POWER FUNCTIONS in x are of the form x^n. If n > 0, the graph of $y = x^n$ is said to be of the parabolic type (the curve is a parabola for n = 2). If n < 0, the graph of $y = x^n$ is said to be of the hyperbolic type (the curve is a hyperbola for n = -1).

1. Function with positive natural exponent $y = x^n; n \in N$

A) even exponent

Domain = R

Range = $\langle 0, \infty)$

Many – to – one function

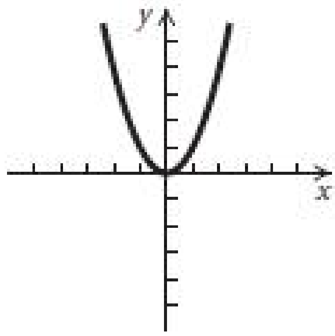
Decreasing $(-\infty, 0\rangle$

Increasing $\langle 0, \infty)$

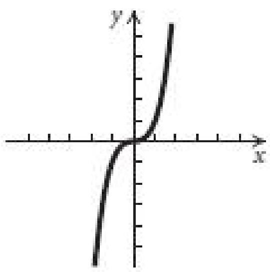
Bounded from below

Even

There is a local minimum at the point $x = 0$



B) odd exponent



Domain = R

Range = R

One to one function

Increasing

Not bounded

Odd

No minimum, No maximum

2. Function with negative integer exponent $y = x^{-n}; n \in Z$

A) even integer

Domain = R- {0}

Range = $(0, \infty)$

Many – to- one function

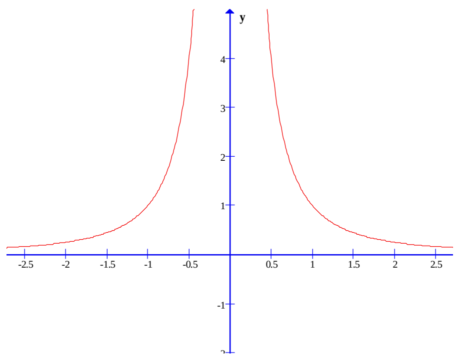
Increasing $(-\infty, 0)$

Decreasing $(0, \infty)$

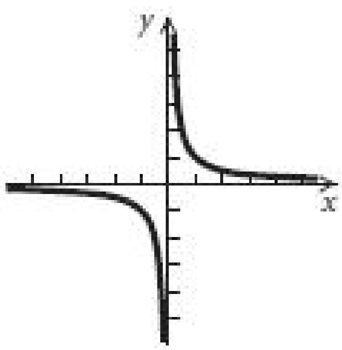
Bounded from below (lower limit)

Even

No minimum, No maximum



B) odd integer



Domain = R- {0}

Range = R- {0}

One – to- one function

Decreasing on the intervals $(-\infty, 0) \cup (0, \infty)$

Not Bounded

Odd

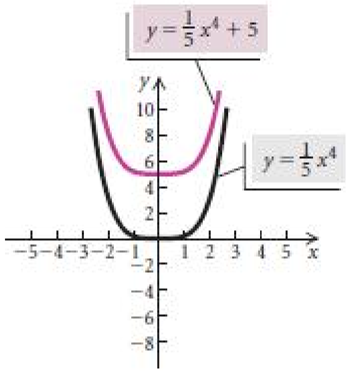
No minimum, No maximum

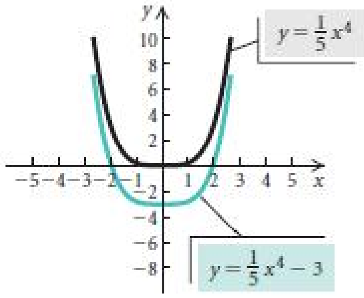
Vertical Translation

For $b > 0$,

the graph of $y = f(x) + b$ is the graph of $y = f(x)$ shifted *up* b units;

the graph of $y = f(x) - b$ is the graph of $y = f(x)$ shifted *down* b units.



