

**A1.1:**

- (a)  $f(-1) = -2$
- (b)  $f(2) \approx 1.8$
- (c)  $f(x) = 2$  at  $x = 1$  and  $x = -3$
- (d)  $f(x) = 0$  at  $x \approx -2.5$  and  $x \approx 0.4$
- (e) The domain of  $f$  is  $[-3, 3]$  and the range of  $f$  is  $[-2, 3]$
- (f)  $f$  is increasing on  $[-1, 3]$

**A1.2:**

- (a)  $f(-4) = -2$  and  $g(3) = 4$
- (b)  $f(x) = g(x)$  at  $x = -2$  and  $x = 2$
- (c)  $f(x) = -1$  at  $x = -3$  and  $x = 4$
- (d)  $f$  is decreasing on  $[0, 4]$
- (e) The domain of  $f$  is  $[-4, 4]$  and the range of  $f$  is  $[-2, 3]$
- (f) The domain of  $g$  is  $[-4, 3]$  and the range of  $g$  is  $[0.5, 4]$

**A1.3:** The range of the vertical ground acceleration function is about  $[-70, 120]$   
 The range of the north-south ground acceleration function is about  $[-300, 420]$   
 The range of the east-west ground acceleration function is about  $[-200, 200]$

**A1.4:** Skip

**A1.5:** Is not a function. Fails the vertical line test.

**A1.6:** Is a function. The domain is  $[-2, 2]$  and the range is  $[-1, 2]$

**A1.7:** Is a function. The domain is  $[-3, 2]$  and the range is  $[-3, -2) \cup [-1, 3]$

**A1.8:** Is not a function. Fails the vertical line test.

**A1.9:** Skip

**A1.10:** Skip

**A1.11:** Skip

**A1.12:** Skip

**A1.13:** Skip

**A1.14:** Skip

**A1.15:** Skip

**A1.16:** Skip

**A1.17:** Skip

**A1.18:** Skip

**A1.19:**

- $f(2) = 3(2)^2 - 2 + 2 = 3 \cdot 4 = 12$
- $f(-2) = 3(-2)^2 - (-2) + 2 = 3 \cdot 4 + 4 = 16$
- $f(a) = 3a^2 - a + 2$
- $f(-a) = 3(-a)^2 - (-a) + 2 = 3a^2 + a + 2$
- $f(a+1) = 3(a+1)^2 - (a+1) + 2 = 3(a^2 + 2a + 1) - a + 3 = 3a^2 + 5a + 6$
- $2f(a) = 2(3a^2 - a + 2) = 6a^2 - 2a + 4$
- $f(2a) = 3(2a)^2 - 2a + 2 = 3 \cdot 4a^2 - 2a + 2 = 12a^2 - 2a + 2$
- $f(a^2) = 3(a^2)^2 - 2a^2 + 2 = 3a^4 - 2a^2 + 2$
- $[f(a)]^2 = [3a^2 - a + 2]^2 = 9a^4 + a^2 + 4 - 3a^3 + 6a^2 - 2a = 9a^4 + 7a^2 - 3a^3 - 2a + 4$
- $f(a+h) = 3(a+h)^2 - (a+h) + 2 = 3(a^2 + 2ah + h^2) - a - h + 2 = 3a^2 - 2ah + h^2 - a - h + 2$

**A1.20:** Let  $f(r) := V(r+1) - V(r)$

$$\begin{aligned}
 f(r) &= \frac{4}{3}\pi(r+1)^3 - \frac{4}{3}\pi r^3 \\
 &= \frac{4}{3}\pi\left((r+1)^3 - r^3\right) \\
 &= \frac{4}{3}\pi\left(r^3 + 3r^2 + 3r + 1 - r^3\right) \\
 &= \frac{4}{3}\pi\left(3r^2 + 3r + 1\right)
 \end{aligned}$$

**A1.21:**

$$\begin{aligned}
 f(2+h) &= (2+h) - (2+h)^2 \\
 &= 2+h-4+4h+h^2 \\
 &= h^2+5h-2
 \end{aligned}$$

$$\begin{aligned}
 f(x+h) &= (x+h) - (x+h)^2 \\
 &= x+h-x^2+2hx+h^2 \\
 &= h^2+h+2hx-x^2+x
 \end{aligned}$$

$$\begin{aligned}
 \frac{f(x+h)-f(x)}{h} &= \frac{(h^2+h+2hx-x^2+x)-(x-x^2)}{h} \\
 &= \frac{h^2+h+2hx}{h} \\
 &= h+1+2x
 \end{aligned}$$

