Transformations of Parent Functions

Name: _____	Date: _____	Score: _____ / 30

Quick Review

Every common function family is built from a **parent** function (the simplest member) by a chain of transformations. Knowing the four basic moves lets you graph or recognize any transformed function fast.

Vertical shifts. $f(x) + k$ shifts the graph up by k (if $k > 0$) or down by $|k|$ (if $k < 0$). **Horizontal shifts.** $f(x - h)$ shifts *right* by h when $h > 0$, *left* by $|h|$ when $h < 0$. (The sign flip on horizontal shifts is the most common trap — "$x + 3$ shifts left.")

Reflections. $-f(x)$ flips across the x-axis. $f(-x)$ flips across the y-axis.

Vertical stretch/compression. $a \cdot f(x)$ multiplies every output by $|a|$. If $|a| > 1$ the graph is stretched taller; if $0 < |a| < 1$ it's compressed. A negative a also reflects across the x-axis.

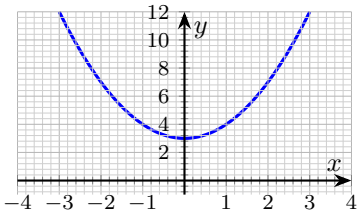
Horizontal stretch/compression. $f(bx)$ multiplies horizontal distances by $\frac{1}{|b|}$. If $|b| > 1$ the graph is compressed horizontally; if $0 < |b| < 1$ it's stretched. Negative b also reflects across the y-axis.

Order matters for combined transformations. For $g(x) = -2(x - 3)^2 + 5$: parent x^2, shift right 3, vertical stretch by 2 and reflect across x-axis, then shift up 5. Vertex moves from $(0, 0)$ to $(3, 5)$; the parabola opens downward.

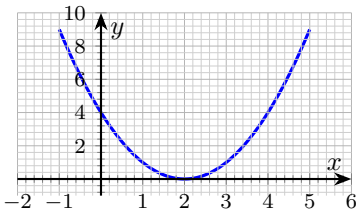
PRACTICE

Apply transformations to identify equations, vertices, and key features.

1. $f(x) = x^2 + 3$ is $y = x^2$ shifted ... (graph below) _____



2. $f(x) = (x - 2)^2$ is $y = x^2$ shifted ... (graph below) _____



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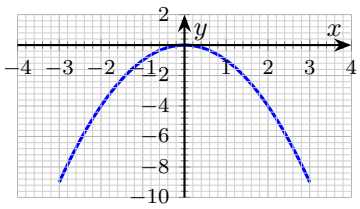
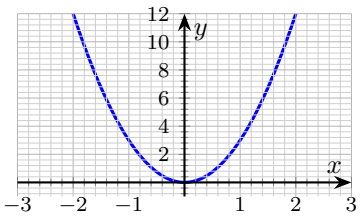
3. $f(x) = -x^2$ is $y = x^2$ reflected over ... (graph below) _____



4. $f(x) = 3x^2$ vs. $y = x^2$ (graph below). Type of transformation? _____



5. Transformations from $y = x^2$ to $f(x) = -2(x+1)^2 - 4$. _____

6. Match: parent $\sqrt{x}$, passes $(0,2), (1,4), (9,8)$. Formula? _____

7. Vertex of $f(x) = -3|x-2| + 5$. _____

8. $f(x) + k$ shifts graph _____

9. $f(x-h)$ shifts graph _____

10. $-f(x)$ reflects graph over _____

11. $f(-x)$ reflects graph over _____

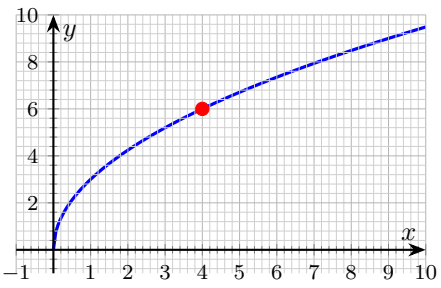
12. Equation: $y = \sqrt{x}$ shifted left 5, down 2. _____

