1 LINEAR EQUATIONS AND GRAPHS

EXERCISE 1-1

2. $7x-6=5x-24$

$2x=-18$

$x=-9$

4. $3(x+6)=5-2(x+1)$

$3x+18=5-2x-2$

$5x=-15$

$x=-3$

6. $\frac{2x+1}{3}-\frac{5x}{2}=4$ (multiply both sides by 6)

$2(2x+1)-15x=24$

$4x+2-15x=24$

$-11x=22$

$x=-2$

8. $-3<x\le 5$

10. $-6\le x\le -1$

12. $x\ge 9$ or $9\le x<\infty$

14. $[-1,5)$

16. $[4,\infty)$

18. $-8<-4x\le 12$ (divide the inequalities by – 4 and reverse the directions)

$2>x\ge -3$ or $-3\le x<2$

$[-3,2)$

20. $\frac{m}{3}-4=\frac{2}{3}$

Multiply both sides of the equation by 3 to obtain:

$m-12=2$

$m=14$

22. $\frac{x}{-4}<\frac{5}{6}$

Multiply both sides by (−4) which will result in changing the direction of the inequality as well.

$x>\frac{-20}{6}$ and simplified we have $x>-\frac{10}{3}$.

24. $-3y+9+y=13-8y$

$-2y+9=13-8y$

$6y=4$

$y=\frac{4}{6}=\frac{2}{3}$

26. $-3(4-x)=5-(x+1)$

$-12+3x=5-x-1$

$-12+3x=4-x$

$12-12+3x=12+4-x$

$3x=16-x$

$4x=16$

$x=4$

28. $x-2\ge 2(x-5)$

$x-2\ge 2x-10$

$x-2+2\ge 2x-10+2$

$x\ge 2x-8$

$-x\ge -8$

$x\le 8$

30. $\frac{y}{4}-\frac{y}{3}=\frac{1}{2}$

Multiply both sides by 12:

$3y-4y=6$

$-y=6$

$y=-6$

32. $\frac{u}{2} - \frac{2}{3} < \frac{u}{3} + 2$

$\frac{u}{2} - \frac{u}{3} < 2 + \frac{2}{3}$

$\frac{u}{6} < \frac{8}{3}$

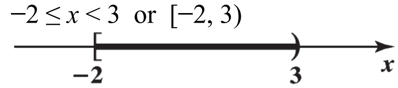
$u < 16$

34. $-4 \le 5x + 6 < 21$

$-6 - 4 \le 5x < 21 - 6$

$-10 \le 5x < 15$

$-2 \le x < 3$ or $[-2, 3)$



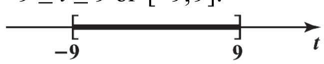
36. $-1 \le \frac{2}{3}t + 5 \le 11$

$-5 - 1 \le \frac{2}{3}t \le 11 - 5$

$-6 \le \frac{2}{3}t \le 6$

$-18 \le 2t \le 18$

$-9 \le t \le 9$ or $[-9,9]$.



38. $y = -\frac{2}{3}x + 8$

$y - 8 = -\frac{2}{3}x + 8 - 8$

$-\frac{2}{3}x = y - 8$

$-2x = 3y - 24$

$x = \frac{3y - 24}{-2} = -\frac{3}{2}y + 12$

40. $y = mx + b$

$y - b = mx + b - b$

$mx = y - b$

$m = \frac{y - b}{x}$

42. $C = \frac{5}{9}(F - 32)$

$\frac{9}{5}C = F - 32$

$32 + \frac{9}{5}C = F$

$F = \frac{9}{5}C + 32$

44. $-10 \le 8 - 3u \le -6$

$-18 \le -3u \le -14$

$18 \ge 3u \ge 14$

$6 \ge u \ge \frac{14}{3}$

$\frac{14}{3} \le u \le 6$ or $[14/3, 6]$

46. If a and b are negative and $\frac{b}{a} > 1$, then multiplying both sides by the negative number a we obtain $b < a$ and hence $a - b > 0$.

48. Let x = number of quarters in the meter. Then
$100 - x$ = number of dimes in the meter.

Now, $0.25x + 0.10(100 - x) = 14.50$ or

$0.25x + 10 - 0.10x = 14.50$

$0.15x = 4.50$

$x = \frac{4.50}{0.15} = 30$

Thus, there will be 30 quarters and 70 dimes.

50. Let x be the amount invested in "Fund A" and $(500{,}000 - x)$ the amount invested in "Fund B". Then $0.052x + 0.077(500{,}000 - x) = 30{,}000$.

Solving for x:

$$(0.077)(500{,}000) - 30{,}000 = (0.077 - 0.052)x$$
$$8{,}500 = 0.025x$$
$$x = \frac{8{,}500}{0.025} = \$340{,}000$$

So, \$340,000 should be invested in Fund A and \$160,000 in Fund B.

52. Let x be the price of the house in 1960. Then

$$\frac{x}{200{,}000} = \frac{29.6}{229.6} \quad \text{(refer to Table 2, Example 10)}$$
$$x = 200{,}000\frac{29.6}{229.6} \approx \$25{,}784$$

To the nearest dollar, the house would be valued \$25,784 in 1960.

54. (A) It is $60 - 0.15(60) = \$51$

(B) Let x be the retail price. Then

$136 = x - 0.15x = 0.85x$

So, $x = \dfrac{136}{0.85} = \$160.$

56. Let x be the number of times you must clean the living room carpet to make buying cheaper than renting. Then

$$(20 + 2(16))x = 300 + 3(9)x$$

Solving for x

$$52x = 300 + 27x$$
$$25x = 300$$
$$x = \frac{300}{25} = 12$$

58. Let x be the amount of the second employee's sales during the month. Then

(A) $3{,}000 + 0.05x = 4{,}000$

or $x = \dfrac{4{,}000 - 3{,}000}{0.05} = \$20{,}000$

(B) In view of Problem 57 we have:

$2{,}000 + 0.08(x - 7{,}000) = 3{,}000 + 0.05x$

Solving for x:

$$2{,}000 - (0.08)7{,}000 - 3{,}000 = 0.05x - 0.08x$$
$$-1{,}560 = -0.03x$$
$$x = \frac{1{,}560}{0.03} = \$52{,}000$$

(C) An employee who chooses (A) will earn more than he or she would with the other option until \$52,000 in sales is achieved, after which the other option would earn more.

