# Linear Inequalities

CHAPTER 6

NCERT FOCUS

## SOLUTIONS

### EXERCISE - 6.1

**1.** Given inequality is $24x < 100$

Dividing both sides by 24, we get

$$x < \frac{100}{24} = \frac{25}{6}$$

(i) $x$ is a natural number, then the set {1, 2, 3, 4} satisfies this inequality .

(ii) $x$ is an integer, then the set {...., –4, –3, – 2, –1, 0, 1, 2, 3, 4} satisfies this inequality.

**2.** Given inequality is $-12x > 30$

Dividing both sides by –12, we get

$$x < -\frac{30}{12} = -\frac{5}{2}$$

(i) This inequality is not true for any natural number.

(ii) Set of integers that satisfy this inequality is {..., –5, –4, –3}.

**3.** Given inequality is $5x - 3 < 7$

Transposing 3 to R.H.S., we get $5x < 7 + 3$ or $5x < 10$

Dividing both sides by 5, we get $x < 2$

(i) When $x$ is an integer, {.... –2, –1, 0, 1} satisfies this inequality.

(ii) When $x$ is real number, the solution set is $(-\infty, 2)$.

**4.** Given inequality is $3x + 8 > 2$

Transposing 8 to R.H.S., we get $3x > 2 - 8 \Rightarrow 3x > -6$

Dividing both sides by 3, we get $x > -2$

(i) When $x$ is an integer, the solution is {–1, 0, 1, 2, 3, ...}

(ii) When $x$ is a real number, the solution is $(-2, \infty)$.

**5.** The inequality is $4x + 3 < 5x + 7$

Transposing $5x$ to L.H.S. and 3 to R.H.S., we get

$4x - 5x < 7 - 3$ or $-x < 4$

Dividing both sides by –1, we get $x > -4$

$\therefore$ The solution set is $(-4, \infty)$.

**6.** The inequality is $3x - 7 > 5x - 1$

Transposing $5x$ to L.H.S. and –7 to R.H.S., we get

$3x - 5x > -1 + 7$ or $-2x > 6$

Dividing both sides by –2, we get $x < -3$

$\therefore$ The solution set is $(-\infty, -3)$.

**7.** The inequality is $3(x - 1) \le 2(x - 3)$ or $3x - 3 \le 2x - 6$

Transposing $2x$ to L.H.S. and –3 to R.H.S., we get

$3x - 2x \le -6 + 3 \Rightarrow x \le -3$

$\therefore$ The solution set is $(-\infty, -3]$.

**8.** The inequality is $3(2 - x) \ge 2(1 - x)$ or $6 - 3x \ge 2 - 2x$

Transposing $-2x$ to L.H.S. and 6 to R.H.S., we get

$-3x + 2x \ge 2 - 6$ or $-x \ge -4$

Multiplying both sides by –1, we get, $x \le 4$

$\therefore$ The solution set is $(-\infty, 4]$.

**9.** The inequality is $x + \frac{x}{2} + \frac{x}{3} < 11$

Simplifying, $\frac{6x + 3x + 2x}{6} < 11$ or $\frac{11x}{6} < 11$

Multiplying both sides by $\frac{6}{11}$, we get $x < 6$

$\therefore$ The solution set is $(-\infty, 6)$.

**10.** The inequality is $\frac{x}{3} > \frac{x}{2} + 1$

Transposing $\frac{x}{2}$ to L.H.S., we get

$$\frac{x}{3} - \frac{x}{2} > 1$$

Simplifying, $\frac{2x - 3x}{6} > 1$ or $-\frac{x}{6} > 1$

Multiplying both sides by –6, we get $x < -6$

$\therefore$ The solution set is $(-\infty, -6)$.

**11.** The inequality is $\frac{3(x - 2)}{5} \le \frac{5(2 - x)}{3}$

Multiply both sides by the L.C.M. of 5, 3 *i.e.*, by 15.

