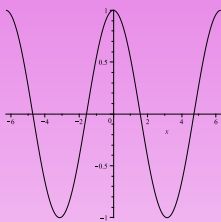
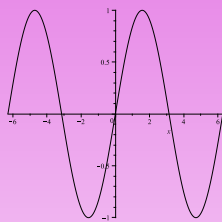


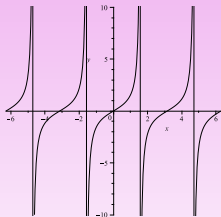
polynomial



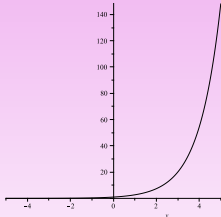
$\cos(x)$



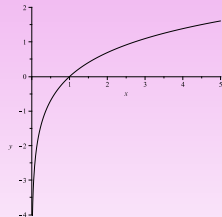
$\sin(x)$



$\tan(x)$



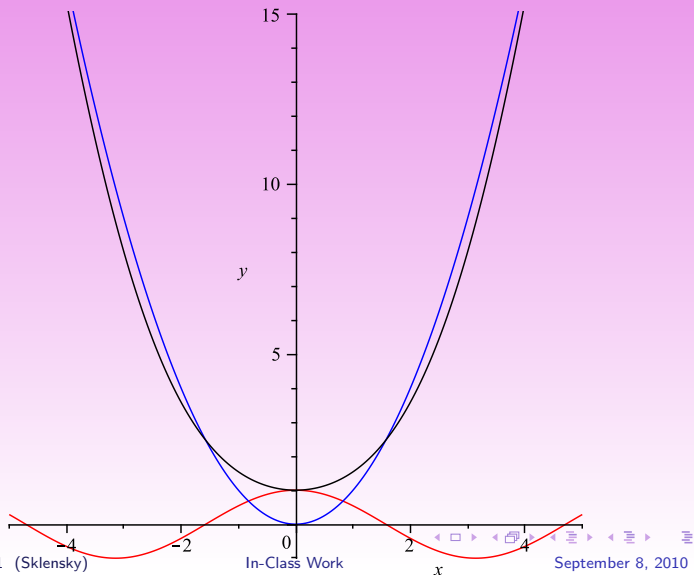
$e^x$



$\ln(x)$

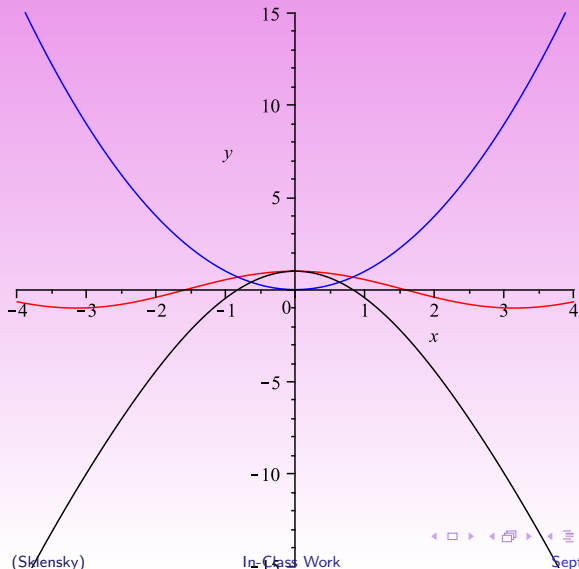
# Addition of Functions

$\cos(x)$ ,  $x^2$ ,  $\cos(x) + x^2$



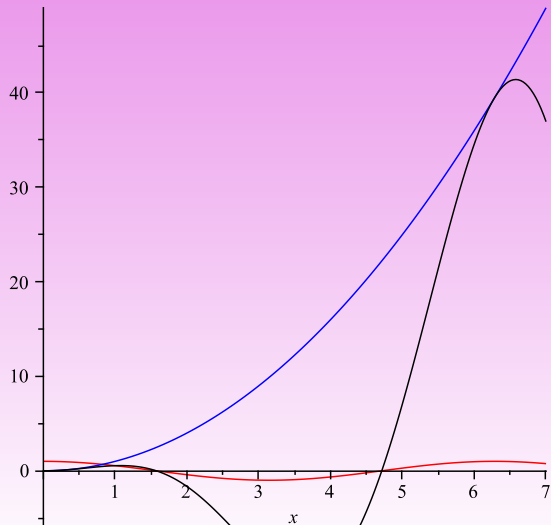
# Subtraction of Functions

$\cos(x)$ ,  $x^2$ ,  $\cos(x) - x^2$



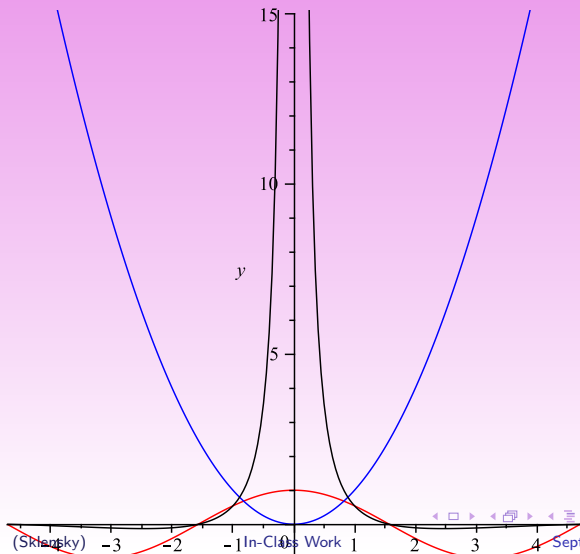
# Multiplication of Functions

$\cos(x)$ ,  $x^2$ ,  $x^2 \cos(x)$



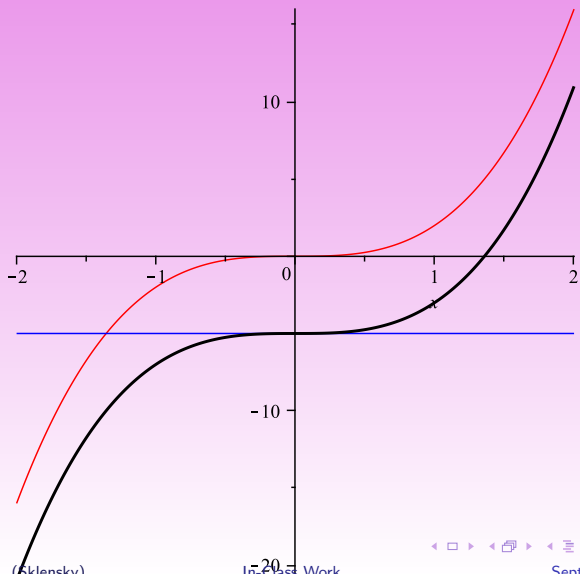