60. Let x = number of books produced. Then

Costs: $C = 2.10x + 92{,}000$
Revenue: $R = 15x$

To find the break-even point, set $R = C$:

$$\begin{aligned} 15x &= 2.10x + 92{,}000 \\ 12.9x &= 92{,}000 \\ x &= \frac{92{,}000}{12.9} \approx 7{,}132 \end{aligned}$$

Thus, 7,132 books will have to be sold for the publisher to break even.

62. Let x = number of books produced.
Costs: $C(x) = 92{,}000 + 2.70x$
Revenue: $R(x) = 15x$

(A) The obvious strategy is to raise the price of the book.

(B) To find the break-even point, set $R(x) = C(x)$:

$$\begin{aligned} 15x &= 92{,}000 + 2.70x \\ 12.30x &= 92{,}000 \\ x &= 7{,}480 \end{aligned}$$

The company must sell more than 7,480 books to make a profit.

(C) From Problem 60, the production level at the break-even point is: 7,132 books. At this production level, the costs are

$$C(7{,}132) = 92{,}000 + 2.70(7{,}132) = \$111{,}256.40$$

If p is the new price of the book, then we need

$$7{,}132p = 111{,}256.40$$
and $p \approx \$15.60$

The company should sell the book for at least \$15.60.

64.

$$\begin{aligned} -49 &\le F \le 14 \\ -49 &\le \frac{9}{5}C + 32 \le 14 \\ -32 - 49 &\le \frac{9}{5}C \le 14 - 32 \\ -81 &\le \frac{9}{5}C \le -18 \\ (-81)\cdot 5 &\le 9C \le (-18)\cdot 5 \\ \frac{(-81)\cdot 5}{9} &\le C \le \frac{(-18)\cdot 5}{9} \\ -45 &\le C \le -10 \end{aligned}$$

66. Note that $\text{IQ} = \dfrac{\text{MA}}{\text{CA}} \times 100$ (see problem 65). Thus

$$\begin{aligned} 80 &< \text{IQ} < 140 \\ 80 &< \frac{\text{MA}}{12} \times 100 < 140 \end{aligned}$$

or $\dfrac{(80)(12)}{100} < \text{MA} < \dfrac{(140)(12)}{100}$

or $9.6 < \text{MA} < 16.8$

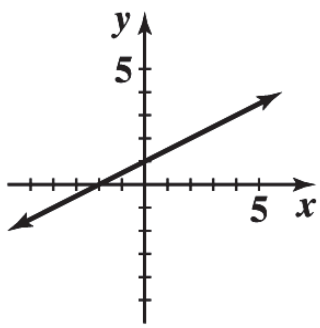
EXERCISE 1-2

2. (A)

4. (B); slope is not defined for a vertical line

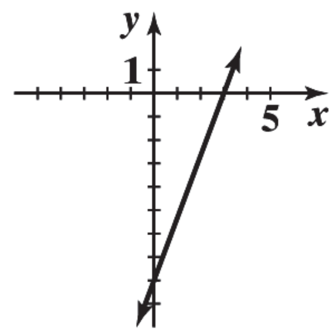
6. $y = \frac{x}{2} + 1$

x	y
0	1
2	2
4	3



8. $8x - 3y = 24$

x	y
0	−8
3	0
6	8



10. Slope: $m = 3$

y intercept: $b = 2$

12. Slope: $m = -\frac{10}{3}$

y intercept: $b = 4$

14. Slope: $m = \frac{1}{5}$, y intercept: $b = -\frac{1}{2}$

16. $y = -4x + 12$; $m = -4$; x-intercept 3

18. $3x + y = 6$; $y = -3x + 6$

$m = -3$, x-intercept 2

20. $9x + 2y = 4$; $y = -\frac{9}{2}x + 2$

$m = -\frac{9}{2}$, x-intercept $\frac{4}{9}$

22. $m = 1$, $b = 5$ so $y = x + 5$

24. $m = \frac{6}{7}$, y intercept: $b = -\frac{9}{2}$ so $y = \frac{6}{7}x - \frac{9}{2}$

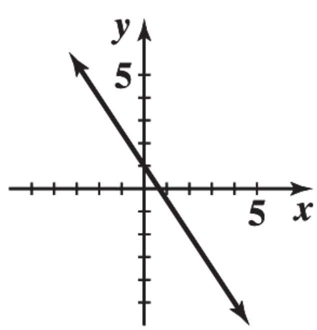
26. x intercept: 1; y intercept: 3; $y = -3x + 3$

28. x intercept: 2, y intercept: −1; $y = \frac{1}{2}x - 1$

30. $y = -\frac{3}{2}x + 1$

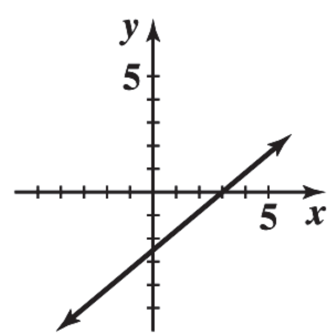
$m = -\frac{3}{2}$, $b = 1$

x	y
0	1
2	−2
−2	4

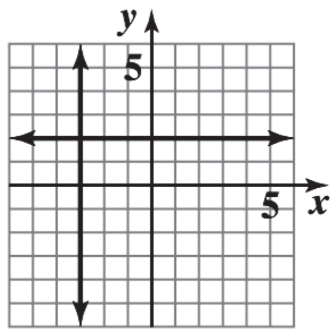


32. $5x - 6y = 15$

x	y
0	−2.5
3	0
−3	−5



34.



