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NCERT Solutions for Class 11 Maths Chapter 5: Linear Inequalities – Free PDF Download

Chapter 5, Linear Inequalities, introduces statements involving <, >, ≤ and ≥ instead of the equality sign, and teaches students how to solve linear inequalities in one variable both algebraically and on the number line. In the current NCERT syllabus this chapter covers one exercise (Exercise 5.1) built around t...

Contents

Chapter 5, Linear Inequalities, introduces statements involving <, >, ≤ and ≥ instead of the equality sign, and teaches students how to solve linear inequalities in one variable both algebraically and on the number line. In the current NCERT syllabus this chapter covers one exercise (Exercise 5.1) built around the rules for solving inequalities, followed by a Miscellaneous Exercise that combines these ideas with real-life word problems on temperature ranges, mixtures, and averages. These Class 11 Maths Chapter 5 solutions are also useful as quick revision notes before exams.

Exercise 5.1

Q1. Solve 24x < 100, when (i) x is a natural number. (ii) x is an integer.

We have $24x < 100$, so dividing both sides by 24 (a positive number, so the inequality sign does not change):
$x < 100/24 = 25/6 = 4.1666\ldots$

x is a natural number: The natural numbers less than 25/6 are 1, 2, 3, 4. Solution set = {1, 2, 3, 4}.

x is an integer: The integers less than 25/6 are ..., −3, −2, −1, 0, 1, 2, 3, 4. Solution set = {..., −3, −2, −1, 0, 1, 2, 3, 4}.

Q2. Solve −12x > 30, when (i) x is a natural number. (ii) x is an integer.

We have $-12x > 30$. Dividing both sides by −12 (a negative number reverses the inequality sign):
$x < 30/(-12) = -5/2 = -2.5$

x is a natural number: Natural numbers are 1, 2, 3, ... which are always positive, so none of them can be less than −2.5. Solution set = ∅ (no solution).

x is an integer: The integers less than −2.5 are −3, −4, −5, ... Solution set = {..., −5, −4, −3}.

Q3. Solve 5x – 3 < 7, when (i) x is an integer. (ii) x is a real number.

$5x - 3 < 7 \Rightarrow 5x < 10 \Rightarrow x < 2$.

x is an integer: Integers less than 2 are ..., −2, −1, 0, 1. Solution set = {..., −2, −1, 0, 1}.

x is a real number: Solution set = $(-\infty, 2)$.

Q4. Solve 3x + 8 > 2, when (i) x is an integer. (ii) x is a real number.

$3x + 8 > 2 \Rightarrow 3x > -6 \Rightarrow x > -2$.

x is an integer: Integers greater than −2 are −1, 0, 1, 2, ... Solution set = {−1, 0, 1, 2, ...}.

x is a real number: Solution set = $(-2, \infty)$.

Solve the inequalities in Exercises 5 to 16 for real x.

Q5. $4x + 3 < 5x + 7$

$4x - 5x < 7 - 3 \Rightarrow -x < 4 \Rightarrow x > -4$ (dividing by −1 reverses the sign).
Solution set = $(-4, \infty)$.

Q6. $3x - 7 > 5x - 1$

$3x - 5x > -1 + 7 \Rightarrow -2x > 6 \Rightarrow x < -3$.
Solution set = $(-\infty, -3)$.

Q7. $3(x - 1) \leq 2(x - 3)$

$3x - 3 \leq 2x - 6 \Rightarrow x \leq -3$.
Solution set = $(-\infty, -3]$.

Q8. $3(2 - x) \geq 2(1 - x)$

$6 - 3x \geq 2 - 2x \Rightarrow 6 - 2 \geq 3x - 2x \Rightarrow 4 \geq x \Rightarrow x \leq 4$.
Solution set = $(-\infty, 4]$.

Q9. $x + x/2 + x/3 < 11$

Multiplying throughout by 6 (LCM of 1, 2, 3): $6x + 3x + 2x < 66 \Rightarrow 11x < 66 \Rightarrow x < 6$.
Solution set = $(-\infty, 6)$.

Q10. $x/3 > x/2 + 1$

Multiplying throughout by 6: $2x > 3x + 6 \Rightarrow -x > 6 \Rightarrow x < -6$.
Solution set = $(-\infty, -6)$.

