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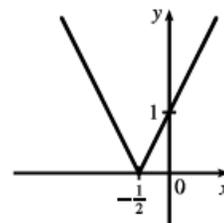
## Homework 1

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3. (a) The point  $(1, 3)$  is on the graph of  $f$ , so  $f(1) = 3$ .
- (b) When  $x = -1$ ,  $y$  is about  $-0.2$ , so  $f(-1) \approx -0.2$ .
- (c)  $f(x) = 1$  is equivalent to  $y = 1$ . When  $y = 1$ , we have  $x = 0$  and  $x = 3$ .
- (d) A reasonable estimate for  $x$  when  $y = 0$  is  $x = -0.8$ .
- (e) The domain of  $f$  consists of all  $x$ -values on the graph of  $f$ . For this function, the domain is  $-2 \leq x \leq 4$ , or  $[-2, 4]$ .  
The range of  $f$  consists of all  $y$ -values on the graph of  $f$ . For this function, the range is  $-1 \leq y \leq 3$ , or  $[-1, 3]$ .
- (f) As  $x$  increases from  $-2$  to  $1$ ,  $y$  increases from  $-1$  to  $3$ . Thus,  $f$  is increasing on the interval  $[-2, 1]$ .
7. No, the curve is not the graph of a function because a vertical line intersects the curve more than once. Hence, the curve fails the Vertical Line Test.
8. Yes, the curve is the graph of a function because it passes the Vertical Line Test. The domain is  $[-2, 2]$  and the range is  $[-1, 2]$ .
9. Yes, the curve is the graph of a function because it passes the Vertical Line Test. The domain is  $[-3, 2]$  and the range is  $[-3, -2) \cup [-1, 3]$ .
10. No, the curve is not the graph of a function since for  $x = 0, \pm 1$ , and  $\pm 2$ , there are infinitely many points on the curve.
14. Runner A won the race, reaching the finish line at 100 meters in about 15 seconds, followed by runner B with a time of about 19 seconds, and then by runner C who finished in around 23 seconds. B initially led the race, followed by C, and then A. C then passed B to lead for a while. Then A passed first B, and then passed C to take the lead and finish first. Finally, B passed C to finish in second place. All three runners completed the race.

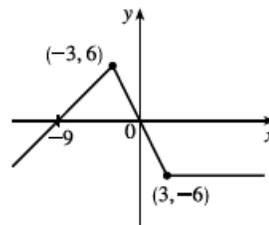
$$44. F(x) = |2x + 1| = \begin{cases} 2x + 1 & \text{if } 2x + 1 \geq 0 \\ -(2x + 1) & \text{if } 2x + 1 < 0 \end{cases}$$
$$= \begin{cases} 2x + 1 & \text{if } x \geq -\frac{1}{2} \\ -2x - 1 & \text{if } x < -\frac{1}{2} \end{cases}$$

The domain is  $\mathbb{R}$ , or  $(-\infty, \infty)$ .



$$50. f(x) = \begin{cases} x + 9 & \text{if } x < -3 \\ -2x & \text{if } |x| \leq 3 \\ -6 & \text{if } x > 3 \end{cases}$$

Note that for  $x = -3$ , both  $x + 9$  and  $-2x$  are equal to 6; and for  $x = 3$ , both  $-2x$  and  $-6$  are equal to  $-6$ . The domain is  $\mathbb{R}$ .



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69.  $f$  is an odd function because its graph is symmetric about the origin.  $g$  is an even function because its graph is symmetric with respect to the  $y$ -axis.

4. (a) The graph of  $y = 3x$  is a line (choice  $G$ ).

(b)  $y = 3^x$  is an exponential function (choice  $f$ ).

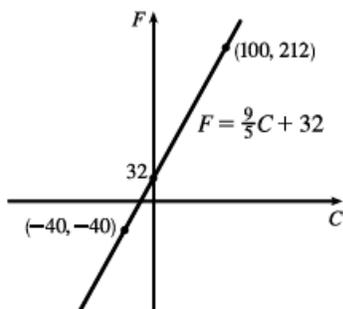
(c)  $y = x^3$  is an odd polynomial function or power function (choice  $F$ ).

(d)  $y = \sqrt[3]{x} = x^{1/3}$  is a root function (choice  $g$ ).

11. (a)  $D = 200$ , so  $c = 0.0417D(a + 1) = 0.0417(200)(a + 1) = 8.34a + 8.34$ . The slope is 8.34, which represents the change in mg of the dosage for a child for each change of 1 year in age.

(b) For a newborn,  $a = 0$ , so  $c = 8.34$  mg.

13. (a)



(b) The slope of  $\frac{9}{5}$  means that  $F$  increases  $\frac{9}{5}$  degrees for each increase of  $1^\circ C$ . (Equivalently,  $F$  increases by 9 when  $C$  increases by 5 and  $F$  decreases by 9 when  $C$  decreases by 5.) The  $F$ -intercept of 32 is the Fahrenheit temperature corresponding to a Celsius temperature of 0.

