## 1 LINEAR EQUATIONS AND GRAPHS

EXERCISE 1-1

**2.**
$$\begin{aligned} 3y - 4 &= 6y - 19 \\ 3y &= 6y - 15 \\ 3y - 6y &= -15 \\ -3y &= -15 \\ y &= 5 \end{aligned}$$

**4.**
$$\begin{aligned} 5x + 2 &> 1 \\ 5x &> -1 \\ x &> -\frac{1}{5} \end{aligned}$$

**6.** $-4x \le 8$

$\frac{-4x}{-4} \ge \frac{8}{-4}$ (Dividing by a negative number)

$x \ge -2$

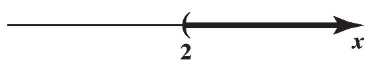
**8.** $-2x + 8 < 4$

$-2x + 8 - 8 < 4 - 8$

$-2x < -4$

$\frac{-2x}{-2} > \frac{-4}{-2}$ (Dividing by a negative number)

$x > 2$ or $(2, \infty)$




**10.** $-4 < 2y - 3 < 9$

$-1 < 2y < 12$

$-\frac{1}{2} < y < 6$ or $(-1/2, 6)$.


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

Multiply both sides of the equation by 3 to obtain:

$m - 12 = 2$

$m = 14$

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

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 $x > -\frac{10}{3}$.

**16.**
$$\begin{aligned} -3y + 9 + y &= 13 - 8y \\ -2y + 9 &= 13 - 8y \\ 6y &= 4 \\ y &= \frac{4}{6} = \frac{2}{3} \end{aligned}$$

**18.**
$$\begin{aligned} -3(4 - x) &= 5 - (x + 1) \\ -12 + 3x &= 5 - x - 1 \\ -12 + 3x &= 4 - x \\ 12 - 12 + 3x &= 12 + 4 - x \\ 3x &= 16 - x \\ 4x &= 16 \\ x &= 4 \end{aligned}$$

**20.** $$\begin{aligned} x-2 &\ge 2(x-5) \\ x-2 &\ge 2x-10 \\ x-2+2 &\ge 2x-10+2 \\ x &\ge 2x-8 \\ -x &\ge -8 \\ x &\le 8 \end{aligned}$$

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

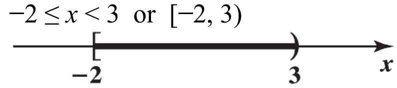
Multiply both sides by 12:

$$\begin{aligned} 3y-4y &= 6 \\ -y &= 6 \\ y &= -6 \end{aligned}$$

**24.** $$\begin{aligned} \frac{u}{2}-\frac{2}{3} &< \frac{u}{3}+2 \\ \frac{u}{2}-\frac{u}{3} &< 2+\frac{2}{3} \\ \frac{u}{6} &< \frac{8}{3} \\ u &< 16 \end{aligned}$$

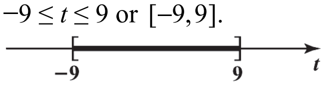
**26.** $$\begin{aligned} -4 \le 5x+6 &< 21 \\ -6-4 \le 5x &< 21-6 \\ -10 \le 5x &< 15 \end{aligned}$$

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




**28.** $$\begin{aligned} -1 \le \frac{2}{3}t+5 &\le 11 \\ -5-1 \le \frac{2}{3}t &\le 11-5 \\ -6 \le \frac{2}{3}t &\le 6 \\ -18 \le 2t &\le 18 \end{aligned}$$

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




**30.** $$\begin{aligned} y &= -\frac{2}{3}x+8 \\ y-8 &= -\frac{2}{3}x+8-8 \\ -\frac{2}{3}x &= y-8 \\ -2x &= 3y-24 \\ x &= \frac{3y-24}{-2} = -\frac{3}{2}y+12 \end{aligned}$$

**32.** $$\begin{aligned} y &= mx+b \\ y-b &= mx+b-b \\ mx &= y-b \\ m &= \frac{y-b}{x} \end{aligned}$$

**34.** $$\begin{aligned} C &= \frac{5}{9}(F-32) \\ \frac{9}{5}C &= F-32 \\ 32+\frac{9}{5}C &= F \\ F &= \frac{9}{5}C+32 \end{aligned}$$

**36.** $$\begin{aligned} -10 \le 8-3u &\le -6 \\ -18 \le -3u &\le -14 \\ 18 \ge 3u &\ge 14 \\ 6 \ge u &\ge \frac{14}{3} \end{aligned}$$

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


**38.** (A) Two must be negative and one positive or all three must be positive.

(B) Two must be positive and one negative or all three must be negative.

(C) Two must be negative and one positive or all three must be positive.

(D) $a \ne 0$ and $b$ and $c$ must have opposite signs.

**40.** 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 $a - b > 0$.

**42.** False. Consider the two closed intervals [1, 2] and [2, 3]. Their intersection is {2} which is not an interval.

**44.** False. Consider the two closed intervals [−1, 0] and [1, 2]. Their union is $[-1, 0] \cup [1, 2]$ which is not an interval.

**46.** True. Let $A = [a, b]$, $B = [c, d]$, where $a \le c \le b$, so that $A \cap B \ne \varnothing$. Then $A \cap B = [c, b]$ if $b \le d$ and $A \cap B = [c, d]$ if $d \le b$. In either case, the intersection is a closed interval.