Q11. $3(x - 2)/5 \leq 5(2 - x)/3$

Multiplying throughout by 15: $9(x - 2) \leq 25(2 - x) \Rightarrow 9x - 18 \leq 50 - 25x \Rightarrow 34x \leq 68 \Rightarrow x \leq 2$.
Solution set = $(-\infty, 2]$.

Q12. $(1/2)(3x/5 + 4) \geq (1/3)(x - 6)$

Multiplying throughout by 6 (LCM of 2 and 3): $3(3x/5 + 4) \geq 2(x - 6) \Rightarrow 9x/5 + 12 \geq 2x - 12$.
Multiplying throughout by 5: $9x + 60 \geq 10x - 60 \Rightarrow 120 \geq x \Rightarrow x \leq 120$.
Solution set = $(-\infty, 120]$.

Q13. $2(2x + 3) - 10 < 6(x - 2)$

$4x + 6 - 10 < 6x - 12 \Rightarrow 4x - 4 < 6x - 12 \Rightarrow 8 < 2x \Rightarrow x > 4$.

Solution set = $(4, \infty)$.

Q14. $37 - (3x + 5) \geq 9x - 8(x - 3)$

$37 - 3x - 5 \geq 9x - 8x + 24 \Rightarrow 32 - 3x \geq x + 24 \Rightarrow 8 \geq 4x \Rightarrow x \leq 2$.
Solution set = $(-\infty, 2]$.

Q15. $x/4 < (5x - 2)/3 - (7x - 3)/5$

Multiplying throughout by 60 (LCM of 4, 3, 5): $15x < 20(5x - 2) - 12(7x - 3) \Rightarrow 15x < 100x - 40 - 84x + 36 \Rightarrow 15x < 16x - 4 \Rightarrow -x < -4 \Rightarrow x > 4$.
Solution set = $(4, \infty)$.

Q16. $(2x - 1)/3 \geq (3x - 2)/4 - (2 - x)/5$

Multiplying throughout by 60 (LCM of 3, 4, 5): $20(2x - 1) \geq 15(3x - 2) - 12(2 - x) \Rightarrow 40x - 20 \geq 45x - 30 - 24 + 12x \Rightarrow 40x - 20 \geq 57x - 54 \Rightarrow 34 \geq 17x \Rightarrow x \leq 2$.
Solution set = $(-\infty, 2]$.

Solve the inequalities in Exercises 17 to 20 and show the graph of the solution in each case on number line.

Q17. $3x - 2 < 2x + 1$

$3x - 2x < 1 + 2 \Rightarrow x < 3$.
Solution set = $(-\infty, 3)$. On the number line, this is shown by an open (unfilled) circle at 3 with the line shaded to the left of 3.

Q18. $5x - 3 \geq 3x - 5$

$5x - 3x \geq -5 + 3 \Rightarrow 2x \geq -2 \Rightarrow x \geq -1$.
Solution set = $[-1, \infty)$. On the number line, this is shown by a dark (filled) circle at –1 with the line shaded to the right of –1.

Q19. $3(1 - x) < 2(x + 4)$

$3 - 3x < 2x + 8 \Rightarrow 3 - 8 < 2x + 3x \Rightarrow -5 < 5x \Rightarrow x > -1$.
Solution set = $(-1, \infty)$. On the number line, this is shown by an open circle at –1 with the line shaded to the right of –1.

Q20. $x/2 \geq (5x - 2)/3 - (7x - 3)/5$

Multiplying throughout by 30 (LCM of 2, 3, 5): $15x \geq 10(5x - 2) - 6(7x - 3) \Rightarrow 15x \geq 50x - 20 - 42x + 18 \Rightarrow 15x \geq 8x - 2 \Rightarrow 7x \geq -2 \Rightarrow x \geq -2/7$.
Solution set = $[-2/7, \infty)$. On the number line, this is shown by a dark circle at –2/7 with the line shaded to the right of –2/7.

Q21. Ravi obtained 70 and 75 marks in first two unit test. Find the minimum marks he

should get in the third test to have an average of at least 60 marks.

Let x be the marks Ravi obtains in the third test. For the average of the three tests to be at least 60:
$(70 + 75 + x)/3 \geq 60 \Rightarrow 145 + x \geq 180 \Rightarrow x \geq 35$.
Ravi must obtain at least 35 marks in the third test.

