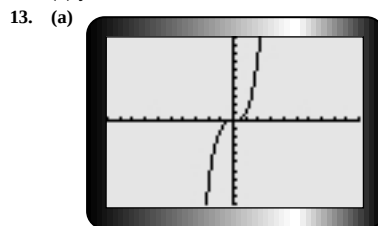


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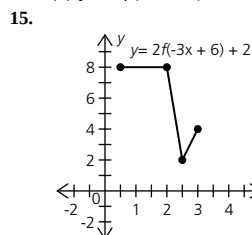
- The “Base Function” determines the shape that is preserved after the transformations. For example, if $f(x) = \sqrt{x}$, then the graph of $y = 3f(x - 2) + 7$ will be the same shape, but will be stretched and translated into a new position. Neither reflections, translations, nor stretches will change the graph’s basic shape.
- (-1, 5), (0, 3), and (1, 7)
- (a) (1, 4), (2, 10), (3, 14), (4, 16)
(b) (1, 4), (2, 7), (3, 9), (4, 10)
(c) (-1, 2), (0, 5), (1, 7), (2, 8)
(d) (0.5, 2), (1, 5), (1.5, 7), (2, 8)
- (b) Multiply x -coordinates of f by 5; subtract 3 from y -coordinates.
(c) $x \rightarrow \boxed{+5} \rightarrow \textcircled{f} \rightarrow \boxed{-3} \rightarrow y$
must be the opposite operation
(d) $g(x) = f\left(\frac{x}{5}\right) - 3$
(e) Divide x -coordinates of g by 5; add 3 to y -coordinates.
(f) $x \rightarrow \boxed{\times 5} \rightarrow \textcircled{g} \rightarrow \boxed{+3} \rightarrow y$
(g) $f(x) = g(5x) + 3$
- (a) no stretches or flips; translate left 2 units and up 3 units.
(b) $x \rightarrow \boxed{+2} \rightarrow \textcircled{f} \rightarrow \boxed{+3} \rightarrow y$
(c) $g(x) = f(x + 2) + 3$
- (a) $x \rightarrow \boxed{-3} \rightarrow \textcircled{f} \rightarrow \boxed{\times 2} \rightarrow y$
(b) Stretch $y = f(x)$ vertically with factor 2, then translate 3 units right (order does not matter).
(c) $f: (-2, 4), (2, 4), (1, 1), (1, -1), (0, 0); y: (5, 8), (4, 2), (1, 8), (3, 0), (2, 2), (5, 8)$
- (a) ii (b) iv (c) x
(d) viii (e) iii (f) i
- (a) ix (b) xii (c) iii (d) xvii
- i. curve in first quadrant down to right through (1, 1), curve in third quadrant down to right through (-1, 1)
ii. (a) f is translated 2 units to the right; (b) f is translated 1 unit left; (c) f is translated up 2 units; (d) f is translated down 6 units; (e) f is stretched vertically with factor 0.5; (f) f is stretched vertically with factor 2; (g) f is stretched horizontally with factor 2; (h) f is stretched horizontally with factor 0.5;
(i) f is reflected in x -axis
iv. (a) $D = \{x \mid x \neq 2, x \in \mathbf{R}\}, R = \{y \mid y \neq 0, y \in \mathbf{R}\}$;
(b) $D = \{x \mid x \neq -1, x \in \mathbf{R}\}, R = \{y \mid y \neq 0, y \in \mathbf{R}\}$;
(c) $D = \{x \mid x \neq 0, x \in \mathbf{R}\}, R = \{y \mid y \neq 2, y \in \mathbf{R}\}$;
(d) $D = \{x \mid x \neq 0, x \in \mathbf{R}\}, R = \{y \mid y \neq -6, y \in \mathbf{R}\}$;
(e) $D = \{x \mid x \neq 0, x \in \mathbf{R}\}, R = \{y \mid y \neq 0, y \in \mathbf{R}\}$;
(f) $D = \{x \mid x \neq 0, x \in \mathbf{R}\}, R = \{y \mid y \neq 0, y \in \mathbf{R}\}$;
(g) $D = \{x \mid x \neq 0\}, R = \{y \mid y \neq 0, y \in \mathbf{R}\}$;
(h) $D = \{x \mid x \neq 0, x \in \mathbf{R}\}, R = \{y \mid y \neq 0, y \in \mathbf{R}\}$;
(i) $D = \{x \mid x \neq 0, x \in \mathbf{R}\}, R = \{y \mid y \neq 0, y \in \mathbf{R}\}$
v. The equations are equivalent.
- (a) $x \rightarrow \boxed{-2} \rightarrow \textcircled{g} \rightarrow \boxed{\times(-3)} \rightarrow \boxed{+1} \rightarrow y$
(b) (6, -47)
(c) Add 2 to x -coordinates: horizontal translation 2 units right; multiply y -coordinates by -3: vertical stretch factor 3 and reflection in x -axis; add 1 y -coordinate: vertical translation, 1 unit up. The horizontal translation can take place at any time, but the vertical stretch and reflection must happen before the vertical translation.

