

So far, when we have been talking about functions, we have been assuming that their domains and ranges have been sets of numbers. This is not necessarily the case. For example, look at this figure:



Let's let our domain be all the different ways we can move this figure around, including flipping it over:

$$D = \left\{ \begin{array}{c} \text{L-shape} \\ \text{rotated 90° clockwise} \\ \text{rotated 180°} \\ \text{rotated 270° clockwise} \\ \text{reflected across vertical line} \\ \text{reflected across horizontal line} \\ \text{reflected across diagonal} \end{array} \right\}$$

Now let  $f$  be the function that rotates the shape  $90^\circ$  clockwise:  $f\left(\begin{array}{c} \text{L-shape} \end{array}\right) = \begin{array}{c} \text{rotated L-shape} \end{array}$ . Let  $g$  be the function that

takes flips the shape over across a vertical line drawn through the center:  $g\left(\begin{array}{c} \text{L-shape} \end{array}\right) = \begin{array}{c} \text{reflected L-shape} \end{array}$

1. Find the following:

(a)  $f\left(\begin{array}{c} \text{rotated L-shape} \end{array}\right)$

(b)  $g\left(\begin{array}{c} \text{reflected L-shape} \end{array}\right)$

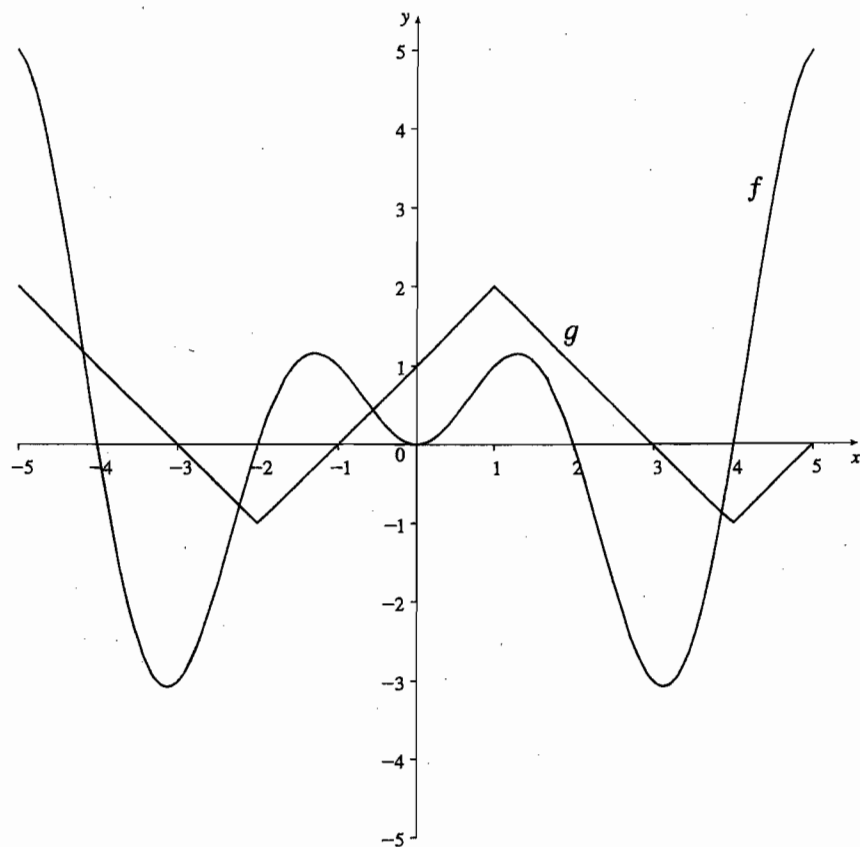
(c)  $f\left(f\left(\begin{array}{c} \text{L-shape} \end{array}\right)\right)$

(d)  $g\left(g\left(\begin{array}{c} \text{reflected L-shape} \end{array}\right)\right)$

2. Is it true that  $f \circ g = g \circ f$ ? Why or why not?

3. Is it true that  $g \circ g \circ g = g$ ? Why or why not?

4. Write, in words, what the function  $f \circ f \circ f$  does to a shape.



✓ 1.  $(f \circ g)(5)$

2.  $(g \circ f)(5)$

3.  $(f \circ g)(0)$

4.  $(f \circ f)(5)$

5.  $(g \circ g)(5)$

✓ 6.  $(g \circ g)(-3)$

7.  $(g \circ g)(-1)$

✓ 8.  $(f \circ g)(1)$

9.  $(g \circ f)(1)$

10.  $(f \circ f \circ g)(4)$

✓ 11.  $(g \circ f \circ f)(4)$

✓ 12.  $(f \circ g \circ f)(4)$