

# Systems of Linear Inequalities

Name: \_\_\_\_\_

Date: \_\_\_\_\_

Score: \_\_\_\_\_ / 30

## Q Quick Review

A **system of linear inequalities** asks for points that satisfy *all* the inequalities at once. **Graphing:** graph each inequality as a half-plane (solid line for  $\leq$  /  $\geq$ , dashed for  $<$  /  $>$ ; shade the side where the inequality is true). The solution to the system is the **overlap** of all the shaded regions. To test which side to shade, pick a point not on the boundary (often  $(0, 0)$  if the line doesn't pass through it) and check whether it satisfies the inequality. If yes, shade that side; if no, shade the other. The solution region often has corner points called **vertices** — these are important in real-world optimization problems (linear programming).

## PRACTICE

Test points or describe solutions.

1. Is  $(0, 0)$  in  $y > x$ ? \_\_\_\_\_

2. Is  $(0, 0)$  in  $y \geq x$ ? \_\_\_\_\_

3. Is  $(1, 3)$  in  $y > 2x$ ? \_\_\_\_\_

4. Is  $(2, 2)$  in  $y < 3x$ ? \_\_\_\_\_

5. Is  $(0, 5)$  in  $y \leq -x + 4$ ? \_\_\_\_\_

6. Is  $(1, 1)$  in both  $y > 0$  and  $x > 0$ ? \_\_\_\_\_

7. Is  $(-1, 2)$  in both  $y > x$  and  $y < 3$ ? \_\_\_\_\_

8. Solid or dashed for  $y \leq 2x + 1$ ? \_\_\_\_\_

9. Solid or dashed for  $y > 3x$ ? \_\_\_\_\_

10. Shade above or below for  $y > x + 2$ ? \_\_\_\_\_

11. Shade above or below for  $y \leq -x$ ? \_\_\_\_\_

12. Test  $(0, 0)$  in  $3x + 2y < 6$  \_\_\_\_\_

13. Test  $(0, 0)$  in  $y \geq x + 1$  \_\_\_\_\_

14. Is  $(3, 4)$  in  $y \leq x + 5$ ? \_\_\_\_\_



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15. System:  $y > 0, x > 0$ . Solution region?

\_\_\_\_\_

16. Boundary of  $y < 2x - 3$

\_\_\_\_\_

17. Is  $(4, 1)$  in  $y \leq x$ ?

\_\_\_\_\_

18. Is  $(0, -1)$  in  $y \geq -x$ ?

\_\_\_\_\_

19. System:  $y \geq 0, y \leq 4$ . Solution?

\_\_\_\_\_

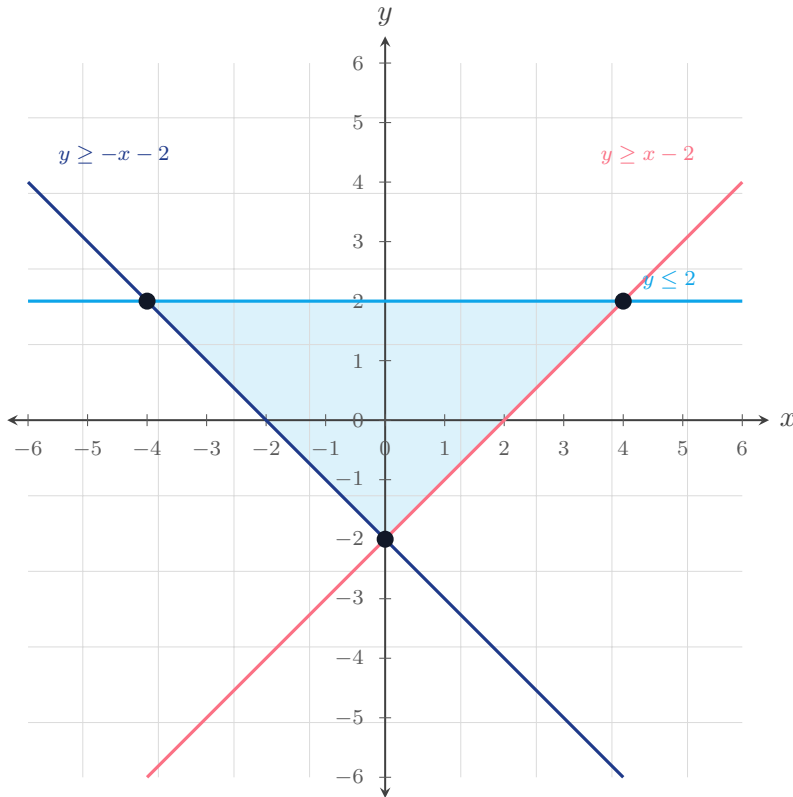
20. Is  $(2, 2)$  in  $y > x - 1$  AND  $y < x + 3$ ?

