# Using Horizontal and Vertical Stretches or Shrinks

| Quick Review | |
|---|---|
| When $x$ is replaced with $ax$ the graph of $y = f(x)$ is stretched or compressed horizontally by a factor of $a$. If $a > 1$ the graph is compressed. If $0 < a < 1$ the graph is stretched.<br><br>That is, $y = f(ax)$ stretches or shrinks the graph of $y = f(x)$ | The parabola $y = 3x^2 - x$ can be stretched horizontally by a factor of 2 by replacing $x$ by $x/2$ to get<br>$y = 3(x/2)^2 - (x/2)$.<br><br>It can be compressed horizontally by a factor of 2 by replacing $x$ by $2x$ to get the function<br>$y = 3(2x)^2 - (2x)$. |
| When $y$ is replaced with $ay$ the graph of $y = f(x)$ is stretched or compressed vertically by a factor of $a$. If $a > 1$ the graph is compressed. If $0 < a < 1$ the graph is stretched.<br><br>That is, $ay = f(x)$ stretches or shrinks the graph of $y = f(x)$ | The parabola $y = 2x^2 - x$ can be stretched vertically by a factor of 2 by replacing y by $y/2$ to get<br>$y/2 = 3x^2 - x$. This is usually written<br>$y = 2(3x^2 - x)$<br><br>It can be compressed vertically by a factor of 2 by replacing $y$ by $2y$ to get the function $2y = 3x^2 - x$. |

## Problems

1. Find the equation of the parabola formed by stretching $y = x^2$ vertically by a factor of two.

2. Find the equation of the parabola formed by compressing $y = x^2$ vertically by a factor of 1/2.

3. Find the equation of the parabola formed by stretching $y = x^2 - 3x$ vertically by a factor of six, and horizontally by a factor of 2.

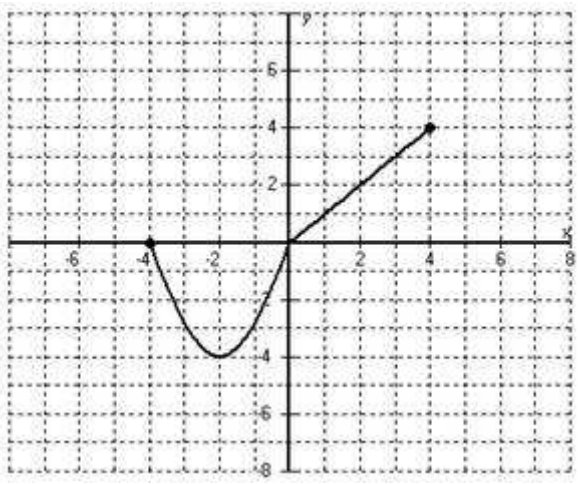
4. Find the equation of the parabola formed by stretching $y = x^2 - 3x$ horizontally by a factor of six, and vertically by a factor of 2

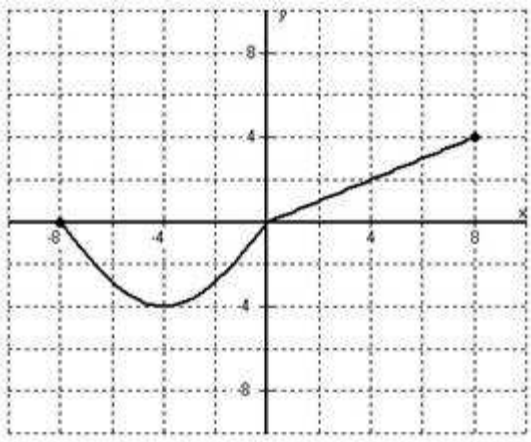
5. If the absolute value graph $y = |x|$ is compressed vertically by a factor of 1/3, what are the slopes of the lines forming the V?

6. Each of the following equations is a stretching or shrinking of $y = 2x - x^2$. Identify each stretch factor or shrink factor and the direction that applies.

   a) $y = 2(2x) - (2x)^2$ b) $y = x - x^2/4$ c) $y = 6x - 9x^2$

7. The graph on the left is some function $y = f(x)$. The graph on the right is $y = f(x/2)$. Each of the graphs below are also stretches or shrinks of $y = f(x)$. Find an equation for each graph.





y = y = f(2x)

(x)

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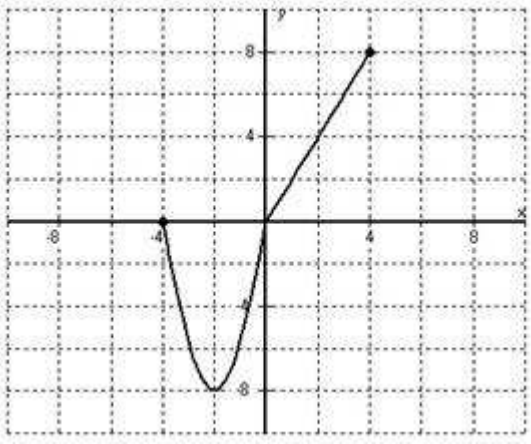
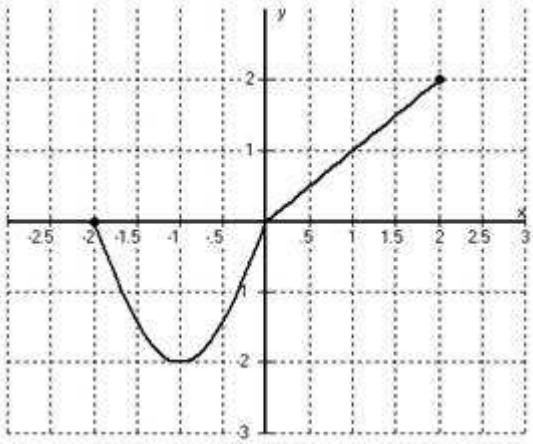


b)



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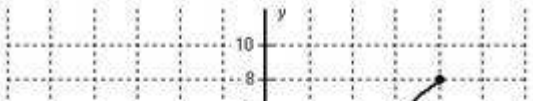

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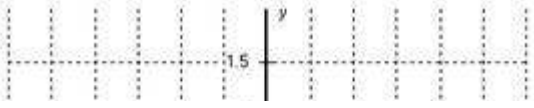
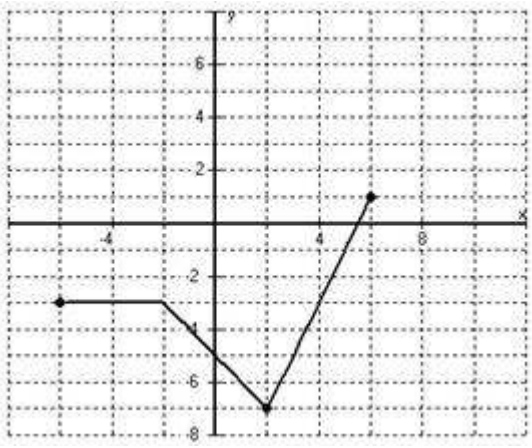


8. This question is about the function $y = g(x)$ shown here. For each equation below, sketch the graph of the transformed function.




a) $y = g(2x)$

b) $y = g(x)/2$

c) $y = 2g(3x)$

d) $y = g(x/2)$

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9. The function $y = xe^{-x} + 2$ is stretched vertically by a factor of 5. What is the equation of the transformed function?

10. The function $y = xe^{-x} + 2$ is compressed horizontally by a factor of 1/3. What is the equation of the transformed function?