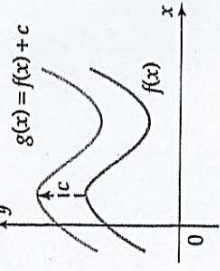
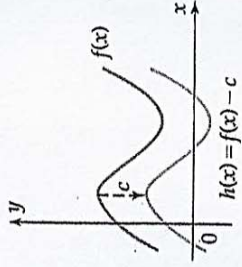


3.4 Graphs and Transformations

Shifts

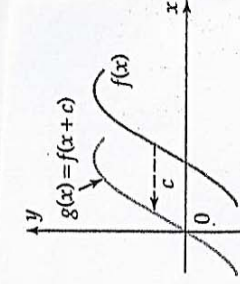


The graph of $g(x) = f(x) + c$ is the graph of f shifted c units upward.



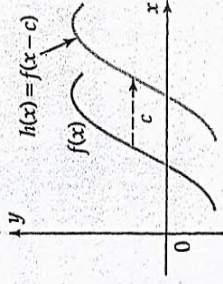
The graph of $h(x) = f(x) - c$ is the graph of f shifted c units downward.

Horizontal Shifts



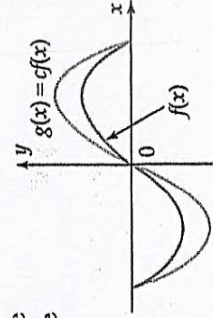
Let f be a function and c a positive constant.

The graph of $g(x) = f(x + c)$ is the graph of f shifted horizontally c units to the left.

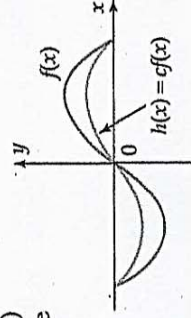


The graph of $h(x) = f(x - c)$ is the graph of f shifted horizontally c units to the right.

Expansions and Contractions

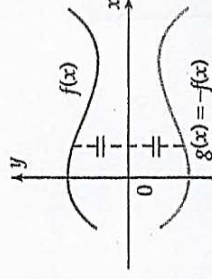


If $c > 1$, then the graph of $g(x) = cf(x)$ is the graph of f stretched vertically away from the x -axis by a factor of c .



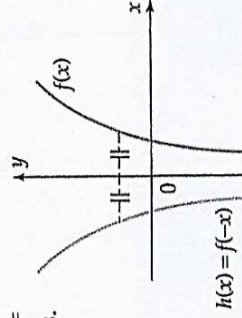
If $0 < c < 1$, then the graph of $h(x) = cf(x)$ is the graph of f shrunk vertically toward the x -axis by a factor of c .

Reflections



Let f be a function. The graph of $g(x) = -f(x)$ is the graph of f reflected in the x -axis.

Reflections



Let f be a function. The graph of $h(x) = f(-x)$ is the graph of f reflected in the y -axis.