$3 \times 3(x - 2) \le 5 \times 5(2 - x)$ or $9(x - 2) \le 25(2 - x)$

Simplifying, $9x - 18 \le 50 - 25x$

Transposing $-25x$ to L.H.S. and –18 to R.H.S., we get

$9x + 25x \le 50 + 18$ or $34x \le 68$

Dividing both sides by 34, we get, $x \le 2$

$\therefore$ Solution set is $(-\infty, 2]$.

**12.** The inequality is $\frac{1}{2}\left(\frac{3x}{5} + 4\right) \ge \frac{1}{3}(x - 6)$

or, $\frac{1}{2}\left(\frac{3x + 20}{5}\right) \ge \frac{1}{3}(x - 6)$

Multiplying both sides by 30, we get

$3(3x + 20) \ge 10(x - 6)$ or, $9x + 60 \ge 10x - 60$

Transposing $10x$ to L.H.S. and 60 to R.H.S., we get

$9x - 10x \ge -60 - 60$ or $-x \ge -120$

Multiplying both sides by –1, we get, $x \le 120$

$\therefore$ The solution set is $(-\infty, 120]$.

**13.** The inequality is $2(2x + 3) - 10 < 6(x - 2)$

Simplifying, $4x + 6 - 10 < 6x - 12$ or $4x - 4 < 6x - 12$

Transposing $6x$ to L.H.S. and – 4 to R.H.S., we get

$4x - 6x < -12 + 4$ or $-2x < -8$

Dividing both sides by –2, we get, $x > 4$

$\therefore$ The solution set is $(4, \infty)$.

**14.** The inequality is $37 - (3x + 5) \ge 9x - 8(x - 3)$

Simplifying, $37 - 3x - 5 \ge 9x - 8x + 24$ or $32 - 3x \ge x + 24$

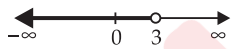
Transposing $x$ to L.H.S. and 32 to R.H.S., we get
$-3x - x \geq 24 - 32$ or $-4x \geq -8$
Dividing both sides by $-4$, we get, $x \leq 2$
$\therefore$ The solution set is $(-\infty, 2]$.

**15.** The inequality is $\frac{x}{4} < \frac{(5x-2)}{3} - \frac{(7x-3)}{5}$

Multiplying each term by the L.C.M. of 4, 3, 5, *i.e.*, by 60, we get
$15x < 100x - 40 - 84x + 36$ or $15x < 100x - 84x - 40 + 36$
or $15x < 16x - 4$
Transposing $16x$ to L.H.S., we get
$15x - 16x < -4$ or $-x < -4$
Multiplying both sides by $-1$, we get, $x > 4$
$\therefore$ The solution set is $(4, \infty)$.

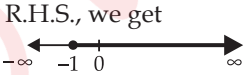
**16.** The inequality is
$\frac{(2x-1)}{3} \geq \frac{(3x-2)}{4} - \frac{(2-x)}{5}$
Multiplying each term by L.C.M. of 3, 4, 5, *i.e.*, by 60
$\frac{(2x-1)}{3} \times 60 \geq \frac{(3x-2)}{4} \times 60 - \frac{(2-x)}{5} \times 60$
or $20(2x-1) \geq (3x-2) \times 15 - (2-x) \times 12$
or $40x - 20 \geq 45x - 30 - 24 + 12x$
or $40x - 20 \geq 57x - 54$
Transposing $57x$ to L.H.S. and $-20$ to R.H.S., we get
$40x - 57x \geq -54 + 20$ or $-17x \geq -34$
Dividing both sides by $-17$, we get, $x \leq 2$
$\therefore$ The solution set is $(-\infty, 2]$.

**17.** The inequality is $3x - 2 < 2x + 1$
Transposing $2x$ to L.H.S. and $-2$ to R.H.S., we get
$3x - 2x < 1 + 2$ or $x < 3$



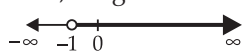

$\therefore$ The solution set is $(-\infty, 3)$.

