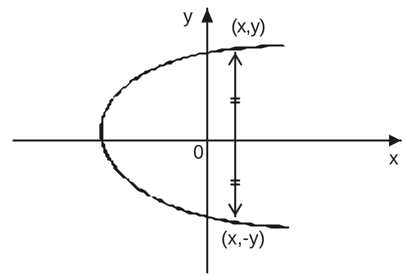
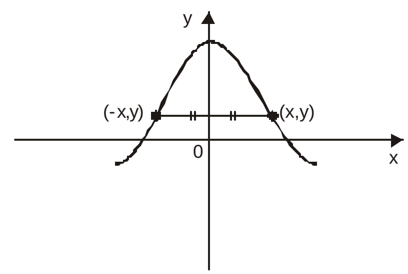
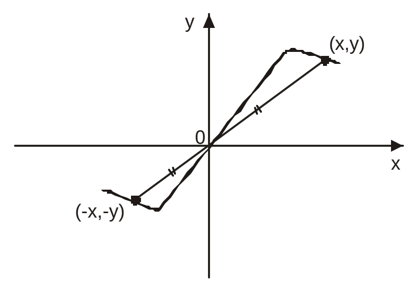
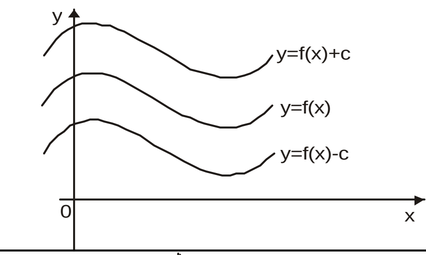
DEFINITION ON SYMMETRY

Type of symmetry	How to test for symmetry	What the graph looks like	Geometric meaning
Symmetry with respect to the *x*-axis	The equation is unchanged when y is replaced by $-y$.	 	Graph is unchanged when reflected in the x-axis.
Symmetry with respect to the y-axis	The equation is unchanged when x is replaced by $-x$.	 	Graph is unchanged when reflected in the y-axis.
Symmetry with respect to the origin	The equation is unchanged when x is replaced by $-x$ and y by $-y$.	 	Graph is unchanged when rotated 180^o about the origin. This is the same as a reflection in the x-axis followed by a reflection in the y-axis.

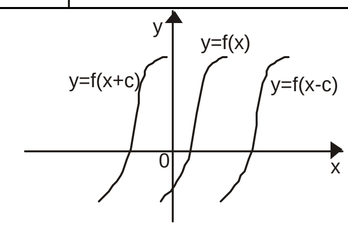
TRANSFORMATIONS OF FUNCTIONS

<table>
<tr><th>TRANSFORMATION</th><th>EQUATION</th><th>HOW TO OBTAIN THE GRAPH</th><th>WHAT THE GRAPH LOOKS LIKE</th></tr>
<tr><td>Vertical shifts of graphs</td><td>$y = f(x) + c, \quad (c > 0)$

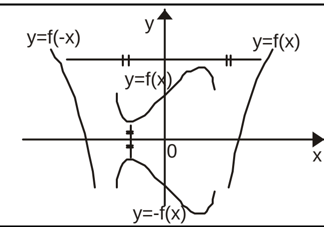
$y = f(x) - c, \quad (c > 0)$</td><td>Shift graph of $y = f(x)$ upward c units.

Shift graph of $y = f(x)$ downward c units.</td><td>
</td></tr>
<tr><td>Horizontal shifts of graphs</td><td>$y = f(x - c), \quad (c > 0)$

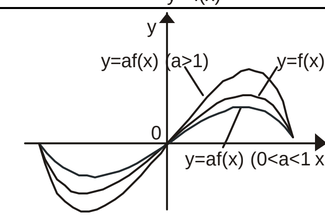
$y = f(x + c), \quad (c > 0)$</td><td>Shift graph of $y = f(x)$ to the right c units.

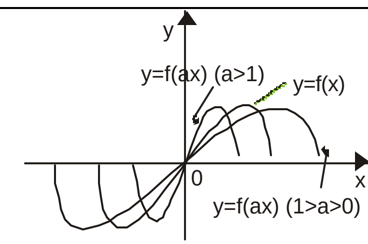
Shift graph of $y = f(x)$ to the left c units</td><td>
</td></tr>
<tr><td>Reflecting graphs</td><td>$y = -f(x)$

$y = f(-x)$</td><td>Reflect the graph of $y = f(x)$ in the x-axis.

Reflect the graph of $y = f(x)$ in the y-axis.</td><td>
</td></tr>
<tr><td>Vertical stretching and shrinking of graphs</td><td>$y = af(x), \quad (a > 1)$

$y = af(x), \quad (0 < a < 1)$</td><td>Stretch the graph of $y = f(x)$ vertically by a factor of a.

Shrink the graph of $y = f(x)$ vertically by a factor of a.</td><td>
</td></tr>
<tr><td>Horizontal shrinking and stretching of graphs</td><td>$y = f(ax), \quad (a > 1)$

$y = f(ax), \quad (0 < a < 1)$</td><td>Shrink the graph of $y = f(x)$ horizontally by a factor of $\frac{1}{a}$.
Stretch the graph of $y = f(x)$ horizontally by a factor of $\frac{1}{a}$.</td><td>
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