\_\_\_\_\_

◆ VISUAL PRACTICE

Use the graph, table, chart, or diagram to answer the question.

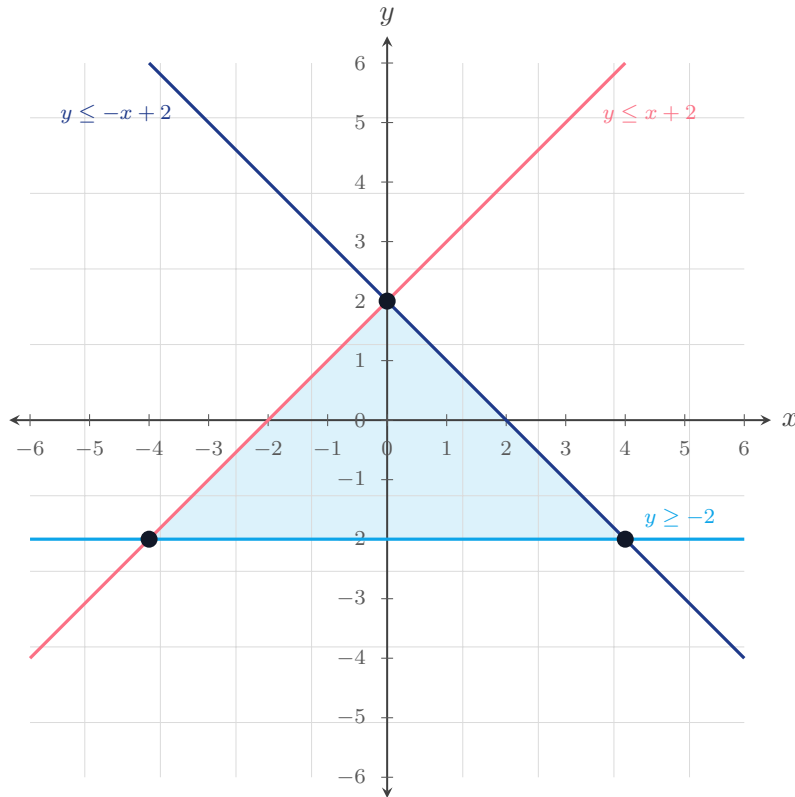
21. List the vertices of the shaded feasible region.



Answer: \_\_\_\_\_



22. List the vertices of the shaded feasible region.



Answer: \_\_\_\_\_

◆ Word Problems

23. A bookstore must sell at least 50 books but no more than 100 per week. Write the system and identify possible  $b$ .

Model: \_\_\_\_\_

Answer: \_\_\_\_\_

24. A diet calls for at most 2000 calories and at least 50 g protein. Let  $c$  = calories,  $p$  = protein. Write the system.

Model: \_\_\_\_\_

Answer: \_\_\_\_\_

25. A factory makes  $x$  chairs (\$20 profit) and  $y$  tables (\$50 profit). Production must satisfy  $x + y \leq 100$  (capacity) and  $x \geq 0, y \geq 0$ . List the corners of the feasible region.

Model: \_\_\_\_\_

Answer: \_\_\_\_\_

26. A student spends at most 20 hours per week on jobs. Job A pays \$10 per hour; Job B pays \$15 per hour. They want at least \$200. Write the system.

