

Linear Inequalities: practice solutions, Grade 9 – download the PDF

Written solutions to the chapter problems. Check each step, then correct yourself.

1

Words to symbols



Match each phrase to a symbol: “at least” and “minimum” mean $\geq$; “fewer than” and “more than” are strict; “no more than” and “at most” mean $\leq$.

a. $x \geq 18$

b. $x < 12$

c. $x \leq 40$

d. $x > 7$

e. $x \leq 9$

f. $x \geq 5$

2

Testing solutions



Substitute each number.

- $x = 5$: $3(5) - 4 = 11$, and $11 < 11$ is false.
- $x = 4$: $8 < 11$, true.
- $x = 6$: $14 < 11$, false.
- $x = -2$: $-10 < 11$, true.

The solutions are 4 and -2 . (In fact, solving gives $x < 5$.)

3

One-step inequalities



- Subtract 7: $x \leq 5$.
- Add 4: $x > 3$.
- Divide by 6: $x < 9$.
- Multiply by 5: $x \geq 15$.

No sign changes, because we only used positive numbers.

4

Flip the sign



In every part we divide or multiply by a negative number, so the sign reverses.

- $x > -6$
- $x \leq -5$
- Multiply by -4 : $x < -8$.
- $x \geq 3$

Check (a) with $x = 0$: $0 < 18$, true, and 0 is greater than -6 .

5 Reading a graph

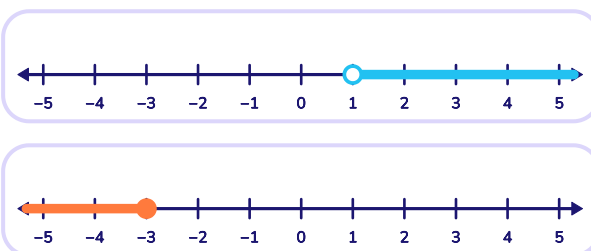


The first graph has a closed circle at -2 and shading to the right: $x \geq -2$. The second has an open circle at 3 and shading to the left: $x < 3$.

6 Drawing graphs



(a) Open circle at 1 , shade to the right. (b) Closed circle at -3 , shade to the left.



7 Two-step inequalities



- a. $2x > 8$, so $x > 4$.
- b. $5x \leq 25$, so $x \leq 5$.
- c. $\frac{x}{3} < 4$, so $x < 12$.
- d. $4x \geq -12$, so $x \geq -3$.

8 Variables on both sides



- a. Subtract $2x$: $3x - 7 > 8$. Add 7: $3x > 15$. So $x > 5$.
- b. Distribute: $3x + 12 \leq 2x + 9$. Subtract $2x$: $x + 12 \leq 9$. So $x \leq -3$.
- c. Subtract $4x$: $7 - 6x \geq 25$. Subtract 7: $-6x \geq 18$. Divide by -6 and flip: $x \leq -3$.
Check $x = -3$: both sides equal 13.

9 All numbers or none

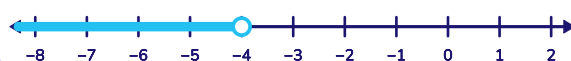


- a. Distribute: $2x + 6 > 2x + 1$. Subtract $2x$: $6 > 1$, which is always true. **All real numbers** are solutions.
- b. Subtract $3x$: $-5 \leq -8$, which is false. **No solution**.
- c. Subtract x : $5 \geq 5$, always true. **All real numbers**.

10 Spot the error



The student divided by a negative number without reversing the sign. Correct: $-2x > 8$ gives $x < -4$. Check $x = -5$: $10 + 1 = 11 > 9$, true; check $x = 0$: $1 > 9$, false.



11 Compound with and



- a. Add 1 to every part: $-6 < 3x \leq 12$. Divide by 3: $-2 < x \leq 4$
- b. Divide every part by -2 , reverse both signs, and reverse the order: $-2 \geq x > -5$, i.e. $-5 < x \leq -2$

12 Compound with or



- a. $x < -2$ or $x \geq 7$.
- b. $2x > 6$ gives $x > 3$; $-x \geq 1$ gives $x \leq -1$. So $x \leq -1$ or $x > 3$.



