

Re-teach Composition of functions

$f \circ g = f(g(x))$       1. Evaluate  $g(x)$  first.  
 2. Then use  $g(x)$  as the input for  $f$

Examples

1.  $g(x) = x^2$  and  $f(x) = x-5$

a.  $(f \circ g)(-3)$   
 $= f(g(-3))$   
 $= f((-3)^2)$   
 $= f(9)$   
 $= 9-5$   
 $= \boxed{4}$

b.  $(g \circ f)(-2)$   
 $= g(f(-2))$   
 $= g(-2-5)$   
 $= g(-7)$   
 $= (-7)^2$   
 $= \boxed{49}$

c.  $(g \circ f)(a)$   
 $= g(f(a))$   
 $= g(a-5)$   
 $= (a-5)^2$   
 $= \boxed{a^2 - 10a + 25}$

2.  $f(x) = 3x^2 - 11x - 4$  and  $g(x) = 3x+1$

a.  $(f \circ g)(-2)$   
 $= f(g(-2))$   
 $= f(3(-2)+1)$   
 $= f(-5)$   
 $= 3(-5)^2 - 11(-5) - 4$   
 $= 3(25) + 55 - 4$   
 $= 75 + 55 - 4$   
 $= \boxed{126}$

b.  $(f \circ f)(0)$   
 $= f(f(0))$   
 $= f(3(0)^2 - 11(0) - 4)$   
 $= f(-4)$   
 $= 3(-4)^2 - 11(-4) - 4$   
 $= 3(16) + 44 - 4$   
 $= 48 + 44 - 4$   
 $= \boxed{88}$

c.  $(f \circ g)(a)$   
 $= f(g(a))$   
 $= f(3a+1)$   
 $= 3(3a+1)^2 - 11(3a+1) - 4$   
 $= 3(9a^2 + 6a + 1) - 33a - 11 - 4$   
 $= 27a^2 + 18a + 3 - 33a - 15$   
 $= \boxed{27a^2 - 15a - 12}$

3.  $f(x) = 3x^2 - 11x - 4$  and  $g(x) = 3x+1$

a.  $\left(\frac{f}{g}\right)(x)$

$$= \frac{3x^2 - 11x - 4}{3x + 1}$$

Domain Restriction

$$\frac{3x + 1 \neq 0}{\frac{3x}{3} \neq -\frac{1}{3}}$$

Now simplify

$$\frac{(3x+1)(x-4)}{(3x+1)}$$

ANSWER:  $x-4, x \neq -\frac{1}{3}$

b.  $(f \circ g)(x) = f(g(x))$

$$= f(3x+1)$$

$$= 3(3x+1)^2 - 11(3x+1) - 4$$

$$= 3(9x^2 + 6x + 1) - 33x - 11 - 4$$

$$= 27x^2 + 18x + 3 - 33x - 15$$

$$= 27x^2 - 15x - 12$$

**Skill 7: Composition of Functions**  
for example: what we just did!

**Skill 8: Simplifying Complex Expressions**  
for example: multiplying/dividing complex numbers

Simplify: Answer should be in a + bi form!

$$\frac{1+i}{2+3i} \cdot \frac{2-3i}{2-3i}$$

Remember  $i^2 = -1$

$$= \frac{(1+i)(2-3i)}{(2+3i)(2-3i)}$$

$$= \frac{2-3i+2i-3i^2}{4-9i^2}$$

$$= \frac{2-3i+2i-3(-1)}{4-9(-1)}$$

$$= \frac{2-3i+2i+3}{4+9}$$

$$= \frac{5-i}{13} = \frac{5}{13} - \frac{1}{13}i$$

$$= 10i - 6i^2 - 6i - 2i^2$$

$$= 10i - 6(-1) - 6i - 2(-1)$$

$$= 10i + 6 - 6i + 2 = 4i + 8$$

$$= 27 + 4i$$

**Skill 9: Solving Cubic Equations**  
example: find all solutions: Answer should be in simplified form!

$$8x^3 = 27$$

$$8x^3 - 27 = 0$$

$$(2x-3)(4x^2+6x+9) = 0$$

$2x-3=0$  or  $4x^2+6x+9=0$

$$x = \frac{3}{2}$$

$$x = \frac{-6 \pm \sqrt{6^2 - 4(4)(9)}}{2(4)}$$

$$x = \frac{-6 \pm \sqrt{36 - 144}}{8}$$

$$x = \frac{-6 \pm \sqrt{-108}}{8} = \frac{-6 \pm \sqrt{36 \cdot 3} \cdot i}{8} = \frac{-6 \pm 6i\sqrt{3}}{8}$$

$$x = \frac{-3 \pm \frac{3}{2}i\sqrt{3}}{4}$$

$x = \left\{ \frac{3}{2}, \frac{-3}{4} \pm \frac{3}{4}i\sqrt{3} \right\}$