36. $5x - y = -2$

$-y = -5x - 2$

Multiply both sides by (-1);

$y = 5x + 2$

$m = 5$

38. $2x - 3y = 18$

$-3y = -2x + 18$

Divide both sides by (-3);

$y = \frac{2}{3}x - 6$

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

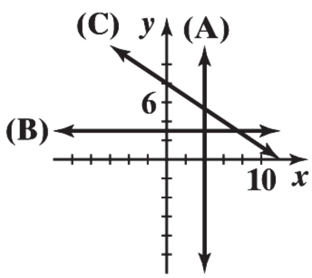
40. $-x + 8y = 4$

$8y = x + 4$

$y = \frac{1}{8}x + \frac{1}{2}$

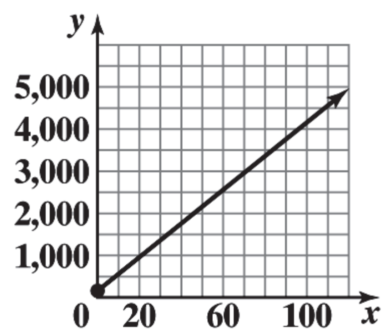
Slope $= \frac{1}{8}$

42.

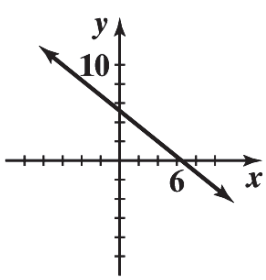


(A) $x = 4$ (B) $y = 3$ (C) $y = -\frac{2}{3}x + 8$

44.



46. (A)

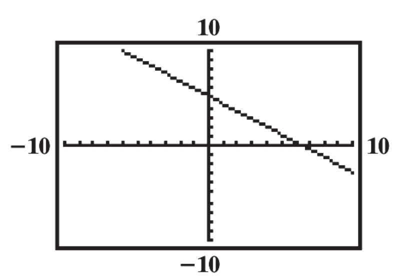


(B) Set $y = 0$,

$-0.8x + 5.2 = 0,\ x = 6.5.$

Set $x = 0,\quad y = 5.2.$

(C)



(D) x intercept: 6.5;

y intercept: 5.2

48. The equation of the vertical line is $x = -5$ and the equation of the horizontal line is $y = 6$.

50. The equation of the vertical line is $x = 2.6$ and the equation of the horizontal line is $y = 3.8$.

52. Slope: $m = 4$; point: (0,6). Using the point-slope form:

$$y - 6 = 4(x - 0)$$
$$y = 4x + 6$$

54. Slope: $m = -10$; point: $(2, -5)$. Using the point-slope form:

$$y - (-5) = -10(x - 2)$$
$$y + 5 = -10x + 20$$
$$y = -10x + 15$$

56. Slope: $m = 2/7$; point: (7,1). Using the point-slope form:

$$y - 1 = \frac{2}{7}(x - 7)$$
$$y - 1 = \frac{2}{7}x - 2$$
$$y = \frac{2}{7}x - 1$$

58. Slope: $m = 0.9$; point: (2.3, 6.7). Using the point-slope form:

$$y - 6.7 = 0.9(x - 2.3)$$
$$y - 6.7 = 0.9x - 2.07$$
$$y = 0.9x + 4.63$$

60. (A) $m = \frac{5-2}{3-1} = \frac{3}{2}$

(B) Using $y - y_1 = m(x - x_1)$, where $m = \frac{3}{2}$ and $(x_1, y_1) = (1,2)$, we obtain:

$$y - 2 = \frac{3}{2}(x - 1) \quad \text{or} \quad 3x - 2y = -1$$

(C) Slope-intercept form: $y = \frac{3}{2}x + \frac{1}{2}$

62. (A) $m = \frac{7-3}{-3-2} = -\frac{4}{5}$

(B) Using $y - y_1 = m(x - x_1)$, where $m = -\frac{4}{5}$ and $(x_1, y_1) = (-3,7)$, we obtain:

$$y - 7 = -\frac{4}{5}(x + 3) \quad \text{or} \quad 4x + 5y = 23.$$

(C) Slope-intercept form: $y = -\frac{4}{5}x + \frac{23}{5}$

64. (A) $m = \dfrac{4-4}{0-1} = \dfrac{0}{-1} = 0$

(B) The line through (1, 4) and (0, 4) is horizontal; $y = 4$.

(C) Slope-intercept form is the same: $y = 4$.

66. (A) $m = \dfrac{-3-0}{2-2} = \dfrac{-3}{0}$ which is not defined.

(B) The line through (2, 0) and (2, −3) is vertical; $x = 2$.

(C) No slope-intercept form

68. The graphs are parallel lines with slope −0.5.

70. Let C be the total weekly cost of producing x picnic tables. Then

$C = 1{,}200 + 45x$

For $C = \$4{,}800$, we have

$1{,}200 + 45x = 4{,}800$

Solving for x we obtain

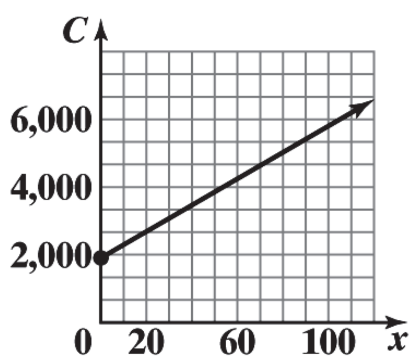
$x = \dfrac{4{,}800 - 1{,}200}{45} = 80$

72. Let y be daily cost of producing x tennis rackets. Then we have two points for (x, y): (50, 3,855) and (60, 4,245).

(A) Since x and y are linearly related, then the two points (50, 3,855) and (60, 4,245) will lie on the line expressing the linear relationship between x and y. Therefore

$y - 3{,}855 = \dfrac{(4{,}245 - 3{,}855)}{(60 - 50)}(x - 50)$ or $y = 39x + 1{,}905$

(B)



(C) The y intercept, \$1,905, is the fixed cost and the slope, \$39, is the cost per racket.