13 Absolute value equations



- a. $x = 8$ or $x = -8$.
- b. $x + 3 = 5$ gives $x = 2$; $x + 3 = -5$ gives $x = -8$.
- c. $3x - 6 = 12$ gives $x = 6$; $3x - 6 = -12$ gives $x = -2$.
- d. An absolute value cannot equal -4 , so there is **no solution**.

14 Absolute value inequalities



- a. $\sqrt{-6}$
- b. $x \leq -4$ or $x \geq 4$.
- c. $-3 \leq x - 2 \leq 3$, so $-1 \leq x \leq 5$.
- d. $x + 1 > 2$ gives $x > 1$; $x + 1 < -2$ gives $x < -3$. So $x < -3$ or $x > 1$.

15 School supplies budget



Let n be the number of notebooks. Then $22.50 + 3.75n \leq 60$. Subtract 22.50:

$3.75n \leq 37.50$. Divide by 3.75: $n \leq 10$.

Mia can buy **at most 10 notebooks**. Check: $22.50 + 37.50 = 60$, exactly her budget.

16 Fractions and decimals



- a. Multiply every term by 12: $4(2x - 1) - 3(x + 2) \geq 12$. Expand:
 $8x - 4 - 3x - 6 \geq 12$, so $5x - 10 \geq 12$, $5x \geq 22$, $x \geq 4.4$.
- b. Multiply by 10: $\sqrt{4x+12}$

17 Harder absolute equations



- a. Subtract 4 and divide by 3: $|2x - 1| = 5$. Then $2x - 1 = 5$ gives $x = 3$; $2x - 1 = -5$ gives $x = -2$.
- b. Two expressions have the same absolute value when they are equal or opposites.
Case 1: $3x - 2 = x + 6$, so $x = 4$. Case 2: $3x - 2 = -(x + 6)$, so $4x = -4$ and $x = -1$. Check: $|10| = |10|$ and $|-5| = |5|$.
- c. $5 - 2x = 7$ gives $x = -1$; $5 - 2x = -7$ gives $x = 6$.

18 Harder absolute inequalities



- a. $2|x - 4| < 8$, so $|x - 4| < 4$. Then $-4 < x - 4 < 4$, so $0 < x < 8$.
- b. Divide by -3 and flip: $|x + 1| \geq 4$. Then $x + 1 \geq 4$ gives $x \geq 3$; $x + 1 \leq -4$ gives $x \leq -5$. So $x \leq -5$ or $x \geq 3$.
- c. Add 5: $|4x - 3| > 5$. Then $4x - 3 > 5$ gives $x > 2$; $4x - 3 < -5$ gives $x < -\frac{1}{2}$. So $x < -0.5$ or $x > 2$.

19 Bottle tolerance



- (a) $|v - 500| \leq 6$.
- (b) $-6 \leq v - 500 \leq 6$, so $494 \leq v \leq 506$.
- (c) 507 is greater than 506, so the bottle is **not** acceptable.
- (d) $494 \times 0.0338 \approx 16.7$ and $506 \times 0.0338 \approx 17.1$, so about 16.7 to 17.1 fluid ounces.

20 Reaching a test average



The sum of the first four is $82 + 90 + 78 + 88 = 338$. We need $\frac{338 + s}{5} \geq 85$. Multiply by 5: $338 + s \geq 425$, so $s \geq 87$. Since scores cannot exceed 100: $87 \leq s \leq 100$.

Jordan needs a score **between 87 and 100**.

21 Bakery profit



Let m be the number of muffins. Profit is revenue minus costs:

$2.75m - (1.10m + 120) \geq 300$. Simplify: $1.65m - 120 \geq 300$, so $1.65m \geq 420$ and $m \geq 254.5 \dots$

Because m must be a whole number, the bakery must sell **at least 255 muffins**. Check: 254 muffins give $1.65 \times 254 = 419.10 < 420$; 255 give $420.75 \geq 420$.

22 Comparing two plans



Let m be the number of movies. Plan B is cheaper when $4 + 1.6m < 12$. Subtract 4: $1.6m < 8$. Divide by 1.6: $m < 5$.

(a) Plan B is cheaper for fewer than 5 movies, i.e. 0, 1, 2, 3, or 4 movies. (b) At $m = 5$: $4 + 8 = 12$, so the prices are equal.



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