13. Abs-value vertex $(-4, 3)$, opens down, stretch 2. Equation? _____

14. $f(x) = (x+1)^3 - 2$ has parent _____

15. Vertex of $f(x) = 2(x-1)^2 - 3$. _____

16. Sketch hint for $y = \sqrt{x}$ stretched up by 3 (graph below); read the value at $x = 4$. _____



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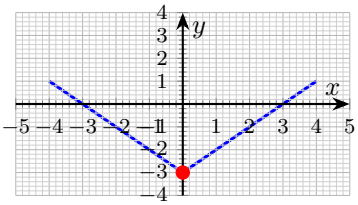
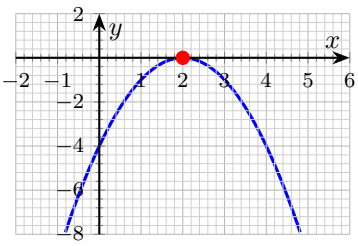
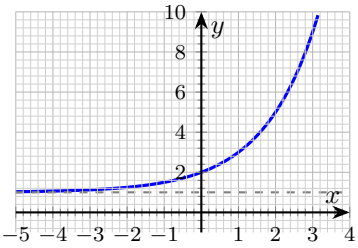
17. For $f(x) = |x| - 3$ (graph below), find the vertex. _____



18. For $f(x) = -(x-2)^2$ (graph below), find the vertex and opening. _____



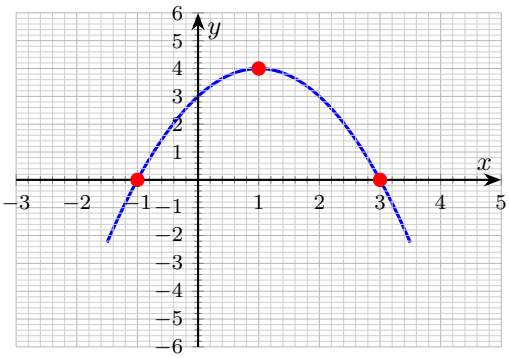
19. For $f(x) = 2^x + 1$ (graph below), state the horizontal asymptote. _____



20. List the transformations from $y = |x|$ to $f(x) = -|x+2| - 1$. _____

♦ Word Problems

21. Sketch $y = -(x-1)^2 + 4$ on the plane below. Label the vertex and intercepts. Then describe the chain of transformations from $y = x^2$. ____



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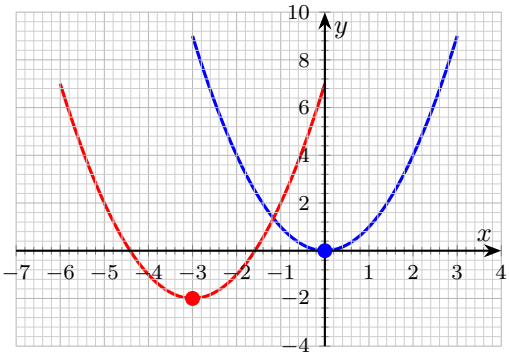
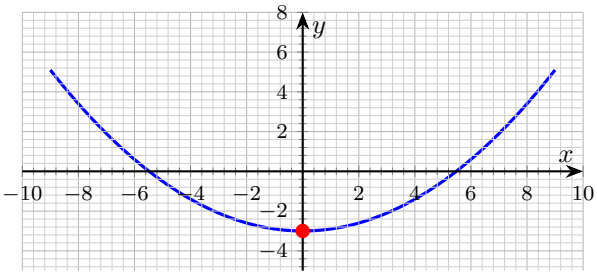
22. For each transformed function in the table, name the parent function and the chain of transformations. _____

Function	Parent	Transformations
$y = (x-4)^2 - 2$	?	?
$y = -2\sqrt{x+1}$	?	?
$y = 3\|x\| - 5$	?	?

23. Compare the graphs of $y = x^2$ and $y = (x+3)^2 - 2$ side by side. Identify the vertex of each, and the shift that takes one to the other. ____



24. A bridge cable hangs along $y = 0.1x^2$ (in some units). To support a flatter version of the cable that hangs 3 units lower at center but otherwise has the same shape, write the new equation. Sketch the new cable. ____