74. Let R and C be retail price and cost respectively. Then two points for (C, R) are (20, 33) and (60, 93).

(A) If C and R are linearly related, then the line expressing their relationship passes through the points (20, 33) and (60, 93). Therefore,

$R - 33 = \dfrac{(93 - 33)}{(60 - 20)}(C - 20)$

or $R = 1.5C + 3$

(B) For R = \$240 we have

$$240 = 1.5C + 3$$

$$\text{or } C = \frac{240-3}{1.5} = \$158$$

76. We observe that for (t, V) two points are given: (0, 224,000) and (16, 115,200)

(A) A linear model will be a line passing through the two points (0, 224,0000) and (16, 115,200). The equation of this line is:

$$V - 115{,}200 = \frac{(224{,}000-115{,}200)}{(0-16)}(t-16) \text{ or } V = -6{,}800t + 224{,}000$$

(B) For $t = 10$

$$V = -6{,}800(10) + 224{,}000 = \$156{,}000$$

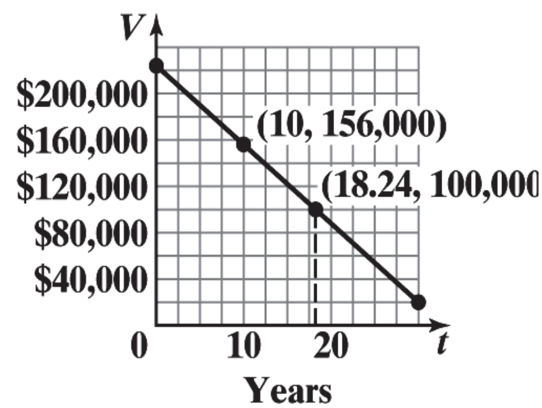
(C) For V = \$100,000

$$100{,}000 = -6{,}800t + 224{,}000$$

$$\text{or } t = \frac{(224{,}000-100{,}000)}{6{,}800} \approx 18.24$$

So, during the 19th year, the depreciated value falls below \$100,000.

(D)



78. We have two representations for (x, T) namely: (29.9, 212) and (28.4, 191).

(A) The line of the form $T = mx + b$ has slope:

$$m = \frac{(212-191)}{(29.9-28.4)} = 14$$

Using, say (29.9, 212), will give the value for b: $b = -206.6$

(B) For $x = 31$, we have

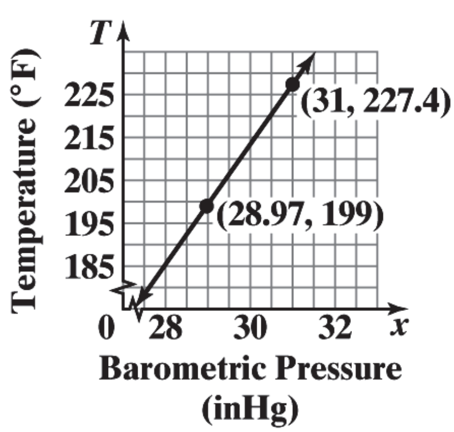
$$T = 14(31) - 206.6 = 227.4\text{°F}$$

(C) For $T = 199$°F, we have

$$199 = 14x - 206.6$$

$$\text{or } x = \frac{199+206.6}{14} \approx 28.97 \text{ in Hg}$$

(D)



80. Let T be the true airspeed at the altitude A (thousands of feet). Since T increases 1.6% , $T(1000) = 200(1.016) = 203.2$.

(A) A linear relationship between A and T has slope

$$m = \frac{(203.2 - 200)}{1} = 3.2 . \quad \text{Therefore,} \quad T = 3.2A + 200.$$

(B) For $A = 6.5$ (6,500 feet), $T = 3.2(6.5) + 200 = 20.8+200 = 220.8$ mph

82. (A) $I = mt + b$

At $t = 0$, $I = 30{,}000$. Therefore, $I = mt + 30{,}000$.

At $t = 25$, $I = 55{,}775 = m(25)+30{,}000$

$$25m = 55{,}775 - 30{,}000$$
$$25m = 25{,}775$$
$$m = 1031$$

Therefore, $I = 1031t + 30{,}000$.

(B) At $t = 40$, $I = 1031(40) + 30{,}000 = 71{,}240$

The median income in 2030 will be $71,240.

84. (A) $f = mt + b$

At $t = 0$, $f = 25.7$. Therefore, $f = mt + 25.7$.

At $t = 15$,

$$16.7 = 15m + 25.7$$
$$15m = -9$$
$$m = -0.6$$

Therefore, $f = -0.6t + 25.7$.

(B) Solve $-0.6t + 25.7 < 7$ for t

$$-0.6t < -18.7$$
$$t > 31.2$$

The percentage of male smokers will fall below 7% in 2031.

86. (A) For (x, p) we have two representations: (9,800, 3.2) and (9,300, 2.95).

The slope is

$$m = \frac{3.2 - 2.95}{9{,}800 - 9{,}300} = 0.0005 = 0.0005$$

Using one of the points, say (9,800, 3.2), we find b:

$3.2 = (0.0005)(9{,}800) + b$

or $b = -1.7$

So, the desired equation is: $p = 0.0005x - 1.7$.

(B) Here the two representations of (x, p) are: (9,200, 3.2) and (9,700, 2.95). The slope is

$$m = \frac{3.2 - 2.95}{9,200 - 9,700} = -0.0005$$

Using one of the points, say (9,200, 3.2) we find b:

$3.2 = -0.0005(9{,}200) + b$

or $b = 7.8$

So, the desired equation is: $p = -0.0005x + 7.8$.

(C) To find the equilibrium point, we need to solve

$0.0005x - 1.7 = -0.0005x + 7.8$ for x. This gives

$0.001x = 9.5$ or

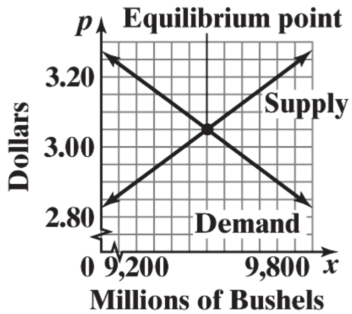
$$x = \frac{9.5}{0.001} = 9,500$$

Substituting $x = 9{,}500$ in either of the equations in (A) or (B), we use (A), we obtain

$p = 0.0005(9,500) - 1.7 = 3.05$

So, the desired point is (9,500, 3.05).

(D)



88. We have two representations of (w, d): (3, 18) and (5, 10).

(A) The line through these two points has a slope $\frac{(18-10)}{(3-5)} = -4$.

So, the equation of the line is

$d - 10 = -4(w - 5)$

or $d = -4w + 30$

(B) For $w = 0$, $d = 30$ in.

