Transforming Linear Functions

Name: _____	Date: _____	Score: _____ / 56

Quick Review

Start with the **parent line** $f(x) = x$ (slope 1, through the origin). Four transformations stretch, flip, or slide it. **Vertical shift**: $f(x) + k$ moves the line up by k (down if $k < 0$) — this changes the y-intercept. **Horizontal shift**: $f(x - h)$ moves the line right by h ("opposite of what you'd guess"). **Vertical stretch/compression**: $a \cdot f(x)$ multiplies the slope by a. If $|a| > 1$ the line gets steeper; if $0 < |a| < 1$ it flattens. **Reflection**: a negative a reflects the line across the x-axis (slope flips sign). For lines, horizontal stretches by $f(bx)$ also change the slope (multiply by b); they look like vertical stretches because every line can be rewritten in either language. The big idea: transformations on $y = x$ just give you $y = mx + b$ in disguise — a stretch sets the slope, a shift sets the intercept.

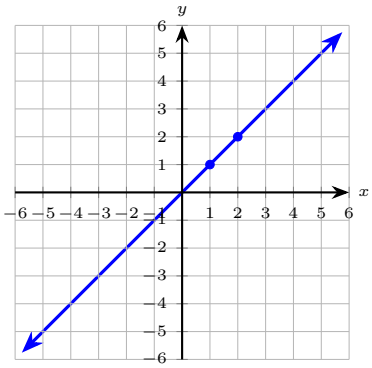
PRACTICE

Apply each transformation. Write the new function in $y = mx + b$ form.

1. $f(x) = x$; shift up 4 _____

2. $f(x) = x$; shift right 3 _____

3. The parent line $f(x) = x$ is graphed below. Apply a vertical stretch by 2 and write the new function in $y = mx + b$ form. _____



4. $f(x) = x$; reflect over the x-axis. _____

5. $f(x) = x$; shift down 5 then stretch by 3. _____

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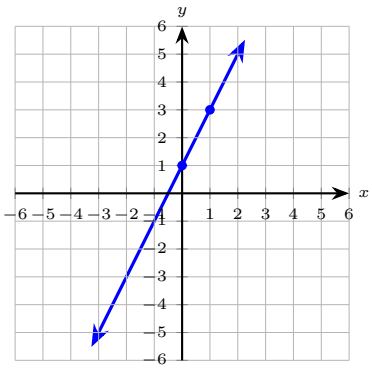
6. The line $f(x) = 2x + 1$ is graphed below. Shift it up 3 units and write the new function in $y = mx + b$ form. _____

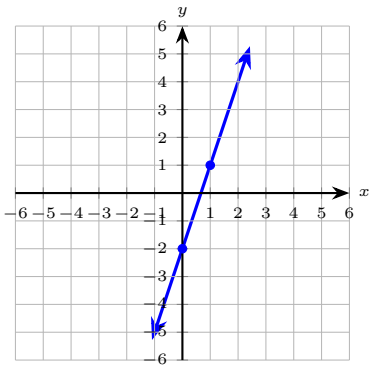


7. $f(x) = 2x + 1;$ shift left 2 _____

8. $f(x) = -x + 3$; reflect over the x-axis. _____

9. $f(x) = x$; shift right 4 and up 2. _____

10. The line $f(x) = 3x - 2$ is graphed below. Shift it down 4 units and write the new function in $y = mx + b$ form. _____



11. $f(x) = x;$ vertical compression by factor $\frac{1}{2}$ _____

12. $f(x) = 4x;$ shift right 1 _____

13. $f(x) = -2x + 5$; shift up 1 and left 3. _____

14. $f(x) = x + 2;$ stretch vertically by 2 _____

15. Find the parent transformation: $y = \frac{1}{3}x - 7$ _____

16. If $g(x) = f(x) + 3$ and $f(x) = 2x - 1$, find $g(x)$. _____

17. If $g(x) = f(x - 2)$ and $f(x) = 3x + 1$, find $g(x)$. _____

18. Slope of $5 \cdot f(x)$ where $f(x) = x + 9$. _____

19. y-intercept of $f(x) + 2$ where $f(x) = 4x - 3$. _____

20. If $g(x) = -f(x)$ and $f(x) = -2x + 6$, find $g(x)$. _____

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Word Problems

21. Field-trip cost is $C(n) = 12n + 50$. The booster club covers $\$25$ of the fixed cost. Write the new cost function as a transformation of C. ____

22. A driver's pay is $P(h) = 20h$. The company adds a $\$15$ daily stipend. Write the new pay function and name the transformation. ____

23. A trail's elevation gain is $E(t) = 8t$. A hiker starts 200 feet above the zero mark. Write the new elevation function. ____

24. A taxi fare is $f(m) = 2.5m + 3$. A surcharge doubles the per-mile rate but keeps the pickup fee. Write the new fare. ____