**18.** The inequality is $5x - 3 \geq 3x - 5$
Transposing $3x$ to L.H.S. and $-3$ to R.H.S., we get
$5x - 3x \geq -5 + 3$ or $2x \geq -2$




Dividing both sides by 2, we get $x \geq -1$
$\therefore$ The solution set is $[-1, \infty)$.

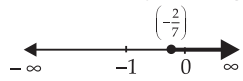
**19.** The inequality is $3(1-x) < 2(x+4)$
Simplifying, $3 - 3x < 2x + 8$
Transposing $2x$ to L.H.S. and 3 to R.H.S., we get
$-3x - 2x < 8 - 3$ or $-5x < 5$




Dividing both sides by $-5$, we get $x > -1$
$\therefore$ The solution set is $(-1, \infty)$.

**20.** The inequality is
$\frac{x}{2} \geq \frac{(5x-2)}{3} - \frac{(7x-3)}{5}$
Multiply each term by L.C.M. of 2, 3, 5, *i.e.*, by 30
$\frac{x}{2} \times 30 \geq \frac{(5x-2)}{3} \times 30 - \frac{(7x-3)}{5} \times 30$
or $15x \geq 10(5x-2) - 6(7x-3)$
or $15x \geq 50x - 20 - 42x + 18$
or $15x - 8x \geq -2$ or $7x \geq -2$
Dividing both sides by 7, we get

$x \geq -\frac{2}{7}$




$\therefore$ The solution set is $\left[-\frac{2}{7}, \infty\right)$.

**21.** Let Ravi gets $x$ marks in third unit test.
$\therefore$ Average marks obtained by Ravi $= \frac{70+75+x}{3}$
He has to obtain an average of atleast 60 marks.
$\therefore$ $\frac{70+75+x}{3} \geq 60$ or $\frac{145+x}{3} \geq 60$
Multiplying both sides by 3, we get
$145 + x \geq 180$
Transposing 145 to R.H.S., we get
$x \geq 180 - 145 \Rightarrow x \geq 35$
$\therefore$ Ravi should get atleast 35 marks in the third unit test.

**22.** Let Sunita obtained $x$ marks in the fifth examination.
$\therefore$ Average marks of 5 examinations
$= \frac{87+92+94+95+x}{5} = \frac{368+x}{5}$
This average must be atleast 90.
$\therefore$ $\frac{368+x}{5} \geq 90$
Multiplying both sides by 5, we get
$368 + x \geq 450$
Transposing 368 to R.H.S., we get $x \geq 450 - 368 \Rightarrow x \geq 82$
$\therefore$ Sunita should obtain atleast 82 marks in the fifth examination.

**23.** Let $x$ be the smaller of the two odd positive integers. Then the other integer is $x + 2$. We should have $x + 2 < 10$ and $x + (x + 2) > 11$ or,
Since, $x + 2 < 10$ *i.e.*, $x < 8$ and $2x + 2 > 11$
or $x < 8$ and $2x > 11 - 2$
or $x < 8$ and $x > \frac{9}{2}$
Hence, if one number is 5 (odd number), then the other is 7. If the smaller number is 7, then the other is 9. Hence, possible pairs are (5, 7) and (7, 9).

**24.** Let $x$ be the smaller of the two positive even integers then the other one is $x + 2$. We should have $x > 5$ and $x + x + 2 < 23$ or $2x + 2 < 23$
or $2x < 21$ or $x < \frac{21}{2}$
Thus, the value of $x$ may be 6, 8, 10 (even integers).
Hence, the pairs are (6, 8), (8, 10), (10, 12).

**25.** Let the shortest side measures $x$ cm.
The longest side will be $3x$ cm.
Third side will be $(3x - 2)$ cm.
According to the problem,
$x + 3x + 3x - 2 \geq 61$
or $7x - 2 \geq 61$ or $7x \geq 63$ or $x \geq 9$
Hence, the minimum length of the shortest side is 9 cm.