(C) For $d = 0$,

$-4w + 30 = 0$

or $w = \frac{30}{4} = 7.5$ lbs.

EXERCISE 1-3

2. (A) $w = 52 + 1.9h$

(B) The rate of change of weight with respect to height is 1.9 inches per kilogram.

(C) 5'8" is 8 inches over 5 feet and the model predicts the weight to be

$w = 52 + 1.9(8) = 67.2$ kg.

(D) For $w = 70$, we have

$70 = 52 + 1.9h$

or $h = \frac{70-52}{1.9} \approx 9.5$

So, the height of this man is predicted to be 5'9.5".

4. We have two representations of (d, P): (0, 14.7) and (34, 29.4).

(A) A line relating P to d passes through the above two points.
Its equation is:

$P - 14.7 = \frac{(29.4-14.7)}{(34-0)}(d-0)$

or $P \approx 0.432d + 14.7$

(B) The rate of change of pressure with respect to depth is approximately
0.432 lbs/in^2 per foot.

(C) For $d = 50$,

$P = 0.432(50) + 14.7 \approx 36.3$ lbs/in^2

(D) For $P = 4$ atmospheres, we have $P = 4(14.7) = 58.8$ lbs/in^2
and hence

$58.8 = 0.432d + 14.7$

or $d = \frac{58.8-14.7}{0.432} \approx 102$ ft.

6. We have two representations of (t, a): (0, 2,880) and (180, 0).

(A) The linear model relating altitude a to the time in air t has
the following equation:

$a - 2{,}880 = \frac{(0-2{,}880)}{(180-0)}(t-0)$

or $a = -16t + 2{,}880$

(B) The rate of descent for an ATPS system parachute is 16 ft/sec.

(C) It is 16 ft/sec.

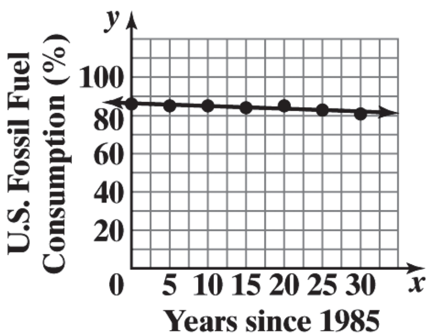
8. We have two representations of (t, s): (0, 1,403) and (20, 1,481).
So, the line passing through these points has the following equation:

$s - 1{,}403 = \frac{(1{,}481-1{,}403)}{(20-0)}(t-0)$

or $s = 3.9t + 1{,}403$

The slope of this line (model) is the rate of change of the speed of sound with respect to temperature; 3.9 m/s per ˚C.

10. (A)



(B) The percent rate of change of fossil fuel consumption is −0.14% per year.

(C) For $x = 40$ (2025 is 40 years from 1985), we have

$$y = -0.14(40) + 86.18 = 80.58$$

i.e. $\approx 81\%$ of total consumption.

(D) Solve $-0.14x + 86.18 < 80$ for x:

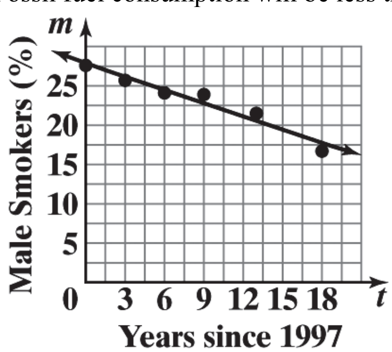
$$-0.14x + 86.18 < 80$$

$$-0.14x < 80 - 86.18 = -6.18$$

$$x > 44.1$$

Fossil fuel consumption will be less than 80% of total energy consumption in 2030.

12. (A)



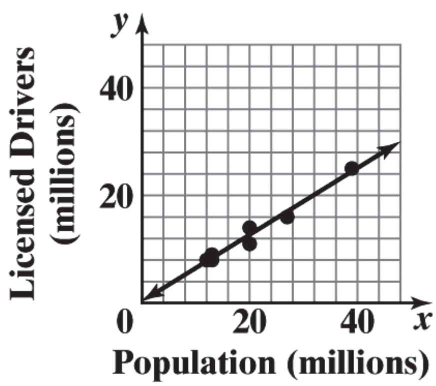
(B) Solve $-0.56t + 27.82 < 10$ for t:

$$-0.56t < 10 - 27.82 = -17.82$$

$$t > 31.82$$

The first year in which the percentage of male smokers will be less than 10% is 2029.

14. (A)



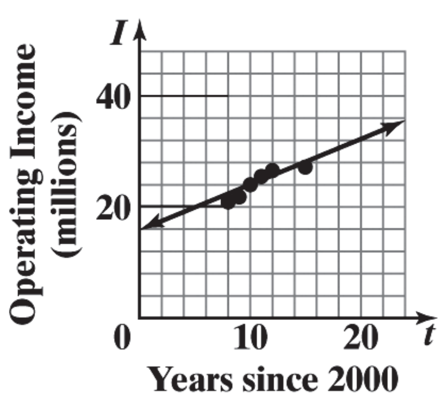
$y = 0.62x + 0.29$

(B) For $x = 9.9$,
$y(9.9) = 0.62(9.6) + 0.29 = 6.428$, so there were about 6,428,000 licensed drivers in Michigan in 2014.

(C) Solve $6.7 = 0.62x + 0.29$ for x:
$0.62x = 6.7 - 0.29 = 6.41$, $x \approx 10.339$

The population of Georgia in 2014 was approximately 10,339,000

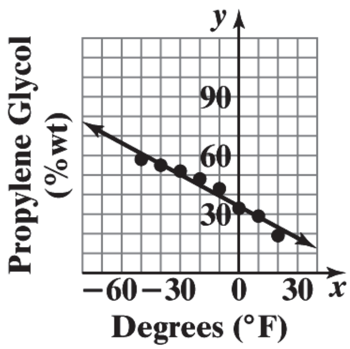
16. (A)



$I = 0.82t + 15.84$

(B) At $t = 26$, $I = 0.82(26) + 15.84 = 37.16$. Walmart's operating in 2026 will be approximately 37.2 billion dollars.