Q22. To receive Grade 'A' in a course, one must obtain an average of 90 marks or more in five examinations (each of 100 marks). If Sunita's marks in first four examinations are 87, 92, 94 and 95, find minimum marks that Sunita must obtain in fifth examination to get grade 'A' in the course.

Let x be the marks Sunita obtains in the fifth examination. Sum of first four marks = 87 + 92 + 94 + 95 = 368. For an average of at least 90 over 5 exams:
$(368 + x)/5 \geq 90 \Rightarrow 368 + x \geq 450 \Rightarrow x \geq 82$.
Sunita must obtain at least 82 marks (and at most 100, the maximum possible) in the fifth examination to secure grade 'A'.

Q23. Find all pairs of consecutive odd positive integers both of which are smaller than 10 such that their sum is more than 11.

Let x be the smaller of the two consecutive odd positive integers, so the other is x + 2. Since both are smaller than 10: $x < 10$ and $x + 2 < 10$, i.e., $x < 8$. Also, their sum is more than 11:
$x + (x + 2) > 11 \Rightarrow 2x + 2 > 11 \Rightarrow x > 4.5$.
So $4.5 < x < 8$, and since x must be an odd positive integer, x = 5 or x = 7.
The required pairs are (5, 7) and (7, 9).

Q24. Find all pairs of consecutive even positive integers, both of which are larger than 5 such that their sum is less than 23.

Let x be the smaller of the two consecutive even positive integers, so the other is x + 2. Since both are larger than 5: $x > 5$, i.e., $x \geq 6$ (as x is even). Also, their sum is less than 23:
$x + (x + 2) < 23 \Rightarrow 2x + 2 < 23 \Rightarrow x < 10.5$.
So $6 \leq x < 10.5$, and since x must be even, x = 6, 8, or 10.
The required pairs are (6, 8), (8, 10) and (10, 12).

Q25. The longest side of a triangle is 3 times the shortest side and the third side is 2 cm shorter than the longest side. If the perimeter of the triangle is at least 61 cm, find the minimum length of the shortest side.

Let the shortest side be x cm. Then the longest side = 3x cm, and the third side = (3x – 2) cm. Since the perimeter is at least 61 cm:
$x + 3x + (3x - 2) \geq 61 \Rightarrow 7x - 2 \geq 61 \Rightarrow 7x \geq 63 \Rightarrow x \geq 9$.
The minimum length of the shortest side is 9 cm.

Q26. A man wants to cut three lengths from a single piece of board of length 91cm. The second length is to be 3cm longer than the shortest and the third length is to be twice as long as the shortest. What are the possible lengths of the shortest board if the third

piece is to be at least 5cm longer than the second? [Hint: If x is the length of the shortest board, then x, (x + 3) and 2x are the lengths of the second and third piece, respectively. Thus, x + (x + 3) + 2x ≤ 91 and 2x ≥ (x + 3) + 5].

Let x be the length of the shortest piece. The second piece = (x + 3) cm and the third piece = 2x cm.
Since the total length cannot exceed 91 cm: $x + (x + 3) + 2x \le 91 \Rightarrow 4x + 3 \le 91 \Rightarrow 4x \le 88 \Rightarrow x \le 22$.
Since the third piece must be at least 5 cm longer than the second: $2x \ge (x + 3) + 5 \Rightarrow 2x \ge x + 8 \Rightarrow x \ge 8$.
Combining both: $8 \le x \le 22$.
The possible lengths of the shortest board lie between 8 cm and 22 cm (inclusive).

Miscellaneous Exercise

Solve the inequalities in Exercises 1 to 6.

Q1. $2 \le 3x - 4 \le 5$

Adding 4 throughout: $6 \le 3x \le 9$. Dividing throughout by 3: $2 \le x \le 3$.
Solution set = [2, 3].

Q2. $6 \le -3(2x - 4) < 12$

Simplifying: $-3(2x - 4) = -6x + 12$, so $6 \le -6x + 12 < 12$. Subtracting 12 throughout: $-6 \le -6x < 0$.
Dividing throughout by −6 (inequality signs reverse): $1 \ge x > 0$, i.e., $0 < x \le 1$.
Solution set = (0, 1].

Q3. $-3 \le 4 - 7x/2 \le 18$

Subtracting 4 throughout: $-7 \le -7x/2 \le 14$. Multiplying throughout by −2/7 (inequality signs reverse): $2 \ge x \ge -4$, i.e., $-4 \le x \le 2$.
Solution set = [−4, 2].