**26.** Let $x$ be the length of the shortest piece of board, then $x + 3$ is the length of second piece and $2x$ is the length of third piece.
Thus, $x + (x + 3) + 2x \leq 91$ or $4x + 3 \leq 91$ or $4x \leq 88$ or $x \leq 22$
According to the problem,

$2x \geq (x + 3) + 5$ or $x \geq 8$

$\therefore$ Atleast 8 cm but not more than 22 cm are the possible lengths for the shortest board.

## NCERT MISCELLANEOUS EXERCISE

**1.** We have, $2 \leq 3x - 4 \leq 5$

Adding 4, we get $2 + 4 \leq 3x - 4 + 4 \leq 5 + 4$

or, $6 \leq 3x \leq 9$

Dividing each side by 3, we have, $2 \leq x \leq 3$.

Thus, the solution is $[2, 3]$.

**2.** We have, $6 \leq -3(2x - 4) < 12$

$\Rightarrow \quad \frac{6}{3} \leq -(2x - 4) < \frac{12}{3}$ (Dividing each side by 3)

$\Rightarrow \quad 2 \leq -(2x - 4) < 4 \quad \Rightarrow \quad 2 \leq -2x + 4 < 4$

$\Rightarrow \quad 2 - 4 \leq -2x + 4 - 4 < 4 - 4$ (Subtracting 4)

$\Rightarrow \quad -2 \leq -2x < 0$

$\Rightarrow \quad \frac{-2}{-2} \geq \frac{-2x}{-2} > 0$ (Dividing each side by $-2$)

$\Rightarrow \quad 1 \geq x > 0$

Hence, $x$ is less than or equal to 1 and greater than 0 *i.e.*, $x \in (0, 1]$.

**3.** We have, $-3 \leq 4 - \frac{7x}{2} \leq 18$

Subtracting 4, we get

$-3 - 4 \leq 4 - \frac{7x}{2} - 4 \leq 18 - 4$ or $-7 \leq \frac{-7x}{2} \leq 14$

Multiplying each side by $-\frac{2}{7}$, we get

$-7 \times \left(-\frac{2}{7}\right) \geq \frac{-7}{2}x \times \left(-\frac{2}{7}\right) \geq 14 \times \left(-\frac{2}{7}\right)$

$\Rightarrow \quad 2 \geq x \geq -4$ or $-4 \leq x \leq 2$

$\therefore$ $x$ is less than or equal to 2 and greater than or equal to $-4$ *i.e.*, $x \in [-4, 2]$

**4.** We have, $-15 < 3\frac{(x-2)}{5} \leq 0$

$-15 \times 5 < \frac{3(x-2)}{5} \times 5 \leq 0 \times 5$ [Multiplying by 5]

$\Rightarrow \quad -75 < 3(x - 2) \leq 0$

$\Rightarrow \quad \frac{-75}{3} < x - 2 \leq \frac{0}{3}$ [Dividing each side by 3]

$\Rightarrow \quad -25 < x - 2 \leq 0$ or $-25 + 2 < x - 2 + 2 \leq 0 + 2$ [Adding 2]

$\Rightarrow \quad -23 < x \leq 2$

Hence, $x$ is less than or equal to 2 and greater than $-23$, *i.e.*, $x \in (-23, 2]$.

**5.** $-12 < 4 - \frac{3x}{-5} \leq 2$

Subtracting 4 from each side, we get

$-12 - 4 < 4 - \frac{3x}{-5} - 4 \leq 2 - 4$

$\Rightarrow \quad -16 < \frac{3x}{5} \leq -2$

Multiplying each side by 5/3, we get

$-16 \times \frac{5}{3} < \frac{3}{5}x \times \frac{5}{3} \leq -2 \times \frac{5}{3}$

$\Rightarrow \quad -\frac{80}{3} < x \leq -\frac{10}{3}$ or $x \in \left(\frac{-80}{3}, \frac{-10}{3}\right]$.

