

Graph Shift Lab

Track several changes to one function.

HIGH SCHOOL • MA.912.F.2.2

MA.912.F.2.2 "Identify the effect on the graph of a given function of two or more transformations defined by adding a real number to the x- or y- values or multiplying the x- or y- values by a real number."

NAME _____

DATE _____

FOLLOW EACH COORDINATE

When each point (x,y) becomes $(ax+b, cy+d)$, the x-values control horizontal changes and the y-values control vertical changes. A negative x multiplier reflects the graph across the y-axis, and a negative y multiplier reflects it across the x-axis. The transformed function is $g(x)=c f((x-b)/a)+d$.

WORKED EXAMPLE

The graph $y=f(x)$ is changed so each point (x,y) becomes $(4x+7, -3y-2)$. Describe the new graph.

1. Multiply each x-value by 4, so the graph stretches horizontally by a factor of 4.
2. Add 7 to each x-value, so the graph shifts right 7 units.
3. Multiply each y-value by -3, so the graph reflects across the x-axis and stretches vertically by a factor of 3.
4. Subtract 2 from each y-value, so the graph shifts down 2 units.

Answer: Horizontal stretch by 4, shift right 7, reflect across the x-axis, vertical stretch by 3, and shift down 2.

PRACTICE 6 problems

- 1** Each point on $y=f(x)$ becomes $(5x-6, 8y+9)$. Describe all transformations.

ANSWER _____

- 2** Describe all transformations from $y=f(x)$ to $g(x)=-5f((x+6)/8)+9$.

ANSWER _____

- 3** Describe all transformations from $y=f(x)$ to $h(x)=8f((x-5)/6)-9$.

ANSWER _____

- 4** A point $(0,0)$ on $y=f(x)$ is transformed by $(x,y) \rightarrow (-8x+9, 5y-6)$. Give the new point and describe the transformations.

ANSWER _____

- 5** Let $f(x)=x^2$. Describe the transformations and state the vertex of $q(x)=6f((x+8)/5)+9$.

ANSWER _____

- 6** Each point on $y=f(x)$ becomes $(9x-8, -6y+5)$. Write the new function $g(x)$ in terms of $f(x)$.

ANSWER _____

APPLY IT Show your work

- 1** A student animation team uses $y=f(x)$ for a character's path. To fit a new screen, the software sends every point (x,y) to $(5x+8, -6y+9)$. Describe how the displayed path changes.

WORK SPACE

ANSWER _____

- 2** A music app uses $f(x)$ to display a track's volume curve. In a redesigned display, $g(x)=8f((x-9)/5)-6$. If $(6,5)$ is on the graph of f , find its corresponding point on g and describe the graph changes.

WORK SPACE

ANSWER _____

CHALLENGE One step up

CHALLENGE

The graph $y=f(x)$ contains the points $(-5,8)$ and $(6,-6)$. A new graph is defined by $g(x)=-8f((x+5)/6)+9$. Find the corresponding points on g . Explain how you found them.

PART 1 • PRACTICE

#	PROBLEM	ANSWER
1	Each point on $y=f(x)$ becomes $(5x-6, 8y+9)$. Describe all transformations.	Horizontal stretch by 5, shift left 6, vertical stretch by 8, and shift up 9.
2	Describe all transformations from $y=f(x)$ to $g(x)=-5f((x+6)/8)+9$.	Horizontal stretch by 8, shift left 6, reflect across the x-axis, vertical stretch by 5, and shift up 9.
3	Describe all transformations from $y=f(x)$ to $h(x)=8f((x-5)/6)-9$.	Horizontal stretch by 6, shift right 5, vertical stretch by 8, and shift down 9.
4	A point $(0,0)$ on $y=f(x)$ is transformed by $(x,y) \rightarrow (-8x+9, 5y-6)$. Give the new point and describe the transformations.	The new point is $(9,-6)$. The graph reflects across the y-axis, stretches horizontally by 8, shifts right 9, stretches vertically by 5, and shifts down 6.
5	Let $f(x)=x^2$. Describe the transformations and state the vertex of $q(x)=6f((x+8)/5)+9$.	Horizontal stretch by 5, shift left 8, vertical stretch by 6, and shift up 9. The vertex is $(-8,9)$.
6	Each point on $y=f(x)$ becomes $(9x-8, -6y+5)$. Write the new function $g(x)$ in terms of $f(x)$.	$g(x)=-6f((x+8)/9)+5$

PART 2 • APPLY IT

- The path stretches horizontally by 5, shifts right 8, reflects across the x-axis, stretches vertically by 6, and shifts up 9.**
Read the new x-coordinate as $5x+8$ and the new y-coordinate as $-6y+9$. The negative y multiplier causes reflection across the x-axis.
- The corresponding point is $(39,34)$. The graph stretches horizontally by 5, shifts right 9, stretches vertically by 8, and shifts down 6.** Set $(x-9)/5$ equal to 6, giving $x=39$, then compute $8(5)-6=34$. Read the remaining changes directly from the function rule.

CHALLENGE

The points are $(-35,-55)$ and $(31,57)$. For each original x-value, use $x_{\text{new}}=6x_{\text{old}}-5$. For each original y-value, use $y_{\text{new}}=-8y_{\text{old}}+9$.

Accept equivalent transformation language, such as horizontal dilation for horizontal stretch. Require reflection across the y-axis for a negative x multiplier and across the x-axis for a negative y multiplier.