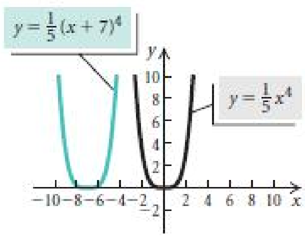


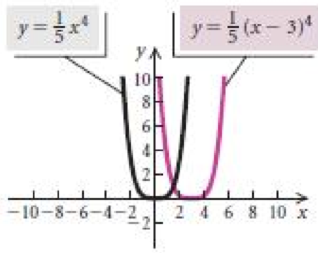
Horizontal Translation

For $d > 0$:

the graph of $y = f(x - d)$ is the graph of $y = f(x)$ shifted *right* d units;

the graph of $y = f(x + d)$ is the graph of $y = f(x)$ shifted *left* d units.



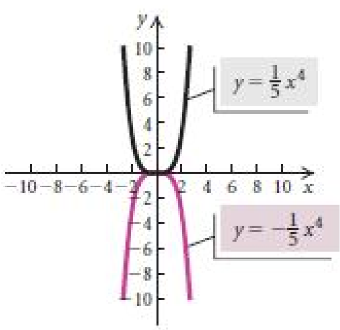


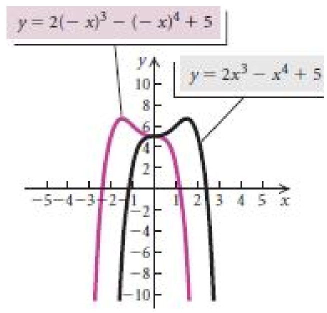
Reflections

The graph of $y = -f(x)$ is the **reflection** of the graph of $y = f(x)$ across the x-axis.

The graph of $y = f(-x)$ is the **reflection** of the graph of $y = f(x)$ across the y-axis.

If a point (x, y) is on the graph of $y = f(x)$, then $(x, -y)$ is on the graph of $y = -f(x)$, and $(-x, y)$ is on the graph of $y = f(-x)$.



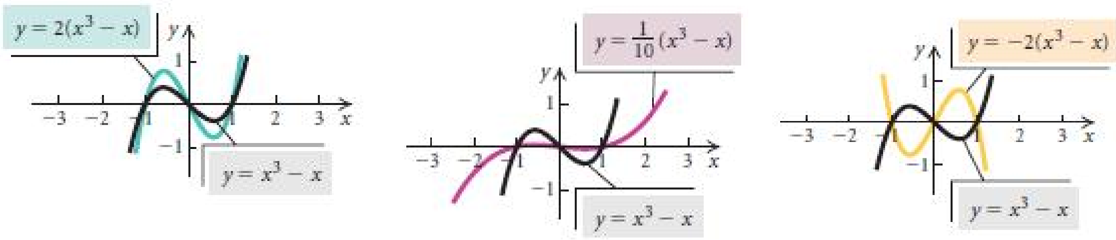


Vertical Stretching and Shrinking

The graph of $y = af(x)$ can be obtained from the graph of $y = f(x)$ by

stretching vertically for $|a| > 1$, or
shrinking vertically for $0 < |a| < 1$.

For $a < 0$, the graph is also reflected across the x-axis. (The y-coordinates of the graph of $y = af(x)$ can be obtained by multiplying the y-coordinates of $y = f(x)$ by a.)