18. (A)



(B) For $P = 30$, we have:
$30 = -0.54T + 34$
or $T = \frac{34-30}{0.54} \approx 7°\text{F}$

(C) For $T = 15$, we have:
$P = -0.54(15) + 34 = 25.9$,
i.e., the estimated percentage of propylene glycol is 25.9%.

20. (A) The rate of change of height with respect to Dbh is 1.66 ft/in.

(B) One inch increase in Dbh produces a height increase of approximately 1.66 ft.

(C) For $x = 12$, we have:
$y = 1.66(12) - 5.14 \approx 15$ ft.

(D) For $y = 25$, we have:
$25 = 1.66x - 5.14$
or $x = \frac{25+5.14}{1.66} \approx 18$ in.

22. Male graduate enrollment: $y = 0.011x + 0.816$, female graduate enrollment: $y = 0.031x + 0.695$.

(A) Graduate male enrollment is increasing at a rate of 11,000 students per year, female graduate enrollment is increasing at the rate of 31,000 students per year.

(B) Male enrollment in 2025: $y = 0.011(45) + 0.816 \approx 1.3$ million;

Female enrollment in 2025: $y = 0.031(45) + 0.695 \approx 2.1$ million.

(C) Solve $0.031x + 0.695 > 0.011x + 0.816 + 1 = 1.816$ for x:
$0.02x > 1.816 - 0.695 = 1.121$
$x > 56.05$

Female graduate enrollment will exceed graduate male enrollment by 1 million in 2037.

24. Linear regression model $y = 0.051x + 30.166$. Annual precipitation estimate for 2025:

$y = 0.051(65) + 30.166 \approx 33.48$ inches.

26. Men: $y = -0.247x + 119.097$
Women: $y = -0.122x + 128.494$

The graphs of these lines indicate that the women will not catch up with the men. To see this algebraically, we set the equations equal to each other and solve for x; we obtain $x = -75.2$, so the lines intersect at a point outside of the domain of our functions. Also, the men's slope is steeper so their times, already lower, are decreasing more rapidly.

28. Supply: $y = 1.53x + 2.85$;
Demand: $y = -2.21x + 10.66$

To find equilibrium price we solve the following equation for x and then use that to find y:

$$1.53x + 2.85 = -2.21x + 10.66$$

$$\text{or} \quad x = \frac{(10.66 - 2.85)}{(1.53 + 2.21)} \approx 2.09,$$

and $y = 1.53(2.09) + 2.85 \approx \$6.05$.

CHAPTER 1 REVIEW

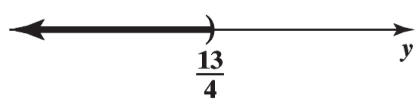
1. $2x + 3 = 7x - 11$
$-5x = -14$
$x = \frac{14}{5} = 2.8$ (1-1)

2. $\frac{x}{12} - \frac{x-3}{3} = \frac{1}{2}$
Multiply each term by 12:
$x - 4(x - 3) = 6$
$x - 4x + 12 = 6$
$-3x = 6 - 12$
$-3x = -6$
$x = 2$ (1-1)

3. $2x + 5y = 9$
$5y = 9 - 2x$
$y = \frac{9}{5} - \frac{2}{5}x = 1.8 - 0.4x$ (1-1)

4. $3x - 4y = 7$
$3x = 7 + 4y$
$x = \frac{7}{3} + \frac{4}{3}y$
(1-1)

5. $4y - 3 < 10$
$4y < 13$
$y < \frac{13}{4}$ or $\left(-\infty, \frac{13}{4}\right)$



(1-1)

6. $-1 < -2x + 5 \le 3$
$-6 < -2x \le -2$
$3 > x \ge 1$
or $[1, 3)$

(Divide the inequalities by –2 and reverse the direction.)

(1-1)

7. $1 - \frac{x-3}{3} \le \frac{1}{2}$

Multiply both sides of the inequality by 6. We do not reverse the direction of the inequality, since $6 > 0$.

$6 - 2(x - 3) \le 3$

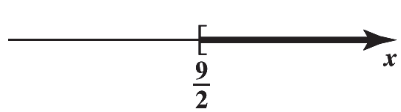
$6 - 2x + 6 \le 3$

$-2x \le 3 - 12$

$-2x \le -9$

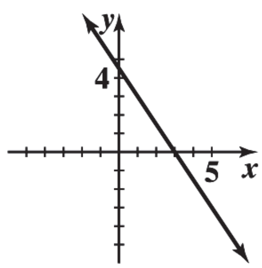
Divide both sides by –2 and reverse the direction of the inequality, since $-2 < 0$.

$x \ge \frac{9}{2}$ or $\left[\frac{9}{2}, \infty\right)$



(1-1)

8. $3x + 2y = 9$



(1-2)

9. The line passes through (6, 0) and (0, 4)

slope $m = \frac{4-0}{0-6} = -\frac{2}{3}$

From the slope-intercept form: $y = -\frac{2}{3}x + 4$; multiplying by 3 gives:

$3y = -2x + 12$, so $2x + 3y = 12$ (1-2)

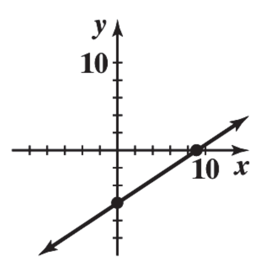
10. x-intercept: $2x = 18$, $x = 9$;

y-intercept: $-3y = 18$, $x = -6$;

slope-intercept form:

$y = \frac{2}{3}x - 6$; slope $= \frac{2}{3}$

Graph:



(1-2)

11. $y = -\frac{2}{3}x + 6$ (1-2)

12. Vertical line: $x = -6$; horizontal line: $y = 5$ (1-2)

13. Use the point-slope form:

(A) $y - 2 = -\frac{2}{3}[x - (-3)]$

$y - 2 = -\frac{2}{3}(x + 3)$

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

(B) $y - 3 = 0(x - 3)$

$y = 3$

(1-2)