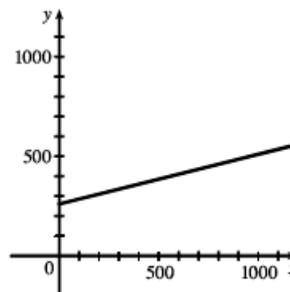
18. (a) Using  $d$  in place of  $x$  and  $C$  in place of  $y$ , we find the slope to be  $\frac{C_2 - C_1}{d_2 - d_1} = \frac{460 - 380}{800 - 480} = \frac{80}{320} = \frac{1}{4}$ .

So a linear equation is  $C - 460 = \frac{1}{4}(d - 800) \Leftrightarrow C - 460 = \frac{1}{4}d - 200 \Leftrightarrow C = \frac{1}{4}d + 260$ .

(b) Letting  $d = 1500$  we get  $C = \frac{1}{4}(1500) + 260 = 635$ .

The cost of driving 1500 miles is \$635.

(c)



The slope of the line represents the cost per mile, \$0.25.

(e) A linear function gives a suitable model in this situation because you have fixed monthly costs such as insurance and car payments, as well as costs that increase as you drive, such as gasoline, oil, and tires, and the cost of these for each additional mile driven is a constant.

3. (a) (graph 3) The graph of  $f$  is shifted 4 units to the right and has equation  $y = f(x - 4)$ .  
 (b) (graph 1) The graph of  $f$  is shifted 3 units upward and has equation  $y = f(x) + 3$ .  
 (c) (graph 4) The graph of  $f$  is shrunk vertically by a factor of 3 and has equation  $y = \frac{1}{3}f(x)$ .  
 (d) (graph 5) The graph of  $f$  is shifted 4 units to the left and reflected about the  $x$ -axis. Its equation is  $y = -f(x + 4)$ .  
 (e) (graph 2) The graph of  $f$  is shifted 6 units to the left and stretched vertically by a factor of 2. Its equation is  $y = 2f(x + 6)$ .

32.  $f(x) = x - 2$ ;  $g(x) = x^2 + 3x + 4$ .  $D = \mathbb{R}$  for both  $f$  and  $g$ , and hence for their composites.

(a)  $(f \circ g)(x) = f(g(x)) = f(x^2 + 3x + 4) = (x^2 + 3x + 4) - 2 = x^2 + 3x + 2$ .

(b)  $(g \circ f)(x) = g(f(x)) = g(x - 2) = (x - 2)^2 + 3(x - 2) + 4 = x^2 - 4x + 4 + 3x - 6 + 4 = x^2 - x + 2$ .

(c)  $(f \circ f)(x) = f(f(x)) = f(x - 2) = (x - 2) - 2 = x - 4$ .

(d)  $(g \circ g)(x) = g(g(x)) = g(x^2 + 3x + 4) = (x^2 + 3x + 4)^2 + 3(x^2 + 3x + 4) + 4$   
 $= (x^4 + 9x^2 + 16 + 6x^3 + 8x^2 + 24x) + 3x^2 + 9x + 12 + 4$   
 $= x^4 + 6x^3 + 20x^2 + 33x + 32$

42. Let  $g(x) = \cos x$  and  $f(x) = x^2$ . Then  $(f \circ g)(x) = f(g(x)) = f(\cos x) = (\cos x)^2 = \cos^2 x = F(x)$ .

44. Let  $g(x) = \frac{x}{1+x}$  and  $f(x) = \sqrt[3]{x}$ . Then  $(f \circ g)(x) = f(g(x)) = f\left(\frac{x}{1+x}\right) = \sqrt[3]{\frac{x}{1+x}} = G(x)$ .

51. (a)  $g(2) = 5$ , because the point  $(2, 5)$  is on the graph of  $g$ . Thus,  $f(g(2)) = f(5) = 4$ , because the point  $(5, 4)$  is on the graph of  $f$ .

(b)  $g(f(0)) = g(0) = 3$

(c)  $(f \circ g)(0) = f(g(0)) = f(3) = 0$

(d)  $(g \circ f)(6) = g(f(6)) = g(6)$ . This value is not defined, because there is no point on the graph of  $g$  that has  $x$ -coordinate 6.

(e)  $(g \circ g)(-2) = g(g(-2)) = g(1) = 4$

(f)  $(f \circ f)(4) = f(f(4)) = f(2) = -2$

54. (a) The radius  $r$  of the balloon is increasing at a rate of 2 cm/s, so  $r(t) = (2 \text{ cm/s})(t \text{ s}) = 2t$  (in cm).

(b) Using  $V = \frac{4}{3}\pi r^3$ , we get  $(V \circ r)(t) = V(r(t)) = V(2t) = \frac{4}{3}\pi(2t)^3 = \frac{32}{3}\pi t^3$ .

The result,  $V = \frac{32}{3}\pi t^3$ , gives the volume of the balloon (in  $\text{cm}^3$ ) as a function of time (in s).

56. (a)  $d = rt \Rightarrow d(t) = 350t$

(b) There is a Pythagorean relationship involving the legs with lengths  $d$  and 1 and the hypotenuse with length  $s$ :

$$d^2 + 1^2 = s^2. \text{ Thus, } s(d) = \sqrt{d^2 + 1}.$$

(c)  $(s \circ d)(t) = s(d(t)) = s(350t) = \sqrt{(350t)^2 + 1}$