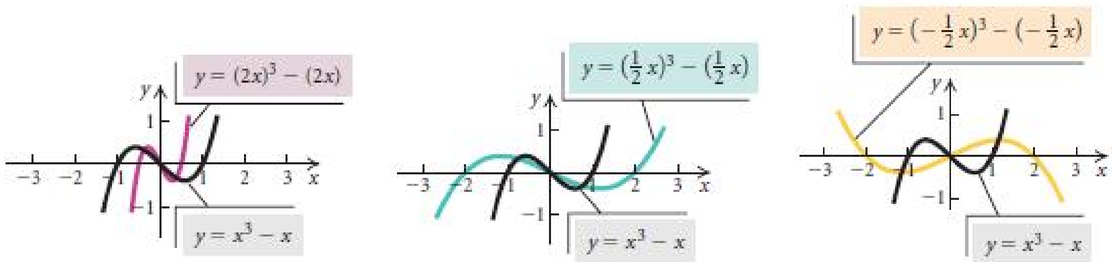


Horizontal Stretching and Shrinking

The graph of $y = f(cx)$ can be obtained from the graph of $y = f(x)$ by

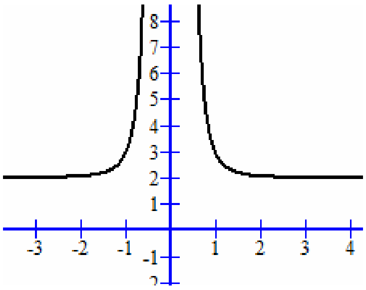
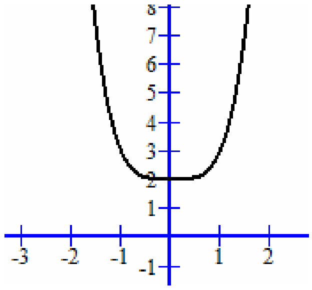
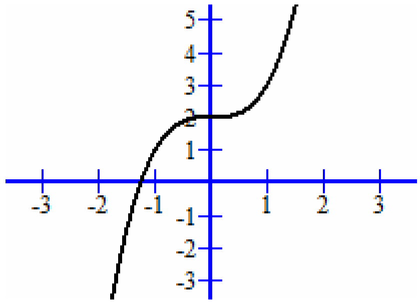
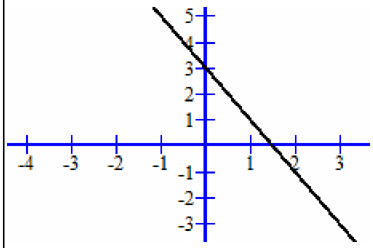
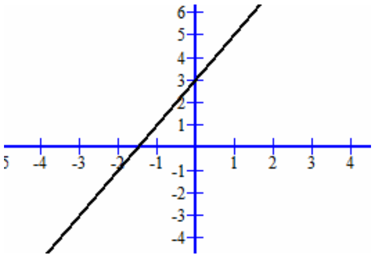
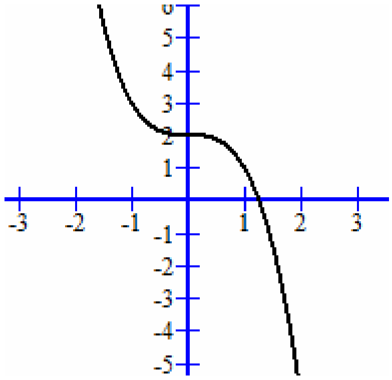
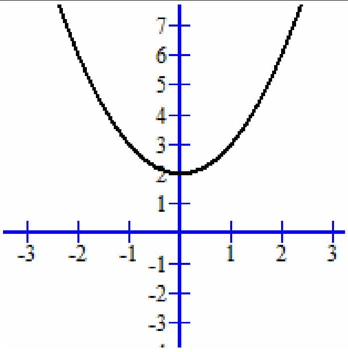
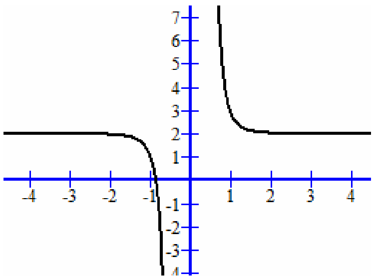
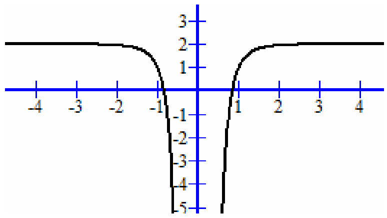
shrinking horizontally for $|c| > 1$, or
stretching horizontally for $0 < |c| < 1$.

For $c < 0$, the graph is also reflected across the y-axis. (The x-coordinates of the graph of $y = f(cx)$ can be obtained by dividing the x-coordinates of the graph of $y = f(x)$ by c.)



Exercise:

Match the graphs with the corresponding equations

1. y = 2x+3	2. $y = x^4 + 2$	3. $y = x^{-5} + 2$	4. $y = -x^4 + 2$	5. $y = x^3 + 2$
6. $y = x^{-4} + 2$	7. $y = -2x + 3$	8. $y = x^2 + 2$	9. $y = -x^3 + 2$	