Additional Practice

25. $f(x) = x$; shift down 6 _____

26. $f(x) = x$; vertical stretch by 4 _____

27. $f(x) = 2x - 3$; shift up 5 _____

28. $f(x) = 3x + 2$; shift right 2 _____

29. $f(x) = -x + 4$; reflect over the x-axis _____

30. $f(x) = x + 5$; vertical compression by $\frac{1}{2}$ _____

31. $f(x) = 4x - 1$; shift left 3 _____

32. $f(x) = 2x + 7$; shift down 7 _____

33. $f(x) = x$; shift left 5 and up 1 _____

34. $f(x) = 5x$; shift right 4 _____

35. $f(x) = -3x + 2$; shift down 4 _____

36. $f(x) = x - 8$; reflect over the x-axis _____

37. $g(x) = f(x) + 6,\ f(x) = 3x - 10$ _____

38. $g(x) = f(x - 1),\ f(x) = 2x + 9$ _____

39. $g(x) = -f(x),\ f(x) = 4x - 6$ _____

40. $g(x) = 3f(x),\ f(x) = x - 2$ _____

41. $f(x) = \frac{1}{2}x + 4$; shift right 6 _____

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42. $f(x) = 6x - 5$; vertical compression by $\frac{1}{3}$ _____

43. $f(x) = x$; reflect, then shift up 9 _____

44. $f(x) = 2x + 3$; shift left 1 and down 5 _____

45. $f(x) = x + 1$; shift right 8 _____

46. $f(x) = 3x$; shift left 2 and up 4 _____

47. $f(x) = -2x + 1$; shift right 3 _____

48. $f(x) = 5x + 2$; shift down 9 _____

49. $f(x) = x - 4$; vertical stretch by 5 _____

50. $g(x) = f(x + 4),\ f(x) = x - 6$ _____

51. $g(x) = f(x) - 8,\ f(x) = -x + 2$ _____

52. $g(x) = 2f(x),\ f(x) = 3x + 1$ _____

53. $f(x) = \frac{1}{4}x - 3$; shift up 6 _____

54. $f(x) = x$; vertical compression by $\frac{3}{4}$ _____

55. $f(x) = 2x - 1$; reflect over the x-axis _____

56. $f(x) = 7x$; shift right 1 and down 2 _____

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Answer Keys

1. $y = x + 4$
2. $y = x - 3$
3. $y = 2x$
4. $y = -x$
5. $y = 3x - 15$
6. $y = 2x + 4$
7. $y = 2x + 5$
8. $y = x - 3$
9. $y = x - 2$
10. $y = 3x - 6$
11. $y = \frac{1}{2}x$
12. $y = 4x - 4$
13. $y = -2x$
14. $y = 2x + 4$
15. compress by $\frac{1}{3}$, shift down 7
16. $g(x) = 2x + 2$
17. $g(x) = 3x - 5$
18. 5
19. $(0, -1)$
20. $g(x) = 2x - 6$
21. $C_{\text{new}}(n) = 12n + 25$
22. $P_{\text{new}}(h) = 20h + 15$; vertical shift up by 15
23. $E_{\text{new}}(t) = 8t + 200$
24. $f_{\text{new}}(m) = 5m + 3$

Additional Practice Answers

25. $y = x - 6$
26. $y = 4x$
27. $y = 2x + 2$
28. $y = 3x - 4$
29. $y = x - 4$
30. $y = \frac{1}{2}x + \frac{5}{2}$
31. $y = 4x + 11$
32. $y = 2x$
33. $y = x + 6$
34. $y = 5x - 20$
35. $y = -3x - 2$
36. $y = -x + 8$
37. $g(x) = 3x - 4$
38. $g(x) = 2x + 7$
39. $g(x) = -4x + 6$
40. $g(x) = 3x - 6$
41. $y = \frac{1}{2}x + 1$
42. $y = 2x - \frac{5}{3}$
43. $y = -x + 9$
44. $y = 2x$
45. $y = x - 7$
46. $y = 3x + 10$
47. $y = -2x + 7$
48. $y = 5x - 7$
49. $y = 5x - 20$
50. $g(x) = x - 2$
51. $g(x) = -x - 6$
52. $g(x) = 6x + 2$
53. $y = \frac{1}{4}x + 3$
54. $y = \frac{3}{4}x$
55. $y = -2x + 1$
56. $y = 7x - 9$

Additional Practice: Answers for all numbered items, including the added practice, are shown in the grid above.