**6.** We have, $7 \leq \frac{3x+11}{2} \leq 11$

Multiplying each side by 2, we get

$7 \times 2 \leq \left(\frac{3x+11}{2}\right) \times 2 \leq 11 \times 2$ or $14 \leq 3x + 11 \leq 22$

Subtracting 11, we get

$14 - 11 \leq 3x + 11 - 11 \leq 22 - 11$

or $3 \leq 3x \leq 11$

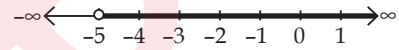
Dividing by 3, we get

$1 \leq x \leq \frac{11}{3}$

*i.e.*, $x$ is greater than or equal to 1 and less than or equal to $\frac{11}{3}$ *i.e.*, $x \in \left[1, \frac{11}{3}\right]$.

**7.** (i) $5x + 1 > -24 \Rightarrow 5x > -24 - 1$ or $5x > -25$

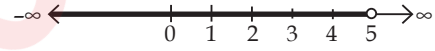
Dividing by 5, we get $x > -5$




(ii) $5x - 1 < 24$

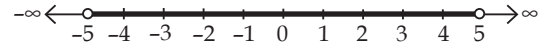
Adding 1, we get $5x < 25$

Dividing by 5, we get $x < 5$



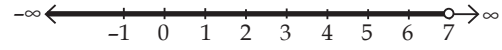

From (i) and (ii), we get

$-5 < x < 5$ or $x \in (-5, 5)$




**8.** (i) $2(x - 1) < x + 5$ or $2x - 2 < x + 5$

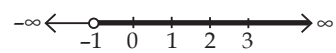
$\Rightarrow \quad 2x - x < 5 + 2 \quad \Rightarrow \quad x < 7$




(ii) $3(x + 2) > 2 - x$ or $3x + 6 > 2 - x$

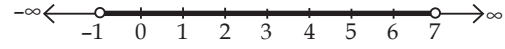
$\Rightarrow \quad 3x + x > 2 - 6$

$\Rightarrow \quad 4x > -4 \quad \Rightarrow \quad x > -1$




From (i) and (ii), we get

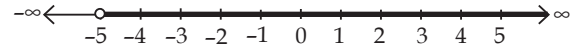
$-1 < x < 7$ i.e., $x \in (-1, 7)$




**9.** (i) $3x - 7 > 2(x - 6)$ or $3x - 7 > 2x - 12$

$\Rightarrow \quad 3x - 2x > -12 + 7$

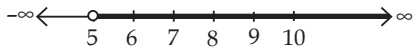
$\Rightarrow \quad x > -5$



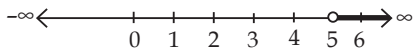

(ii) $6 - x > 11 - 2x$

$\Rightarrow \quad -x + 2x > 11 - 6$

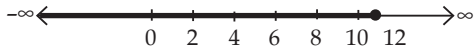
$\Rightarrow \quad x > 5$



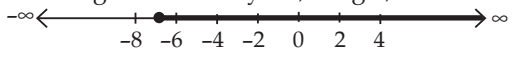

From (i) and (ii), we get
$x > 5$ satisfies both the inequalities $x > -5$ and $x > 5$.
$\therefore$ Solution set is $(5, \infty)$



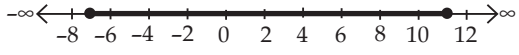

**10.** (i) $5(2x - 7) - 3(2x + 3) \le 0$
$\Rightarrow \quad 10x - 35 - 6x - 9 \le 0$
$\Rightarrow \quad 4x - 44 \le 0$
$\Rightarrow \quad 4x \le 44 \quad \Rightarrow \quad x \le 11$




(ii) $2x + 19 \le 6x + 47$
$\Rightarrow \quad 2x - 6x \le 47 - 19 \quad \Rightarrow \quad -4x \le 28$
Dividing both sides by $-4$, we get, $x \ge -7$