Additional Practice

25. If $f(x) = 2x - 5$, find $f(4)$. _____

26. If $g(x) = x^2 + 1$, find $g(-3)$. _____

27. For $f(x) = 3x + 2$, solve $f(x) = 14$. _____

28. Find $(f+g)(x)$ if $f = x + 1$, $g = 2x - 5$. _____

29. Find $(fg)(x)$ if $f = x - 2$, $g = x + 3$. _____

30. Find $f(g(x))$ if $f(x) = 2x$, $g(x) = x + 7$. _____

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Answer Keys

1.	up 3	**13.**	$y = -2\|x + 4\| + 3$
2.	right 2	**14.**	x^3
3.	x-axis	**15.**	$(1, -3)$
4.	vertical stretch by 3	**16.**	6
5.	L1, stretch 2, reflect over x-axis, down 4	**17.**	$(0, -3)$
6.	$f(x) = 2\sqrt{x} + 2$	**18.**	$(2, 0)$, down
7.	$(2, 5)$	**19.**	$y = 1$
8.	vertically (up if $k > 0$)	**20.**	L2, reflect over x-axis, down 1
9.	horizontally (right if $h > 0$)	**21.**	vertex $(1, 4)$; x-int $-1, 3$
10.	x-axis	**22.**	x^2 : $R4, D2$; $\sqrt{x}$: $L1$, stretch 2, reflect; $\|x\|$: stretch 3, D5
11.	y-axis	**23.**	blue vertex $(0, 0)$; red vertex $(-3, -2)$; shift L3, D2
12.	$y = \sqrt{x + 5} - 2$	**24.**	$y = 0.1x^2 - 3$

Additional Practice Answers

25.	3	**28.**	$3x - 4$
26.	10	**29.**	$x^2 + x - 6$
27.	$x = 4$	**30.**	$2x + 14$

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

Step-by-Step Explanations

1. A constant added *outside* the squaring, $x^2 + 3$, raises every output by 3, so the whole parabola slides up 3. The graph confirms it: the vertex sits at $(0, 3)$ instead of the origin.

2. A change *inside* the squaring, $(x - 2)^2$, shifts horizontally — and the direction is opposite the sign, so $x - 2$ moves the graph right by 2. The vertex lands at $(2, 0)$, as the picture shows.

3. One steady path is: Negative outside flips vertically (over the x-axis). This is the part to check before moving on, because it keeps the answer tied to the original question.

4. Start with the key idea: Coefficient > 1 outside the function stretches outputs. This is the part to check before moving on, because it keeps the answer tied to the original question.

5. Read the transformations off $-2(x + 1)^2 - 4$ piece by piece: $x + 1$ inside shifts left 1 (opposite the sign); the factor 2 stretches vertically by 2; the leading minus reflects across the x-axis (opens downward); the -4 outside shifts down 4.

6. Keep the rule visible: Check: $2\sqrt{0} + 2 = 2$, $2\sqrt{1} + 2 = 4$, $2\sqrt{9} + 2 = 8$. All three points match. That gives a quick check on the answer.

7. In $a|x - h| + k$ the vertex is (h, k). Here $x - 2$ gives $h = 2$ (right 2) and $+5$ gives $k = 5$ (up 5), so the parent's corner at $(0, 0)$ moves to $(2, 5)$. The -3 only flips and stretches; it doesn't move the vertex.

8. Start with the key idea: Outside $+k$ moves the graph up by k. This is the part to check before moving on, because it keeps the answer tied to the original question.

9. A careful way to see it: Inside $x - h$ moves right by h. This is the part to check before moving on, because it keeps the answer tied to the original question.

10. Keep the rule visible: Negative outside the function $\Rightarrow$ vertical flip. This is the part to check before moving on, because it keeps the answer tied to the original question.

11. One steady path is: Negative inside the input $\Rightarrow$ horizontal flip. This is the part to check before moving on, because it keeps the answer tied to the original question.

12. A left shift of 5 goes *inside* the radical with the opposite sign: replace x with $x + 5$. A down shift of 2 goes outside: subtract 2. Combining, $y = \sqrt{x + 5} - 2$.

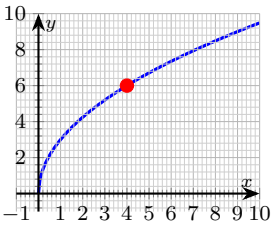
13. Use vertex form $y = a|x - h| + k$ with vertex $(h, k) = (-4, 3)$, so $x - h = x - (-4) = x + 4$ and $k = 3$. "Opens down" makes a negative, and "stretch 2" sets $|a| = 2$, giving $a = -2$. Result: $y = -2|x + 4| + 3$.