14. (A) Slope: $\frac{-1-5}{1-(-3)} = -\frac{3}{2}$

$y - 5 = -\frac{3}{2}(x + 3)$

$3x + 2y = 1$

(B) Slope: $\frac{5-5}{4-(-1)} = 0$

$y - 5 = 0(x - 1)$

$y = 5$

(C) Slope: $\frac{-2-7}{-2-(-2)}$ not defined since $2 - (-2) = 0$

$x = -2$

(1-2)

15. $3x + 25 = 5x$

$-2x = -25$

$x = \frac{25}{2}$ (1-1)

16. $\frac{u}{5} = \frac{u}{6} + \frac{6}{5}$ (multiply by 30)

$6u = 5u + 36$

$u = 36$

(1-1)

17. $\frac{5x}{3} - \frac{4+x}{2} = \frac{x-2}{4} + 1$ (multiply by 12)

$20x - 6(4 + x) = 3(x - 2) + 12$

$20x - 24 - 6x = 3x - 6 + 12$

$11x = 30$

$x = \frac{30}{11}$ (1-1)

18. $0.05x + 0.25(30 - x) = 3.3$

$0.05x + 7.5 - 0.25x = 3.3$

$-0.20x = -4.2$

$x = \frac{-4.2}{-0.20} = 21$ (1-1)

19. $0.2(x - 3) + 0.05x = 0.4$

$0.2x - 0.6 + 0.05x = 0.4$

$0.25x = 1$

$x = 4$ (1-1)

20. $2(x + 4) > 5x - 4$

$2x + 8 > 5x - 4$

$2x - 5x > -4 - 8$

$-3x > -12$ (Divide both sides by –3 and reverse the inequality)

$x < 4$ or $(-\infty, 4)$

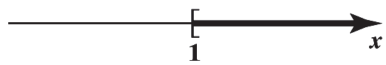
(1-1)

21. $3(2 - x) - 2 \le 2x - 1$

$6 - 3x \le 2x + 1$

$-5x \le -5$ (divide by –5 and reverse the inequality.)

$x \ge 1$ or $[1, \infty)$



(1-1)

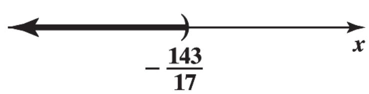
22. $\frac{x+3}{8} - \frac{4+x}{2} > 5 - \frac{2-x}{3}$ (multiply by 24)

$3(x + 3) - 12(4 + x) > 120 - 8(2 - x)$

$3x + 9 - 48 - 12x > 120 - 16 + 8x$

$-17x > 143$ (divide by –17 and reverse the inequality)

$x < -\frac{143}{17}$ or $\left(-\infty, -\frac{143}{17}\right)$



(1-1)

23. $-5 \le 3 - 2x < 1$

$-8 \le -2x < -2$ (divide by –2 and reverse the directions of the inequalities.)

$4 \ge x > 1$ which is the same as $1 < x \le 4$ or $(1, 4]$

(1-1)

24. $-1.5 \le 2 - 4x \le 0.5$

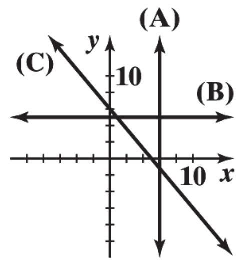
$-3.5 \le -4x \le -1.5$ (divide by –4 and reverse the directions of the inequalities.)

$0.875 \ge x \ge 0.375$ which is the same as $0.375 \le x \le 0.875$

or $[0.375, 0.875] = \left[\frac{3}{8}, \frac{7}{8}\right]$

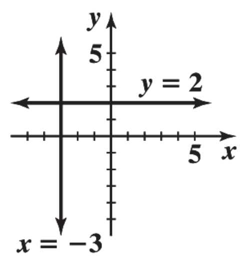
(1-1)

25.



(1-2)

26. The graph of $x = -3$ is a vertical line 3 units to the *left* of the *y*-axis; $y = 2$ is a horizontal line 2 units *above* the *x*-axis.



(1-2)

27. (A) $3x + 4y = 0$; $y = -\frac{3}{4}x$ an oblique line through the origin with slope $-\frac{3}{4}$

(B) $3x + 4 = 0$; $x = -\frac{4}{3}$ a vertical line with *x* intercept $-\frac{4}{3}$

(C) $4y = 0$; $y = 0$ the *x*-axis

(D) $3x + 4y = 36$ an oblique line with *x* intercept 12 and *y*-intercept 9. (1-2)

28. $A = \frac{1}{2}(a + b)h$; solve for *a*; assume $h \neq 0$

$A = \frac{1}{2}(ah + bh) = \frac{1}{2}ah + \frac{1}{2}bh$

$A - \frac{1}{2}bh = \frac{1}{2}ah$ (multiply by $\frac{2}{h}$)

$\frac{2A}{h} - b = a$ and $a = \frac{2A - bh}{h}$ (1-1)

29. $S = \frac{P}{1 - dt}$; solve for d; assume $dt \neq 0$ or 1

$S(1 - dt) = P$ (multiply by $1 - dt$)

$S - Sdt = P$

$-Sdt = P - S$ (divide by $-St$)

$d = \frac{P - S}{-St} = \frac{S - P}{St}$ (1-1)

30. $a + b < b - a$

$2a < 0$

$a < 0$

The inequality is true for $a < 0$ and *b* any number. (1-1)

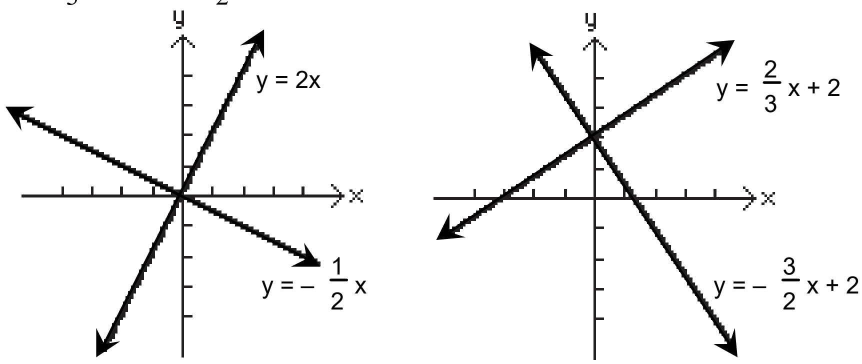
31. $b < a < 0$ (divide by b; reverse the direction of the inequalities since $b < 0$).