# Division of Functions

$$\cos(x), x^2, \frac{\cos(x)}{x^2}$$



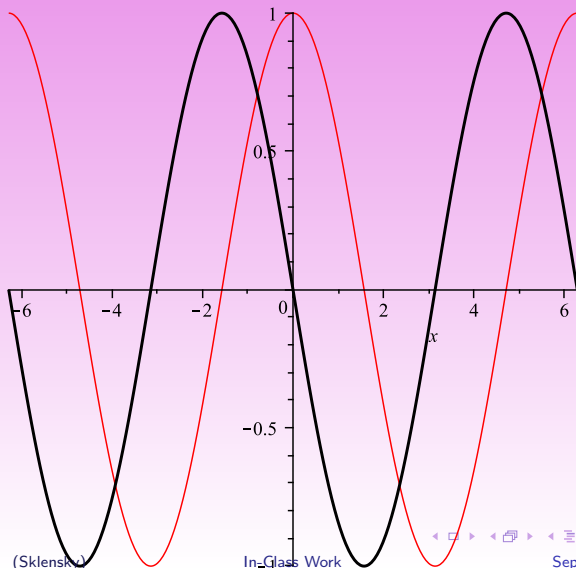
# Vertical Translation

$$2x^3, -5, 2x^3 - 5$$



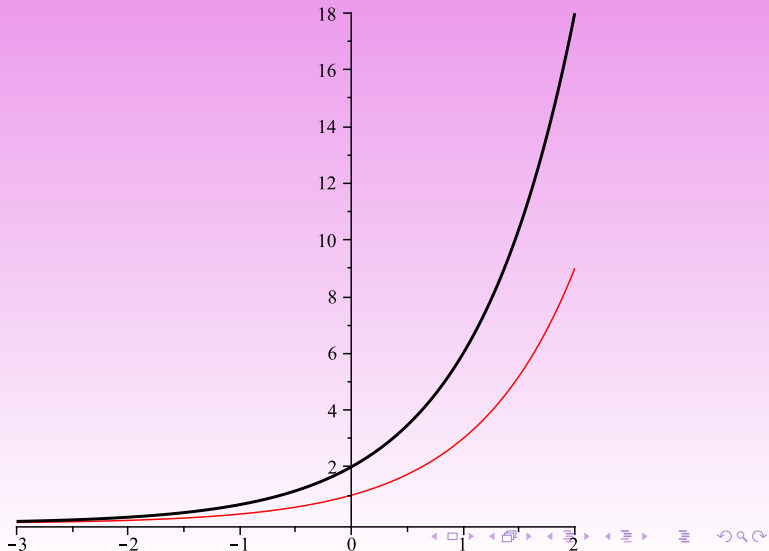
# Horizontal Translation

$$\cos(x), \cos(x + \pi/2)$$



# Vertical Stretching

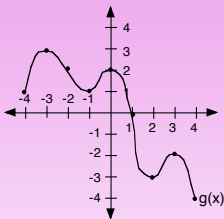
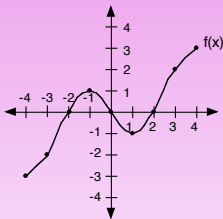
$3^x$ ,  $2 \cdot 3^x$  (which is not the same as  $6^x$ )





## In Class Work

- Given  $f(x) = 2^x$ ,  $g(x) = \cos(x)$ , and  $h(x) = x^3 - 2x$ , find:
  - $f \circ g(x)$
  - $f \circ h(x)$
  - $h \circ g(x)$
  - $f \circ g \circ h(x)$
- The functions below define  $f(x)$  and  $g(x)$ . Find  $f \circ g(-3)$ .