14. Keep the rule visible: Cubic family; shifts only. This is the part to check before moving on, because it keeps the answer tied to the original question.

15. Match to vertex form $y = a(x - h)^2 + k$, whose vertex is (h, k). Here $x - 1$ gives $h = 1$ and -3 gives $k = -3$, so the vertex is $(1, -3)$. The leading 2 stretches but leaves the vertex where it is.

16. Start with the key idea: $3\sqrt{4} = 3 \cdot 2 = 6$. The vertical stretch by 3 triples the parent's outputs. That gives a quick check on the answer.

Answer graph



17. A careful way to see it: Parent vertex $(0, 0)$ shifts down 3. This is the part to check before moving on, because it keeps the answer tied to the original question.

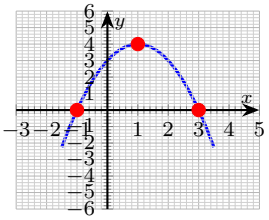
18. Inside $(x - 2)$ shifts right 2, putting the vertex at $(2, 0)$. The leading minus reflects across the x-axis, so the parabola opens downward from that vertex — matching the graph.

19. One steady path is: Parent 2^x has asymptote $y = 0$; shifting up 1 moves it to $y = 1$. That gives a quick check on the answer.

20. Decode $-|x + 2| - 1$ term by term: $x + 2$ inside shifts left 2 (opposite the sign); the leading minus reflects the V across the x-axis so it opens downward; the -1 outside shifts the whole graph down 1.

21. From $y = x^2$: shift right 1 (vertex moves to $(1, 0)$), reflect over the x-axis (parabola now opens downward), shift up 4 (vertex to $(1, 4)$). Set $y = 0$: $(x - 1)^2 = 4 \Rightarrow x = -1$ or 3. Three transformations: shift right, reflect, shift up.

Answer graph



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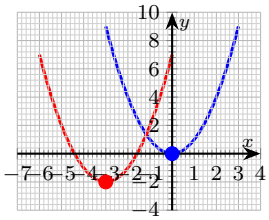
22. Row 1: parent x^2; shift right 4, shift down 2. Row 2: parent $\sqrt{x}$; shift left 1, vertical stretch by 2, reflect across x-axis. Row 3: parent $|x|$; vertical stretch by 3, shift down 5. Read a, h, k off the general form $a \cdot \text{parent}(x - h) + k$, and sign-watch the horizontal shift.

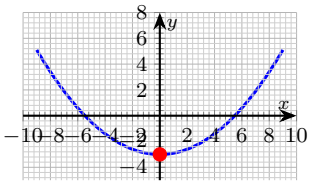
23. Blue is the parent $y = x^2$ with vertex at $(0, 0)$. Red is the transformed parabola with vertex at $(-3, -2)$. The shift left 3 comes from $x + 3$ inside; the shift down 2 from -2 outside. The shape (width and direction of opening) is unchanged — only the position moved.

Answer graph



24. "Same shape, hanging 3 units lower at center" is a pure downward shift by 3, so $y = 0.1x^2 - 3$. Vertex moves from $(0, 0)$ to $(0, -3)$. The width of the curve is unchanged because the coefficient 0.1 in front stays the same.

Answer graph



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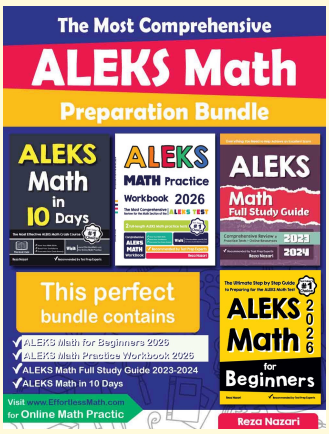

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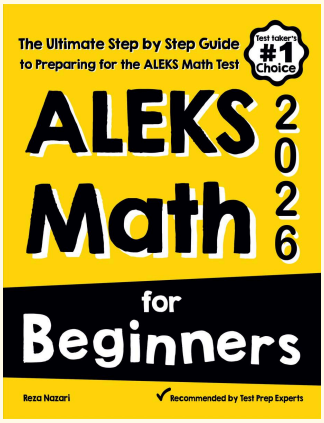

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