Q4. $-15 < 3(x - 2)/5 \le 0$

Multiplying throughout by 5: $-75 < 3(x - 2) \le 0$. Dividing throughout by 3: $-25 < x - 2 \le 0$. Adding 2 throughout: $-23 < x \le 2$.
Solution set = (−23, 2].

Q5. $-12 < 4 - 3x/(-5) \le 2$

Note that $4 - 3x/(-5) = 4 + 3x/5$, so the inequality becomes $-12 < 4 + 3x/5 \le 2$. Subtracting 4 throughout: $-16 < 3x/5 \le -2$.
Multiplying throughout by 5/3: $-80/3 < x \le -10/3$.
Solution set = (−80/3, −10/3].

Q6. $7 \le (3x + 11)/2 \le 11$

Multiplying throughout by 2: $14 \le 3x + 11 \le 22$. Subtracting 11 throughout: $3 \le 3x \le 11$. Dividing throughout by 3: $1 \le x \le 11/3$.

Solution set = [1, 11/3].

Solve the inequalities in Exercises 7 to 10 and represent the solution graphically on number line.

Q7. $5x + 1 > -24$, $5x - 1 < 24$

From the first inequality: $5x > -25 \Rightarrow x > -5$.
From the second inequality: $5x < 25 \Rightarrow x < 5$.
Combining both: $-5 < x < 5$. Solution set = $(-5, 5)$. On the number line, this is the region between -5 and 5 (both open circles), shown by a bold line joining them.

Q8. $2(x - 1) < x + 5$, $3(x + 2) > 2 - x$

From the first inequality: $2x - 2 < x + 5 \Rightarrow x < 7$.
From the second inequality: $3x + 6 > 2 - x \Rightarrow 4x > -4 \Rightarrow x > -1$.
Combining both: $-1 < x < 7$. Solution set = $(-1, 7)$, shown on the number line as the bold region between -1 and 7 (both open circles).

Q9. $3x - 7 > 2(x - 6)$, $6 - x > 11 - 2x$

From the first inequality: $3x - 7 > 2x - 12 \Rightarrow x > -5$.
From the second inequality: $6 - x > 11 - 2x \Rightarrow x > 5$.
Combining both (the stricter condition governs): $x > 5$. Solution set = $(5, \infty)$, shown on the number line as an open circle at 5 with the line shaded to the right.

Q10. $5(2x - 7) - 3(2x + 3) \leq 0$, $2x + 19 \leq 6x + 47$

From the first inequality: $10x - 35 - 6x - 9 \leq 0 \Rightarrow 4x - 44 \leq 0 \Rightarrow x \leq 11$.
From the second inequality: $2x + 19 \leq 6x + 47 \Rightarrow -28 \leq 4x \Rightarrow x \geq -7$.
Combining both: $-7 \leq x \leq 11$. Solution set = $[-7, 11]$, shown on the number line as the bold region between -7 and 11 (both filled circles).

Q11. A solution is to be kept between 68° F and 77° F. What is the range in temperature in degree Celsius (C) if the Celsius/Fahrenheit conversion formula is given by F = 9/5 C + 32?

We are given $68 < F < 77$. Substituting $F = 9C/5 + 32$:
$68 < 9C/5 + 32 < 77$. Subtracting 32 throughout: $36 < 9C/5 < 45$. Multiplying throughout by 5/9: $20 < C < 25$.
The temperature must range between 20°C and 25°C.

Q12. A solution of 8% boric acid is to be diluted by adding a 2% boric acid solution to it. The resulting mixture is to be more than 4% but less than 6% boric acid. If we have 640 litres of the 8% solution, how many litres of the 2% solution will have to be added?

Let x litres of the 2% boric acid solution be added. Total mixture = (640 + x) litres. The amount of pure boric acid must satisfy:
4% of (640 + x) < 8% of 640 + 2% of x < 6% of (640 + x).

From the left part: $(4/100)(640 + x) < (8/100)(640) + (2/100)x$. Multiplying throughout by 100: $4(640 + x) < 8(640) + 2x \Rightarrow 2560 + 4x < 5120 + 2x \Rightarrow 2x < 2560 \Rightarrow x < 1280$.
From the right part: $(8/100)(640) + (2/100)x < (6/100)(640 + x)$. Multiplying throughout by 100: $5120 + 2x < 3840 + 6x \Rightarrow 1280 < 4x \Rightarrow x > 320$.
Combining both: $320 < x < 1280$.
More than 320 litres but less than 1280 litres of the 2% solution must be added.