(d) $D = \mathbf{R}; R = \{y \mid y \geq 0, y \in \mathbf{R}\}$; Only horizontal transformations affect the domain, and vertical transformations affect the range. The horizontal translation does not change the domain since it is $\mathbf{R}$. The new domain is $\mathbf{R}$. The reflection in x -axis caused new range to be $\{y \mid y \leq 0, y \in \mathbf{R}\}$. The vertical stretch has no further effect. The vertical translation of +1 gives new $R = \{y \mid y \leq 1, y \in \mathbf{R}\}$.

- (a) -2 (b) (5, -4)
(c) parabola opening up, vertex (3, -4) through (1, 4) and (5, 4)
- (a) bottom half of parabola opening right, vertex (5, -2) through (9, 8)
(b) $y = -3\sqrt{x - 5} - 2$



- (b) $y = (x + 5)^3 + 3$
- (a) $x \leftarrow \boxed{-1} \leftarrow \boxed{x(-1)} \leftarrow \textcircled{f} \rightarrow \boxed{\times 3} \rightarrow \boxed{+2} \rightarrow y$
(b) $y = 3f(-x - 1) + 2$



- (a) $D = \{x \mid x \geq -4, x \in \mathbf{R}\}, R = \{y \mid y < -2, y \in \mathbf{R}\}$
(b) $D = \{x \mid x \leq 4, x \in \mathbf{R}\}, R = \{y \mid y < -1, y \in \mathbf{R}\}$
(c) $D = \{x \mid x \geq -5, x \in \mathbf{R}\}, R = \{y \mid y < 1, y \in \mathbf{R}\}$
(d) $D = \{x \mid x \leq 9, x \in \mathbf{R}\}, R = \{y \mid y > 3, y \in \mathbf{R}\}$
- (b) $y = 0.55\sqrt{x}$
(c) points on left are above; points on right are below curve in (b). It appears that a translation is needed.
(d) $y = 0.46\sqrt{x} + 0.14$
- (a) The order of the two vertical transformations does matter, but the “right 3” translation can be applied at any time, since it has no impact on y -coordinates. If (0, 1) is stretched first to (0, 2) and then translated down, the image is (0, -2); if (0, 1) translated first to (0, -3) and then stretched, the image is (0, -6).
(b) Yes, the horizontal translation could happen at any time.
- (a) Stretch vertically by factor of 3, then stretch horizontally with factor $\frac{1}{2}$, then translate 2 units to right.
(b) Stretch horizontally by factor $\frac{1}{2}$, stretch vertically by factor 3, then translate 2 units right; horizontal stretch by $\frac{1}{2}$, translation right 2 units, vertical stretch by 3.
- (a) Let H_1 represent the first horizontal transformation: a stretch factor $\frac{1}{2}$. Let H_2 represent the second horizontal transformation: translation 1 unit left. Let V_1 represent the first vertical transformation: reflect in x -axis. Let V_2 represent the second vertical transformation: translate 3 units up. Any sequence that keeps H_1 before H_2 and V_1 before V_2 will work.

- All possible sequences are: $H_1, H_2, V_1, V_2; H_1, V_1, H_2, V_2; H_1, V_1, V_2, H_2; V_1, H_1, H_2, V_2; V_1, H_1, V_2, H_2; V_1, V_2, H_1, H_2$.
- (b) Yes, translate horizontally 2 units left, stretch horizontally with factor $\frac{1}{2}$, translate vertically 3 units down, and then reflect in x -axis.
21. Use order of operations to draw a mapping diagram. Operations to the right of the base function correspond to vertical transformations. Multiplication/ division yields a stretch, and addition/ subtraction gives a translation. Multiplication by -1 is a reflection. The order of operations on the right matches the order the transformations are to be applied. Operations to the left of the base function correspond to horizontal transformations. Reverse the operations and their sequence to find the correct transformations to apply to the base function to graph the required function.
22. (a) 1. Reflect $y = x^2$ in x -axis; 2. Stretch vertically with factor $\frac{1}{4}$; 3. Translate 6 units left; 4. Translate 2 units up.
 (b) $y = -\frac{1}{4}(x + 6)^2 + 2$
23. (a) $y = 5\sqrt{x - 3.1}$ (b) $y \doteq 4.34\sqrt{x - 3.11} + 0.87$
 (c) The equations are similar. The second equation involves a vertical translation that made it closer to the points on the left of the scatter plot.
24. (a) A translation of 3 right and 1 down is needed after any necessary stretches and reflections. The required quadratic equation is $y = \frac{3}{4}(x - 3)^2 - 1$.
 (b) (1) Stretch horizontally factor 2 (multiply x by 2). (2) Stretch vertically factor 3 (multiply y by 3). (3) Translate vertically down 1 (subtract 1 from y); (4) Translate horizontally right 3 (add 3 to x). The required quadratic equation is $y = 3[\frac{1}{2}(x - 3)]^2 - 1$.
 (c) The equation in (b) is the same as in (a); any two parabolas with the same vertex can be stretched into each other using any two points (not the vertices) to find a correspondence.