Step-by-Step Explanations

1. A vertical shift up adds to the *output*, so compute $f(x) + 4 = x + 4$. The slope stays 1; only the y-intercept moves from 0 up to 4.
2. Keep the rule visible: $f(x - 3) = (x - 3)$. The -3 inside is the sneaky part — right shifts *subtract* inside the function. That gives a quick check on the answer.
3. Multiply the output by 2: $2f(x) = 2x$. The slope doubles from 1 (the line you see) to 2, so the stretched line is twice as steep through the origin.
4. Start with the key idea: Multiply the output by -1: $-f(x) = -x$. The slope flips from 1 to -1. That gives a quick check on the answer.
5. A careful way to see it: $f(x) - 5 = x - 5$. Then stretch: $3(x - 5) = 3x - 15$. (Order matters — stretching after the shift multiplies the shift constant too.) That gives a quick check on the answer.
6. Add 3 to the output: $2x + 1 + 3 = 2x + 4$. The slope stays 2 (same steepness as the graph); only the intercept slides up from 1 to 4.
7. One steady path is: Replace x with $x+2$: $2(x+2)+1 = 2x+4+1 = 2x+5$. (Left shift means $+2$ inside.) That gives a quick check on the answer.
8. Flip the sign of the whole output: $-(-x + 3) = x - 3$. Both the slope and the intercept change sign.
9. A careful way to see it: $f(x - 4) + 2 = (x - 4) + 2 = x - 2$. (Two shifts on the parent line collapse into a single new intercept.) That gives a quick check on the answer.
10. Keep the rule visible: $f(x) - 4 = 3x - 2 - 4 = 3x - 6$. The slope stays 3 (the graph's steepness is unchanged); the intercept drops from -2 to -6. That gives a quick check on the answer.
11. One steady path is: Multiply the output by $\frac{1}{2}$. Slope goes from 1 to $\frac{1}{2}$ — a gentler climb. That gives a quick check on the answer.
12. Start with the key idea: $f(x - 1) = 4(x - 1) = 4x - 4$. (The horizontal shift gets multiplied by the slope.) That gives a quick check on the answer.
13. A careful way to see it: $f(x+3)+1 = -2(x+3)+5+1 = -2x-6+6 = -2x$. (The shifts cancel the constant exactly — that happens when the numbers line up.) That gives a quick check on the answer.
14. Keep the rule visible: $2f(x) = 2(x+2) = 2x+4$. Both pieces double. This is the part to check before moving on, because it keeps the answer tied to the original question.
15. Read the function as two transformations of $y = x$. The coefficient $\frac{1}{3}$ (between 0 and 1) is a vertical compression, giving $y = \frac{1}{3}x$; the -7 on the end shifts the whole line down 7.

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16. Adding 3 shifts the output up. Substitute f: $g(x) = (2x - 1) + 3 = 2x + 2$. Slope unchanged, intercept up by 3.
17. A careful way to see it: $f(x-2)$ replaces every x in f with $x-2$: $3(x-2)+1$. Distribute the 3: $3x - 6 + 1 = 3x - 5$. (The inside shift gets multiplied by the slope — a common slip is to forget to distribute.) That gives a quick check on the answer.
18. Multiplying the output by 5 stretches the line: $5(x + 9) = 5x + 45$. The coefficient of x is the slope, so the new slope is 5 (five times steeper than f).
19. Shift the output up 2: $f(x) + 2 = (4x - 3) + 2 = 4x - 1$. The y-intercept is the constant term, -1, written as the point $(0, -1)$.
20. The negative reflects f over the x-axis, flipping the sign of *every* term: $-(-2x + 6) = 2x - 6$. Slope goes from -2 to 2 and the intercept from 6 to -6.
21. The booster club shifts the cost down by 25: $C_{\text{new}}(n) = C(n) - 25 = 12n + 50 - 25 = 12n + 25$. The per-student rate is unchanged; only the intercept moves.
22. Add 15 to the output. The slope (pay rate) stays at $\$20$/hr; the intercept jumps from 0 to 15. Geometrically, the whole line rises by 15.
23. Shift up by 200. New function: $8t + 200$. The line is parallel to the original (same slope of 8 ft/min) but starts higher.
24. Doubling the per-mile rate stretches the slope component without touching the intercept. New function: $5m + 3$. (Note this is *not* simply $2f(m)$, since that would also double the $\$3$ pickup fee — the question keeps the pickup constant.)

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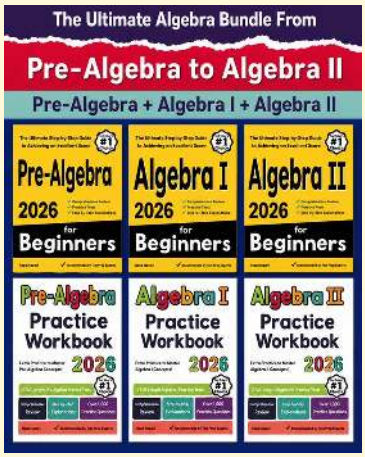

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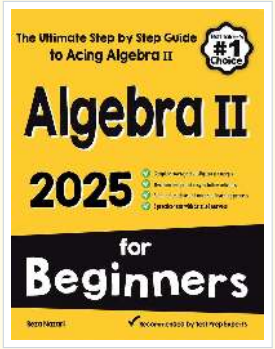

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