

Ways you may see a composition written...

$$3 \rightarrow g \rightarrow f$$

$$(f \circ g)(3) \quad \text{or}$$

Work Backwards

$$3 \rightarrow g \rightarrow f$$

$$f(g(3))$$

Work Inside out

This means to take the input and place it into the first function listed closest to it (furthest to the right) and then input **THAT** answer into the next function (you are working right to left) **OR** work from the inside out.

Examples:

1 If $f(x) = 3x$ and $g(x) = 7x - 1$, what is $(f \circ g)(4)$?

$$g(4) = 7(4) - 1$$

$$= 27$$

$$4 \rightarrow g \xrightarrow{27} f$$

$$f(27) = 3(27)$$

$$= \boxed{81}$$

2 If $f(x) = 3x - 1$ and $g(x) = x^2 + 1$, evaluate $(g \circ f)(-1)$.

$$f(-1) = 3(-1) - 1$$

$$= -4$$

$$-1 \rightarrow f \xrightarrow{-4} g$$

$$g(-4) = (-4)^2 + 1$$

$$= \boxed{17}$$

3 If $f(x) = x - 2$ and $g(x) = x^2$, find $f(g(3))$.

$$g(3) = (3)^2$$

$$= 9$$

$$3 \rightarrow g \xrightarrow{9} f$$

$$f(9) = 9 - 2$$

$$= \boxed{7}$$

4 If $f(x) = \frac{x^3}{3}$ and $g(x) = \sqrt[3]{x}$, find $f(g(9))$. $9 \rightarrow g \xrightarrow{\sqrt[3]{9}} f$

$$g(9) = \sqrt[3]{9}$$

$$f(\sqrt[3]{9}) = \frac{(\sqrt[3]{9})^3}{3} = \frac{9}{3}$$

$$= \boxed{3}$$

5 If f and g are two functions defined by $f(x) = 3x + 5$ and $g(x) = x^2 + 1$, then $g(f(x))$ is $f \rightarrow g$

A. $x^2 + 3x + 6$

B. $9x^2 + 30x + 26$

C. $3x^2 + 8$

D. $9x^2 + 26$

$$(3x + 5)^2 + 1$$

$$(3x + 5)(3x + 5) + 1$$

$$9x^2 + 15x + 15x + 25 + 1$$

$$9x^2 + 30x + 26$$

Given the functions $f(x) = 2x + 5$ and $g(x) = x^2 - 3x + 2$

Find each of the following and state the restricted domain, where necessary.

a) $(f + g)(x)$

$$(2x + 5) + (x^2 - 3x + 2)$$
$$x^2 - x + 7$$

b) $(g - f)(x)$

$$(x^2 - 3x + 2) - (2x + 5)$$
$$x^2 - 3x + 2 - 2x - 5$$
$$x^2 - 5x - 3$$

c) $4f(x)$

$$4(2x + 5)$$
$$8x + 20$$

d) $g(f(1))$

$$1 \rightarrow f \xrightarrow{7} g$$
$$f(1) = 2(1) + 5$$
$$= 7$$
$$g(7) = (7)^2 - 3(7) + 2$$
$$= 30$$

e) $(f \circ g)(1)$

$$1 \rightarrow g \xrightarrow{0} f$$
$$g(1) = (1)^2 - 3(1) + 2$$
$$= 0$$

$$f(0) = 2(0) + 5$$
$$= 5$$

$$f) (g \circ f)\left(\frac{1}{2}\right) \quad \frac{1}{2} \rightarrow f \xrightarrow{6} g$$

$$f\left(\frac{1}{2}\right) = 2\left(\frac{1}{2}\right) + 5 \\ = 6$$

$$g(6) = (6)^2 - 3(6) + 2 \\ = \boxed{20}$$