inequality $2x + 3y > 6$ ......(*i*)

Check for origin O (0, 0), we have

$2 \times 0 + 3 \times 0 > 6$

$0 > 6$, which is not true.

$\therefore$ (0, 0) does not satisfy the inequality (*i*)

Hence $2x + 3y > 6$ is half plane that neither contains the origin nor the points of the line $2x + 3y = 6$.

$\therefore$ Option (*b*) is the correct choice.

19. Since (2, 3) does not satisfy $2x + 3y - 12 \le 0$ as

$2 \times 2 + 3 \times 3 - 12 = 4 + 9 - 12$

$= 1 \not\le 0$

$\therefore$ Option (c) is the correct choice.

20. $Z = 2x + 3y$

$Z(3, 2) = 2 \times 3 + 3 \times 2$

$= 6 + 6$

$= 12$

Option (c) is correct.

21. Since Z occurs maximum at (15, 15) and (0, 20), therefore, $15p + 15q = 0.p + 20q \Rightarrow q = 3p$.

Option (d) is correct.

22. Since (0, 0) does not satisfy $x + y \geqslant 1$

i.e., $0 + 0 \ngeq 1$

$\Rightarrow$ (0, 0) not lie in feasible region represented by $x + y \geqslant 1$.

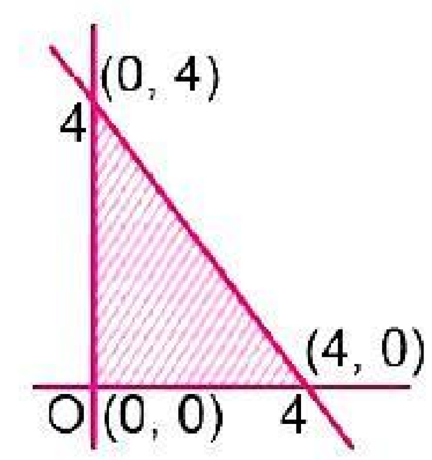
Option (b) is correct.

23. Feasible region for an LPP is always a convex polygon

Option (c) is correct.

24.

Points	$Z = 2x + 3y$
(0, 0)	$0 + 0 = 0$
(4, 0)	$8 + 0 = 8$
(0, 4)	$0 + 12 = 12$ ← Maximum



Option (c) is correct.

25.

Corner Point	$Z = 0.7x + y$
(0, 0)	$0.7 \times 0 + 0 = 0$
(40, 0)	$0.7 \times 40 + 0 = 28$
(30, 20)	$0.7 \times 30 + 20 = 41$ ← Maximum
(0, 40)	$0.7 \times 0 + 40 = 40$

Option (d) is correct.

26. (0, 3) satisfy the equation $2x + 3y \leqslant 12$

$2 \times 0 + 3 \times 3 \leqslant 12$

$9 \leq 12$

But (3, 3), (4, 3), (0, 5) does not satisfy $2x + 3y \leqslant 12$.

Option (a) is correct.

27. Feasible region is the set of points which satisfy all of the given constraints.

Option (c) is correct.

28. Objective functions of a LPP is A linear function to be optimised.

Option (c) is correct.