**A1.22:**

$$\begin{aligned}
 f(2+h) &= \frac{2+h}{2+h+1} \\
 &= \frac{2+h}{3+h}
 \end{aligned}$$

$$f(x+h) = \frac{x+h}{x+h+1}$$

$$\begin{aligned} \frac{f(x+h) - f(x)}{h} &= \frac{\frac{x+h}{x+h+1} - \frac{x}{x+1}}{h} \\ &= h^{-1} \left( \frac{(x+h)(x+1)}{(x+h+1)(x+1)} - \frac{x(x+h+1)}{(x+h+1)(x+1)} \right) \\ &= h^{-1} \left( \frac{x^2 + hx + x + h - x^2 - hx - x}{x^2 + hx + x + x + h + 1} \right) \\ &= h^{-1} \left( \frac{h}{x^2 + hx + 2x + h + 1} \right) \\ &= \frac{1}{x^2 + 2x + hx + h + 1} \end{aligned}$$

**A1.23:** The domain of  $f$  is  $\mathbb{R} - \{1/3\}$

**A1.24:** The domain of  $f$  is  $\mathbb{R} - \{-2, -1\}$

**A1.25:** The domain of  $f$  is  $[0, \infty)$

**A1.26:** The domain of  $g$  is  $[0, 4]$

**A1.27:** The domain of  $h$  is all  $x$  for which  $x^2 - 5x > 0$ , so either  $x < 0$  or  $x > 5$ . The domain is  $(-\infty, 0) \cup (5, \infty)$

**A1.28:** The domain of this function is  $[-2, 2]$ , the range of this function is  $[0, 2]$ . I can't sketch it, but the graph is the upper half of a circle of radius 2 centered at the origin.

**A1.29:** Domain:  $\mathbb{R}$

**A1.30:** Domain:  $\mathbb{R}$

**A1.31:** Domain:  $\mathbb{R}$

**A1.32:** Domain:  $\mathbb{R} - \{2\}$

**A1.33:** Domain:  $[5, \infty)$

**A1.34:** Domain:  $\mathbb{R}$

**A1.35:** Domain:  $\mathbb{R} - \{0\}$

**A1.36:** Domain:  $\mathbb{R} - \{0\}$

**A1.37:** Domain:  $\mathbb{R}$

**A1.38:** Domain:  $\mathbb{R}$

**A1.39:** Domain:  $\mathbb{R}$

**A1.40:** Domain:  $\mathbb{R}$

**A1.41:** The slope is  $(-6 - 1)/4 - (-2) = -7/6$ . The domain is  $[-2, 4]$ . So

$$f(x) = -7/6(x+2) + 1 \quad -2 \leq x \leq 4$$

**A1.42:**

$$f(x) = -5/9(x+3) + 1 \quad -3 \leq x \leq 6$$

**A1.43:**

$$f(x) = -\sqrt{-x} + 1 \quad x \leq 0$$

**A1.44:**

$$f(x) = +\sqrt{(1 - (x - 1))^2}$$

**A1.45:**

$$f(x) = \begin{cases} x + 1 & -1 \leq x < 2 \\ -\frac{3}{2}(x - 2) & 2 \leq x \leq 4 \end{cases}$$

**A1.46:**

$$f(x) = \begin{cases} -2x + 2 & 0 \leq x < 1 \\ x - 1 & 1 \leq x \end{cases}$$

**A1.47:** Let  $l$  denote length and  $w$  denote width. Then a perimeter of 20 means

$$20 = 2l + 2w$$

The area of a rectangle is  $A = lw$ . We eliminate  $w$  by solving for  $w$  in the constraint above. We have that  $w = (20 - 2l)/2 = 10 - l$ . So our function is

$$f(l) = l(10 - l)$$

**A1.48:** Same as above, but solve for  $w$  using the area constraint:  $w = 16/l$ . Then

$$f(l) = 2l + 2\frac{16}{l} = 2l + \frac{32}{l}$$

**A1.49:** The area of any triangle is the length of a side times the length of the altitude whose base is that side, divided by two. Let the length of a side be  $s$ . By symmetry, any altitude will bisect a side. Hence an altitude's height can be found by the Pythagorean theorem, with side lengths  $s$  and  $s/2$ . The relationship between  $s$  and  $h$  is then