$1 > \frac{a}{b} > 0$

Thus, $0 < \frac{a}{b} < 1$; $\frac{a}{b} < 1$; $\frac{a}{b}$ is less than 1. (1-1)

32. The graphs of the pairs $\{y = 2x, y = -\frac{1}{2}x\}$ and

$\{y = \frac{2}{3}x + 2, y = -\frac{3}{2}x + 2\}$ are shown below:



In each case, the graphs appear to be perpendicular to each other. It can be shown that two slant lines are perpendicular if and only if their slopes are negative reciprocals.

(1-2)

33. Let x = amount invested at 5%.
Then $300{,}000 - x$ = amount invested at 9%.
Yield = 300,000(0.08) = 24,000
Solve $x(0.05) + (300{,}000 - x)(0.09) = 24{,}000$ for x:

$$0.05x + 27{,}000 - 0.09x = 24{,}000$$
$$-0.04x = -3{,}000$$
$$x = 75{,}000$$

Invest \$75,000 at 5%, \$225,000 at 9%. (1-1)

34. Let x = the number of DVD's.
Cost: $C(x) = 90{,}000 + 5.10x$
Revenue: $R(x) = 14.70x$
Break-even point: $C(x) = R(x)$

$$90{,}000 + 5.10x = 14.70x$$
$$90{,}000 = 9.60x$$
$$x = 9{,}375$$

9,375 DVDs must be sold to break even. (1-1)

35. Let x = person's age in years.
(A) Minimum heart rate: $m = (220 - x)(0.6) = 132 - 0.6x$
(B) Maximum heart rate: $M = (220 - x)(0.85) = 187 - 0.85x$

(C) At $x = 20$, $m = 132 - 0.6(20) = 120$
$M = 187 - 0.85(20) = 170$
range – between 120 and 170 beats per minute.

(D) At $x = 50$, $m = 132 - 0.6(50) = 102$
$M = 187 - 0.85(50) = 144.5$
range – between 102 and 144.5 beats per minute. (1-3)

36. $V = mt + b$

(A) At $t = 0$, $V = 224{,}000$; at $t = 8$, $V = 100{,}000$

$$\text{slope } m = \frac{100{,}000 - 224{,}000}{8 - 0} = -\frac{124{,}000}{8} = -15{,}500$$

$V = -15{,}500t + 224{,}000$

(B) At $t = 12$, $V = -15{,}500(12) + 224{,}000 = 38{,}000$.
The bulldozer will be worth $38,000 after 12 years. (1-2)

37. $R = mC + b$

(A) From the given information, the points (50, 80) and (130, 208) satisfy this equation. Therefore:

$$\text{slope } m = \frac{208 - 80}{130 - 50} = \frac{128}{80} = 1.6$$

Using the point-slope form with $(C_1, R_1) = (50, 80)$:

$R - 80 = 1.6(C - 50) = 1.6C - 80$
$R = 1.6C$

(B) At $C = 120$, $R = 1.6(120) = 192$; $192.

(C) At $R = 176$, $176 = 1.6C$

$$C = \frac{176}{1.6} = 110; \$110$$

(D) Slope $m = 1.6$. The slope is the rate of change of retail price with respect to cost. (1-2)

38. Let x = weekly sales
$E = 400 + 0.10(x - 6{,}000)$ for $x \geq 6{,}000$
At $x = 4000$, $E = 400$; $400
At $x = 10{,}000$, $E = 400 + 0.10(10{,}000 - 6{,}000) = 400 + 0.10(4{,}000) = 800$; $800. (1-1)

39. $p = mx + b$
From the given information, the points (1,160, 3.79) and (1,320, 3.59) satisfy this equation. Therefore,

$$\text{slope } m = \frac{3.59 - 3.79}{1{,}320 - 1{,}160} = -\frac{0.20}{160} = -0.00125$$

Using the point-slope form with $(x_1, p_1) = (1{,}160, 3.79)$

$p - 3.79 = -0.00125(x - 1{,}160) = -0.00125x + 1.45$
$p = -0.00125x + 5.24$

If $p = 3.29$, solve $3.29 = -0.00125x + 5.24$ for x:

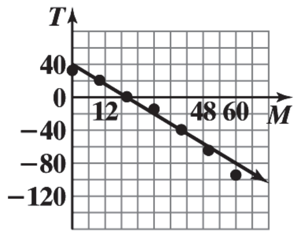
$-0.00125x = 3.29 - 5.24 = -1.95$

$x = 1{,}560$

The stores would sell 1,560 bottles. (1-2)

40. $T = 40 - 2M$

(A)



(B) At $M = 35$, $T = 40 - 2(35) = -30$; -30°F.

(C) At $T = -50$,

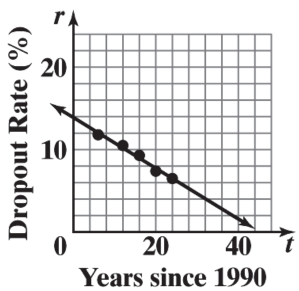
$-50 = 40 - 2M$

$-2M = -90$

$M = 45$; 45% (1-3)

41. (A) The dropout rate is decreasing at a rate of 0.308 percentage point per year.

(B)



(C) Solve $-0.308t + 13.9 < 3$ for t:

$-0.308t < -10.9$

$t > 35.4$

The first year for which the dropout rate is below 3% is 2026. (1-3)

42. (A) The CPI is increasing at a rate of 4.295 units per year.

(B) At $x = 34$, $y = 4.295(34) + 130.59 = 276.62$; the CPI in 2024 will be 276.62. (1-3)

43. $y = 0.74x + 2.83$

(A) The rate of change of tree height with respect to Dbh is 0.74.

(B) Tree height increases by 0.74 foot.

(C) At $x = 25$, $y = 0.74(25) + 2.83 = 21.33$. To the nearest foot, the tree is 21 feet high.

(D) Solve $15 = 0.74x + 2.83$ for x:

$0.74x = 15 - 2.83 = 12.17$

$x = 16.446$

To the nearest inch, the Dbh is 16 inches. (1-3)