- Let  $f(x) = x^2$ . In each case, sketch all listed functions on the same set of axes.
  - $f(x)$ ,  $f(x) + 2$ , and  $f(x) - 3$
  - $f(x)$ ,  $f(x + 2)$ , and  $f(x - 3)$
  - $f(x)$ ,  $2f(x)$ ,  $-3f(x)$ , and  $\frac{1}{2}f(x)$

## Solutions to In Class Work

1. Given  $f(x) = 2^x$ ,  $g(x) = \cos(x)$ , and  $h(x) = x^3 - 2x$ , find:

(a)  $f \circ g(x)$

$$f \circ g(x) = f(g(x)) = f(\cos(x)) = 2^{\cos(x)}.$$

(b)  $f \circ h(x)$

$$f \circ h(x) = f(h(x)) = f(x^3 - 2x) = 2^{x^3 - 2x}.$$

(c)  $h \circ g(x)$

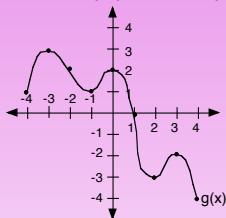
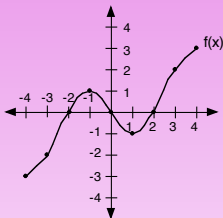
$$h \circ g(x) = h(g(x)) = h(\cos(x)) = (\cos(x))^3 - 2\cos(x).$$

(d)  $f \circ g \circ h(x)$

$$\begin{aligned} f \circ g \circ h(x) &= f(g(h(x))) = f(g(x^3 - 2x)) = f(\cos(x^3 - 2x)) \\ &= 2^{\cos(x^3 - 2x)}. \end{aligned}$$

## In Class Work

2. The functions below define  $f(x)$  and  $g(x)$ . Find  $f \circ g(-3)$ .

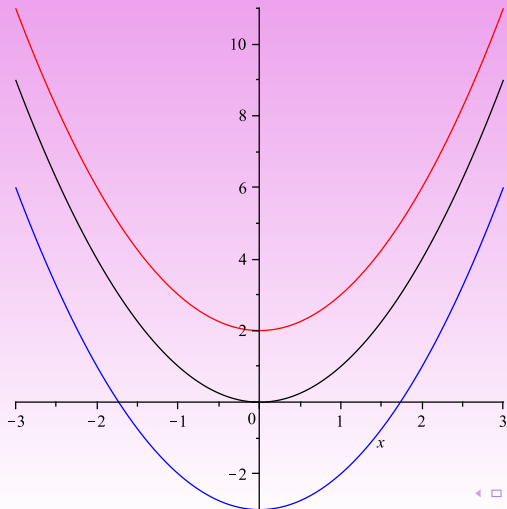


- ▶  $f \circ g(-3) = f(g(-3))$ .
- ▶ From the graph of  $g(x)$ ,  $g(-3) = 3$ .
- ▶ Thus  $f \circ g(-3) = f(g(-3)) = f(3)$
- ▶ From the graph of  $f(x)$ ,  $f(3) = 2$ .
- ▶ Thus  $f \circ g(-3) = 2$ .

## In Class Work

3. Let  $f(x) = x^2$ . In each case, sketch all listed functions on the same set of axes.

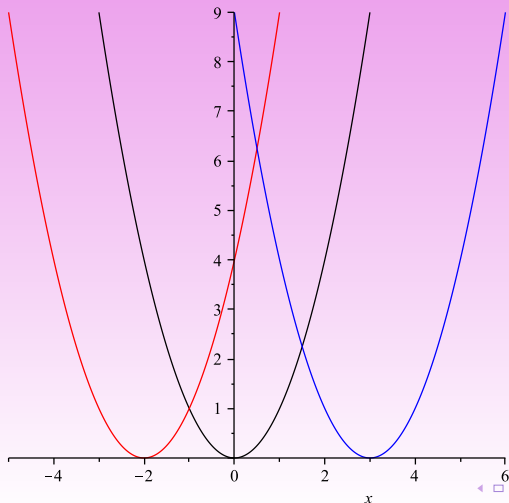
(a)  $f(x)$ ,  $f(x) + 2$ , and  $f(x) - 3$



## In Class Work

3. Let  $f(x) = x^2$ . In each case, sketch all listed functions on the same set of axes.

(b)  $f(x)$ ,  $f(x + 2)$ , and  $f(x - 3)$



## In Class Work

3. Let  $f(x) = x^2$ . In each case, sketch all listed functions on the same set of axes.

(c)  $f(x)$ ,  $2f(x)$ ,  $-3f(x)$ , and  $\frac{1}{2}f(x)$