Q13. How many litres of water will have to be added to 1125 litres of the 45% solution of acid so that the resulting mixture will contain more than 25% but less than 30% acid content?

Let x litres of water be added. The amount of pure acid stays fixed at 45% of 1125 = 506.25 litres, and the total mixture becomes (1125 + x) litres. We need:
25% of $(1125 + x) < 506.25 <$ 30% of $(1125 + x)$.
From the left part: $(25/100)(1125 + x) < 506.25 \Rightarrow 1125 + x < 2025 \Rightarrow x < 900$.
From the right part: $506.25 < (30/100)(1125 + x) \Rightarrow 1687.5 < 1125 + x \Rightarrow x > 562.5$.
Combining both: $562.5 < x < 900$.
More than 562.5 litres but less than 900 litres of water must be added.

Q14. IQ of a person is given by the formula IQ = MA/CA × 100, where MA is mental age and CA is chronological age. If 80 ≤ IQ ≤ 140 for a group of 12 years old children, find the range of their mental age.

Here CA = 12. We are given $80 \leq IQ \leq 140$, so:
$80 \leq (MA/12) \times 100 \leq 140$. Dividing throughout by 100: $0.8 \leq MA/12 \leq 1.4$. Multiplying throughout by 12: $9.6 \leq MA \leq 16.8$.
The mental age of the children ranges between 9.6 years and 16.8 years.

Class 11 Maths Chapter 5 – Notes and Extra Questions

Two real numbers or two algebraic expressions related by the symbols <, >, ≤ or ≥ form an **inequality**. If it contains only numbers it is a numerical inequality; if it contains variables it is a literal (or linear) inequality.

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

Rule 2 (Multiplication/Division): Both sides of an inequality can be multiplied or divided by the same positive number without changing the sign. But when both sides are multiplied or divided by a negative number, the inequality sign is reversed.

A value of the variable that makes an inequality a true statement is called a **solution** of that inequality, and the collection of all such values is its **solution set**.

On a number line, $x < a$ or $x > a$ is represented with an **open (unfilled) circle** at a, since a itself is not included; $x \leq a$ or $x \geq a$ is represented with a **dark (filled) circle** at a, since a is included.

For a system of two or more inequalities in one variable, solve each inequality separately, then take the **intersection** of their individual solution sets to get the combined solution.

Word problems on inequalities usually involve phrases like “at least” (≥), “at most” (≤), “more than” (>) and “less than” (<) — translating these correctly into symbols is the key first step before solving.

Compound inequalities of the form $a < px + q \le b$ can be solved directly by performing the same operation on all three parts simultaneously, keeping careful track of the direction of each inequality sign.

How many exercises are there in Class 11 Maths Chapter 5, Linear Inequalities?

In the current (2026-27) NCERT textbook, Chapter 5 contains a single exercise, Exercise 5.1 (26 questions), followed by a Miscellaneous Exercise (14 questions). Earlier editions of this chapter also included separate exercises on graphing linear inequalities in two variables and on systems of linear inequalities in two variables, but these topics and their exercises have been removed from the current rationalised syllabus.

What is the difference between an equation and an inequality?

An equation states that two expressions are equal (using the sign =), and it usually has one or a few specific solutions. An inequality compares two expressions using <, >, ≤ or ≥, and its solution is typically an entire range or interval of values rather than a single number.

Why does the inequality sign reverse when multiplying or dividing by a negative number?

Multiplying or dividing both sides of an inequality by a negative number flips the relative order of the numbers on the number line. For example, $3 > 2$, but multiplying both sides by -1 gives $-3 < -2$. This is why Rule 2 requires reversing the inequality sign whenever both sides are multiplied or divided by a negative quantity.

How do you solve a word problem based on linear inequalities?

First, identify the unknown quantity and assign it a variable (usually x). Then translate the given condition into an inequality using the correct symbol for phrases such as “at least” (≥), “at most” (≤), “more than” (>), or “less than” (<). Solve the resulting inequality using the standard rules, and finally interpret the solution set in the context of the original problem (for example, rounding to a sensible whole number where the situation demands it).