$$s^2 = h^2 + \left(\frac{s}{2}\right)^2$$

So

$$h = \sqrt{s^2 - \frac{s^2}{4}} = \sqrt{\frac{3s^2}{4}} = \frac{s}{2}\sqrt{3}$$

Then the area of the triangle is

$$f(s) = \frac{sh}{2} = \frac{s^2}{4}\sqrt{3}$$

**A1.50:** The volume of a cube with edge length  $s$  is  $V = s^3$ . The surface area is  $6s^2$ . We have that

$$6s^2 = 6 \cdot (s^3)^{\frac{2}{3}}$$

So

$$f(V) = 6V^{\frac{2}{3}}$$

**A1.51:** Let  $s$  be the length of a side of the base. Then its volume is  $s^2 \cdot h$ , where  $h$  is the height of the box, so we have that

$$2 = s^2 h$$

The surface of this box, since it is open topped, is  $s^2 + 4sh$ . We can write  $h$  in terms of  $s$  by solving the volume constraint for it. This gives us  $h = 2/s^2$ . Then

$$f(s) = s^2 + 4s \left( \frac{2}{s^2} \right) = s^2 + \frac{8}{s}$$

**A1.52:** The perimeter of the window is  $30 = x + 2h + x\pi/2$ , where  $h$  is the height of the rectangular region. Then  $h = 30 - x(1 + \pi/2)$ . The area of the window is  $xh + \pi(x/2)^2$ . Then

$$\begin{aligned} f(x) &= x(30 - x(1 + \pi/2)) + \pi \left( \frac{x}{2} \right)^2 \\ &= 30x - \frac{2 + \pi}{2}x^2 + \frac{\pi}{4}x^2 \\ &= 30x + \frac{\pi - 2\pi - 4}{4}x^2 \\ &= 30x - \frac{\pi + 4}{4}x^2 \end{aligned}$$

**A1.53:** The volume of the box is  $xlw$ , where  $l = 20 - 2x$  and  $w = 12 - 2x$ . Then our volume function is

$$f(x) = x(20 - 2x)(12 - 2x)$$

**A1.54:**

$$f(x) = \begin{cases} 2 & 0 < x \leq 1 \\ 2.2 & 1 < x \leq 1.1 \\ 2.4 & 1.1 < x \leq 1.2 \\ 2.6 & 1.2 < x \leq 1.3 \\ 2.8 & 1.3 < x \leq 1.4 \\ 3 & 1.4 < x \leq 1.5 \\ 3.2 & 1.5 < x \leq 1.6 \\ 3.4 & 1.6 < x \leq 1.7 \\ 3.6 & 1.7 < x \leq 1.8 \\ 3.8 & 1.8 < x \leq 1.9 \\ 4 & 1.9 < x < 2 \end{cases} = \begin{cases} 2 & 0 < x \leq 1 \\ 2 + 0.2 \cdot \text{ceil}(10(x - 1)) & 1 < x < 2 \end{cases}$$

**A1.55:**

(a)

$$R(I) = \begin{cases} 0 & I \leq 10000 \\ \frac{I - 0.1 \cdot (I - 10000)}{I} & 10000 < I \leq 20000 \\ \frac{I - 0.1 \cdot (10000) - 0.15(I - 20000)}{I} & 20000 < I \end{cases}$$

(b) The amount of tax for 14000 is  $4000 \cdot 0.1 = 400$  dollars. For 26000 it's  $10000 \cdot 0.1 + 6000 \cdot 0.15 = 1000 + 900 = 1900$  dollars.

(c)

$$T(I) = \begin{cases} 0 & I \leq 10000 \\ 0.1(I - 10000) & 10000 < I \leq 20000 \\ 1000 + 0.15(I - 20000) & 20000 < I \end{cases}$$

**A1.56:** Skip

**A1.57:**

(a)  $g$  is even and  $f$  is odd.

(a)  $f$  is neither and  $g$  is odd.

**A1.58:** The point  $(-5, 3)$

**A1.59:** The point  $(-5, -3)$

**A1.60:**

(a) Mirror along  $y$  axis

(b) Mirror along  $y$  axis and flip (the copy) along  $x$  axis.

**A1.61:** Even.  $f(-x) = (-x)^{-2} = ((-x)^2)^{-1} = (x^2)^{-1} = x^{-2} = f(x)$ .

**A1.62:** Odd.  $f(-x) = (-x)^{-3} = ((-x)^3)^{-1} = -(x^3)^{-1} = -x^{-3} = -f(x)$ .

**A1.63:** Neither.  $f(1) = 2$ , but  $f(-1) = 0$ .

**A1.64:** Even.

**A1.65:** Odd.

**A1.66:** Neither.