Model: \_\_\_\_\_

Answer: \_\_\_\_\_



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**◆ Word Problems**

27. A club can spend no more than \$120 on shirts and hats. Shirts cost \$8 each and hats cost \$5 each. They also want at least 18 items. Write the system.

Model: \_\_\_\_\_

Answer: \_\_\_\_\_

28. A bakery can make at most 60 items. Muffins take 2 minutes each and loaves take 6 minutes each; there are at most 180 minutes available. Write the system.

Model: \_\_\_\_\_

Answer: \_\_\_\_\_

29. A feasibility-region check uses the system  $x + y \leq 15$  and  $3x + 2y \geq 30$ . Determine whether the point  $(6, 8)$  satisfies both inequalities.

Model: \_\_\_\_\_

Answer: \_\_\_\_\_

30. For the feasible region described by  $x \geq 0$ ,  $y \geq 0$ ,  $x + y \leq 12$ , and  $y \leq 2x$ , list the corner points.

Model: \_\_\_\_\_

Answer: \_\_\_\_\_



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## Answer Keys

- |  |  |
|--|--|
| <ol style="list-style-type: none"> <li>1. <input type="text" value="no"/></li> <li>2. <input type="text" value="yes"/></li> <li>3. <input type="text" value="yes"/></li> <li>4. <input type="text" value="yes"/></li> <li>5. <input type="text" value="no"/></li> <li>6. <input type="text" value="yes"/></li> <li>7. <input type="text" value="yes"/></li> <li>8. <input type="text" value="solid"/></li> <li>9. <input type="text" value="dashed"/></li> <li>10. <input type="text" value="above"/></li> <li>11. <input type="text" value="below"/></li> <li>12. <input type="text" value="yes"/></li> <li>13. <input type="text" value="no"/></li> <li>14. <input type="text" value="yes"/></li> <li>15. <input type="text" value="Quadrant I"/></li> </ol> | <ol style="list-style-type: none"> <li>16. <input type="text" value="dashed line &lt;math&gt;y = 2x - 3&lt;/math&gt;"/></li> <li>17. <input type="text" value="yes"/></li> <li>18. <input type="text" value="no"/></li> <li>19. <input type="text" value="horizontal strip"/></li> <li>20. <input type="text" value="yes"/></li> <li>21. <input type="text" value="(-4, 2), (0, -2), (4, 2)"/></li> <li>22. <input type="text" value="(-4, -2), (0, 2), (4, -2)"/></li> <li>23. <input type="text" value="50 ≤ b ≤ 100"/></li> <li>24. <input type="text" value="c ≤ 2000, p ≥ 50"/></li> <li>25. <input type="text" value="(0, 0), (100, 0), (0, 100)"/></li> <li>26. <input type="text" value="a + b ≤ 20, 10a + 15b ≥ 200, a ≥ 0, b ≥ 0"/></li> <li>27. <input type="text" value="8s + 5h ≤ 120, s + h ≥ 18, s ≥ 0, h ≥ 0"/></li> <li>28. <input type="text" value="m + ℓ ≤ 60, 2m + 6ℓ ≤ 180, m ≥ 0, ℓ ≥ 0"/></li> <li>29. <input type="text" value="yes"/></li> <li>30. <input type="text" value="(0, 0), (12, 0), (4, 8)"/></li> </ol> |
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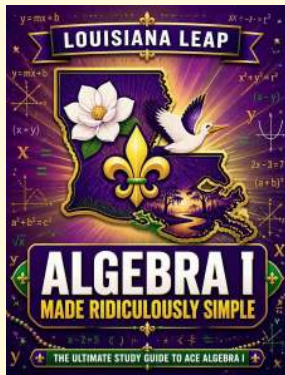
### Step-by-Step Tutor Notes