From (i) and (ii), the solution is $-7 \le x \le 11$
*i.e.*, $x \in [-7, 11]$




**11.** We have, $F = \frac{9}{5}C + 32$ but $68 < F < 77$

$\therefore \quad 68 < \frac{9}{5}C + 32 < 77$

Subtracting 32 from each side, we get

$$68 - 32 < \frac{9}{5}C + 32 - 32 < 77 - 32$$

$$\Rightarrow \quad 36 < \frac{9}{5}C < 45$$

Multiplying each side by 5/9, we get

$$36 \times \frac{5}{9} < C < 45 \times \frac{5}{9}$$

$\Rightarrow \quad 20 < C < 25$
$\therefore$ Required temperature is between 20°C and 25°C.

**12.** Let the 2% boric acid solution be $x$ litres.
$\therefore$ Mixture is $(640 + x)$ litres.
(i) Now, 2% of $x$ + 8% of 640 > 4% of $(640 + x)$

$$\text{or} \quad \frac{2x}{100} + \frac{8 \times 640}{100} > \frac{4}{100}(640 + x)$$

$\Rightarrow \quad 2x + 5120 > 2560 + 4x$
$\Rightarrow \quad 5120 - 2560 > 4x - 2x$
$\Rightarrow \quad 2x < 2560 \quad \text{or} \quad x < 1280 \qquad \ldots (1)$

(ii) 2% of $x$ + 8% of 640 < 6% of $(640 + x)$

$$\text{or} \quad \frac{2x}{100} + \frac{8 \times 640}{100} < \frac{6}{100}(640 + x)$$

$\Rightarrow \quad 2x + 5120 < 3840 + 6x$
$\Rightarrow \quad 5120 - 3840 < 6x - 2x$
$\Rightarrow \quad 4x > 1280 \quad \text{or} \quad x > 320 \qquad \ldots (2)$

From (1) and (2), we have $320 < x < 1280$
Thus, the quantity to be added, should be greater than 320 litres and less than 1280 litres.

**13.** Let $x$ litres water is added to 45% solution of acid.

(i) $25\%$ of $(1125 + x) < \frac{1125 \times 45}{100}$

[$\because$ Amount of acid in resulting mixture = 45% of 1125]

$$\text{or} \quad \frac{1125 + x}{4} < \frac{1125 \times 9}{20}$$

$\Rightarrow \quad 5(1125 + x) < 10125 \quad \Rightarrow \quad 5625 + 5x < 10125$
$\Rightarrow \quad 5x < 10125 - 5625$

$$\Rightarrow \quad x < \frac{4500}{5} \quad \Rightarrow x < 900 \qquad \ldots (1)$$

(ii) Further, 30% of $(1125 + x) > \frac{1125 \times 45}{100}$

$$\text{or} \quad \frac{30}{100} \times (1125 + x) > \frac{1125 \times 9}{20}$$

$\Rightarrow \quad 6(1125 + x) > 1125 \times 9 \Rightarrow 6750 + 6x > 10125$
$\Rightarrow \quad 6x > 10125 - 6750 \quad \Rightarrow \quad 6x > 3375$

$$\Rightarrow \quad x > \frac{3375}{6} \Rightarrow x > 562.5 \qquad \ldots (2)$$

From (1) and (2), we have
$562.5 < x < 900$
Thus, the quantity of water to be added should be greater than 562.5 litres and less than 900 litres.

**14.** We have, $IQ = \frac{MA}{CA} \times 100$

We are given that $80 \le IQ \le 140$
Putting the value of IQ in it, we get

$$80 \le \frac{MA}{CA} \times 100 \le 140$$

Also we have, CA = 12 years

$$80 \le \frac{MA}{12} \times 100 \le 140$$

Multiplying each side by 12, we get
$12 \times 80 \le MA \times 100 \le 140 \times 12 \quad \text{or} \quad 960 \le 100 \times MA \le 1680$
Dividing each side by 100, we get
$9.6 \le MA \le 16.8$
Hence, mental age is greater than or equal to 9.6 years and less than or equal to 16.8 years.

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