

How to use this worksheet. Thirty questions, about 35 minutes. Dividing by a **negative** number reverses the sign. Then read the last few words: "where x is a natural number" can turn a good algebraic answer into **no solution**.

Formula sheet

Adding or subtracting keeps the sign | Multiplying or dividing by a negative number reverses it
 $|x| < a \Rightarrow -a < x < a$ | $|x| > a \Rightarrow x < -a$ or $x > a$ ($a > 0$)

For a quotient, mark where numerator and denominator vanish, then test each interval
[] includes the endpoint | () excludes it | natural numbers start at 1

Section A · Level 1 — Rules, notation and number lines

Ten questions. None should take more than twenty seconds.

- The solution of the inequality $2x + 3 < 7$ is:
 (1) $x < 2$ (2) $x > 2$ (3) $x \leq 2$ (4) $x \geq 2$
- When both sides of an inequality are multiplied by a negative number, the inequality sign:
 (1) Stays the same (2) Reverses (3) Becomes an equality (4) Disappears
- The solution of $-3x \geq 9$ is:
 (1) $x \geq 3$ (2) $x \leq 3$ (3) $x \geq -3$ (4) $x \leq -3$
- The solution set of $|x| < 5$ is:
 (1) $x < 5$ (2) $x > -5$ (3) $-5 < x < 5$ (4) $x < -5$ or $x > 5$
- The solution set of $|x| > a$, where a is positive, is:
 (1) $-a < x < a$ (2) $x < -a$ or $x > a$ (3) $x > a$ only (4) No solution
- In interval notation, a square bracket means the endpoint is:
 (1) Excluded (2) Included (3) Infinite (4) Negative
- On a number line, the solution $x > 3$ is shown by:
 (1) A filled circle at 3 with shading to the right (2) An open circle at 3 with shading to the right (3) A filled circle at 3 with shading to the left (4) An open circle at 3 with shading to the left
- The region represented by $x \geq 0$ and $y \geq 0$ is:
 (1) The first quadrant (2) The second quadrant (3) The third quadrant (4) The whole plane
- The graph of the inequality $x + y \leq 4$ is:
 (1) The line $x + y = 4$ only (2) The half plane above the line, excluding it (3) The half plane containing the origin, including the line (4) The whole plane
- If $a < b$ and c is negative, then:
 (1) $ac < bc$ (2) $ac > bc$ (3) $ac = bc$ (4) Nothing can be said

Working space — Questions 1 to 10

Write the formula before you substitute.

Section B · Level 2 — Solving linear and modulus inequalities

Nine questions. Watch the sign whenever you divide by a negative number.

- The solution of $5x - 3 < 3x + 1$ is:
 (1) $x < 2$ (2) $x > 2$ (3) $x < -2$ (4) $x > -2$

12. The solution of $3(x - 1) \leq 2(x - 3)$ is:

- (1) $x \leq 3$ (2) $x \geq 3$ (3) $x \leq -3$ (4) $x \geq -3$

13. The solution of $4x + 3 < 6x + 7$ is:

- (1) $x < -2$ (2) $x > -2$ (3) $x < 2$ (4) $x > 2$

14. The solution of $2 \leq 3x - 4 \leq 8$ is:

- (1) $[2, 4]$ (2) $(2, 4)$ (3) $[-2, 4]$ (4) $[2, 12]$

15. The solution of $-12 < 4 - 3x \leq 2$ is:

- (1) $(2/3, 16/3)$ (2) $[2/3, 16/3]$ (3) $(2/3, 16/3]$ (4) $[2/3, 16/3]$

16. The solution of $|x - 3| > 2$ is:

- (1) $1 < x < 5$ (2) $x < 1$ or $x > 5$ (3) $x < -1$ or $x > 5$ (4) $-1 < x < 5$

17. The solution of $|2x - 1| \leq 5$ is:

- (1) $[-2, 3]$ (2) $[-3, 2]$ (3) $[2, 3]$ (4) $[-2, 2]$

18. The solution of $3x - 2 \leq 7$, where x is a natural number, is:

- (1) $\{1, 2, 3\}$ (2) $\{0, 1, 2, 3\}$ (3) $\{1, 2, 3, 4\}$ (4) All $x \leq 3$

19. The solution of $7x + 3 < 5x + 9$, where x is a natural number, is:

- (1) $\{1, 2\}$ (2) $\{1, 2, 3\}$ (3) $\{0, 1, 2\}$ (4) No solution

Working space — Questions 11 to 19 Write the formula before you substitute.

Section C · Level 3 — Systems, quotients and integer solutions

Six questions. Check whether the endpoints belong to the solution set.

20. The solution of the system $x + 3 > 0$ and $2x < 8$ is:

- (1) $(-3, 4)$ (2) $[-3, 4]$ (3) $(-\infty, 4)$ (4) $(-3, \infty)$

21. The number of integer solutions of $|x| \leq 3$ is:

- (1) 3 (2) 6 (3) 7 (4) Infinite

22. If $x > 0$ and $1/x < 1/3$, then:

- (1) $x < 3$ (2) $x > 3$ (3) $0 < x < 3$ (4) $x < -3$

23. The solution of $(x - 1) / (x + 2) \geq 0$ is:

- (1) $[-2, 1]$ (2) $(-\infty, -2) \cup [1, \infty)$ (3) $(-2, 1]$ (4) $[1, \infty)$

24. A quotient inequality such as $(x - a) / (x - b) \geq 0$ should never be solved by:

- (1) Testing intervals (2) Marking the critical points on a number line (3) Cross-multiplying by the denominator (4) Checking the sign of each factor

25. The feasible region of a system of linear inequalities is:

- (1) The union of all the half planes (2) The intersection of all the half planes (3) The boundary lines only (4) Always unbounded

Working space — Questions 20 to 25 Write the formula before you substitute.

Section D · Previous year questions — Straight from the AAI ATC papers

Five questions from the 2023 papers, recovered by optical character recognition of the scanned answer sheets and independently re-solved with a computer algebra system.

26. Which of the following is the solution of the given inequality, $8x + 2 \geq 2x + 14$, where x is a real number?

[PYQ 2023 · Morning]

(1) $(2, \infty)$ (2) $(-\infty, \infty)$ (3) $[2, \infty)$ (4) $[-2, 2]$

27. Which of the following is the solution of the given inequality $6x + 7 < x - 28$, where x is a natural number?

[PYQ 2023 · Morning]

(1) No solution (2) $x \geq 5$ (3) $x < -5$ (4) $x \geq 3$

28. A company manufactures educational toys. Its cost equation for a week is $C = 300 + 1.5x$ and its revenue equation is $R = 2x$, where x is the number of toys sold in a week. How many toys must be sold per week so that the company realises a profit? [PYQ 2023 · Morning]

(1) More than 750 (2) More than 900 (3) More than 825 (4) More than 600

29. If $|x - 4| / (x - 4) \geq 0$, then: [PYQ 2023 · Evening]

(1) $x \in (4, \infty)$ (2) $x \in [4, \infty)$ (3) $x \in (-\infty, 4)$ (4) $x \in (-\infty, 4]$

30. If x satisfies $|x - 2| + |x - 4| + |x - 9| \leq 15$, then: [PYQ 2023 · Evening]

(1) $x < 0$ or $x > 10$ (2) $0 < x < 10$ (3) $x > 0$ or $x < 10$ (4) $0 \leq x \leq 10$

Working space — Questions 26 to 30 Write the formula before you substitute.

Stuck on any of these? Bring them to a live class.

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