1. Start with the definition the problem is testing, then apply it directly.  $0 > 0$  is false (not strict). So the answer is no.
2. Start with the definition the problem is testing, then apply it directly.  $0 \geq 0$  is true. So the answer is yes.
3. Focus on the main idea of the problem, then simplify carefully.  $3 > 2(1) = 2$ . True. So the answer is yes.
4. Focus on the main idea of the problem, then simplify carefully.  $2 < 6$ . True. So the answer is yes.
5. Start with the definition the problem is testing, then apply it directly.  $5 \leq 4$ ? No. So the answer is no.
6. This is a good place to slow down, check the notation, and simplify cleanly. Both true. So the answer is yes.
7. This is a good place to slow down, check the notation, and simplify cleanly.  $2 > -1 \checkmark$  and  $2 < 3 \checkmark$ . So the answer is yes.
8. Focus on the main idea of the problem, then simplify carefully.  $\leq$  includes the boundary. So the answer is solid.
9. Focus on the main idea of the problem, then simplify carefully.  $>$  excludes the boundary. So the answer is dashed.
10. Start with the definition the problem is testing, then apply it directly.  $y$  greater than the line means above. So the answer is above.
11. Use the clue in the question first, then let the arithmetic finish the job.  $y$  less than means below. So the answer is below.
12. Focus on the main idea of the problem, then simplify carefully.  $0 < 6 \checkmark$ . Shade origin side. So the answer is yes.
13. This is a good place to slow down, check the notation, and simplify cleanly.  $0 \geq 1$ ? No. Shade the other side. So the answer is no.
14. Take it one clear step at a time and keep the original question in mind.  $4 \leq 8 \checkmark$ . So the answer is yes.
15. Take it one clear step at a time and keep the original question in mind. Both positive — first quadrant. So the answer is Quadrant I.
16. Take it one clear step at a time and keep the original question in mind. Strict inequality  $\rightarrow$  dashed. So the answer is dashed line  $y = 2x - 3$ .
17. This is a good place to slow down, check the notation, and simplify cleanly.  $1 \leq 4 \checkmark$ . So the answer is yes.
18. Focus on the main idea of the problem, then simplify carefully.  $-1 \geq 0$ ? No. So the answer is no.
19. This is a good place to slow down, check the notation, and simplify cleanly.  $0 \leq y \leq 4$  for any  $x$ . Strip between two horizontal lines. So the answer is horizontal strip.
20. Take it one clear step at a time and keep the original question in mind.  $2 > 1 \checkmark$  and  $2 < 5 \checkmark$ . So the answer is yes.
21. The shaded overlap is a triangle. Its corner points are  $(-4, 2)$ ,  $(0, -2)$ , and  $(4, 2)$ .
22. The shaded overlap is bounded by three lines. Its vertices are  $(-4, -2)$ ,  $(0, 2)$ , and  $(4, -2)$ .
23. "At least 50" is  $b \geq 50$ , "no more than 100" is  $b \leq 100$ . Combined:  $50 \leq b \leq 100$ .
24. Two separate constraints. Solution region is the overlap of two half-planes. With a nonnegative context, the feasible region is unbounded, not a rectangle.
25. Triangle with vertices at the axis intercepts and the origin. (For max profit, you'd check each vertex;  $y = 100$  tables gives \$5000, the best.)
26. Use the given numbers to build the model, then finish the calculation. Capacity, income, and non-negativity. Feasible region is bounded by these four inequalities.
27. The budget gives  $8s + 5h \leq 120$ . The item goal gives  $s + h \geq 18$ . Counts cannot be negative.
28. Name the quantities first so the model is easy to read. Capacity limits total items. Time limits total minutes. Both variables must be nonnegative.
29. Check both:  $6 + 8 = 14 \leq 15$  and  $3(6) + 2(8) = 34 \geq 30$ . Since both are true, the point is feasible.
30. The axes give  $(0, 0)$  and  $(12, 0)$ . The slanted boundaries meet where  $y = 2x$  and  $x + y = 12$ , so  $3x = 12$ ,  $x = 4$ , and  $y = 8$ .



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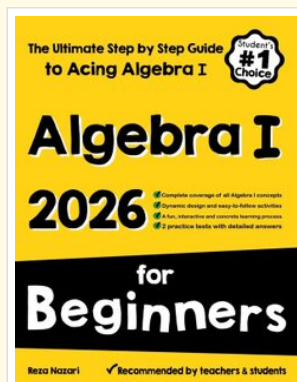
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