**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, $x = \frac{136}{0.85} = \$160.$

**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 $x$

$52x = 300 + 27x$

$25x = 300$

$x = \dfrac{300}{25} = 12$

**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 $x$:

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

(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 $\text{IQ} = \frac{\text{MA}}{\text{CA}} \times 100$ (see problem 65). Thus

$$\begin{aligned} &80 < \text{IQ} < 140 \\ &80 < \frac{\text{MA}}{12} \times 100 < 140 \\ \text{or } &\frac{(80)(12)}{100} < \text{MA} < \frac{(140)(12)}{100} \\ \text{or } &9.6 < \text{MA} < 16.8 \end{aligned}$$

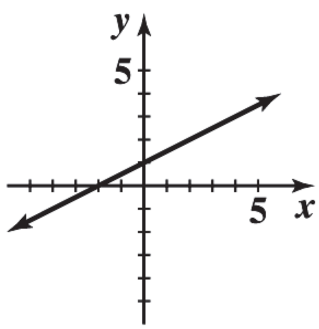
EXERCISE 1-2

**2.** (A)

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

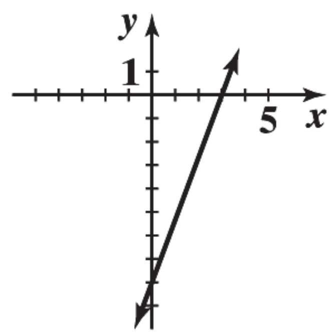
**6.** $y = \frac{x}{2} + 1$

| $x$ | $y$ |
|---|---|
| 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.** $m = 1$, $b = 5$ so $y = x + 5$

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

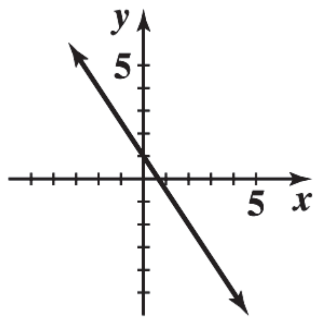
**20.** $x$ intercept: 1; $y$ intercept: 3; $y = -3x + 3$

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

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

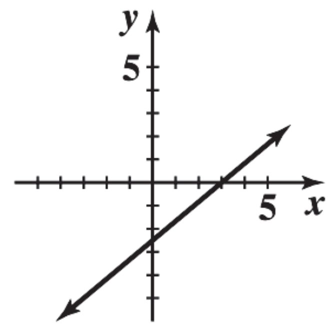
$m = -\frac{3}{2}$, $b = 1$

| $x$ | $y$ |
|---|---|
| 0 | 1 |
| 2 | −2 |
| −2 | 4 |

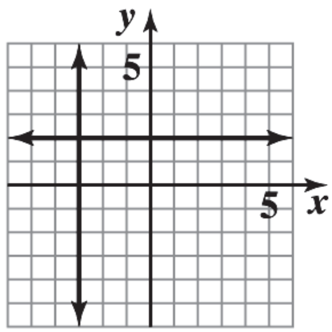



**26.** $5x - 6y = 15$

| $x$ | $y$ |
|---|---|
| 0 | −2.5 |
| 3 | 0 |
| −3 | −5 |




**28.**




**30.** $5x - y = -2$

$-y = -5x - 2$

Multiply both sides by (−1);

$y = 5x + 2$

$m = 5$

**32.** $2x - 3y = 18$

$-3y = -2x + 18$

Divide both sides by (−3);

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

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

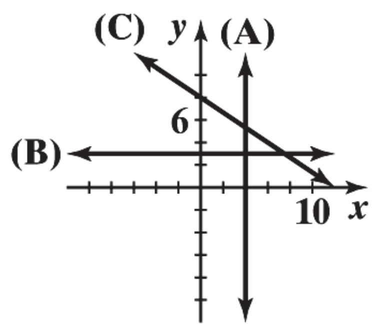
**34.** $-x + 8y = 4$

$8y = x + 4$

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

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

**36.**

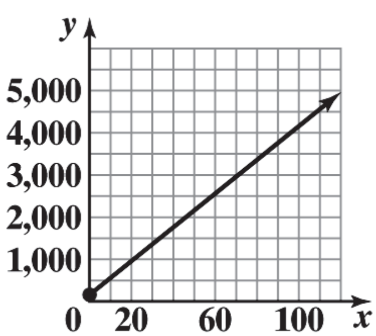



(A) $x = 4$

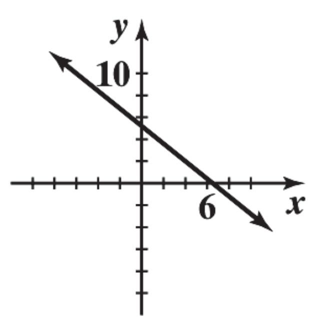
(B) $y = 3$

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

**38.**




**40.** (A)

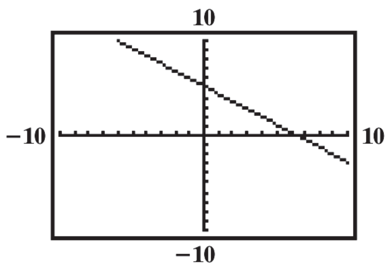



(B) Set $y = 0$,

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

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

(C)




(D) $x$ intercept: 6.5;
$y$ intercept: 5.2

(E) $x > 6.5$

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

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

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

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

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

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

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

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

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

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

**54.** (A) $m = \dfrac{5-2}{3-1} = \dfrac{3}{2}$

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

$y - 2 = \dfrac{3}{2}(x-1)$ or $3x - 2y = -1$

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

**56.** (A) $m = \dfrac{7-3}{-3-2} = -\dfrac{4}{5}$

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

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

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

**58.** (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: $y = 4$.

**60.** (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

**62.** The graphs are parallel lines with slope −0.5.

**64.** 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
$x = \dfrac{4{,}800 - 1{,}200}{45} = 80$

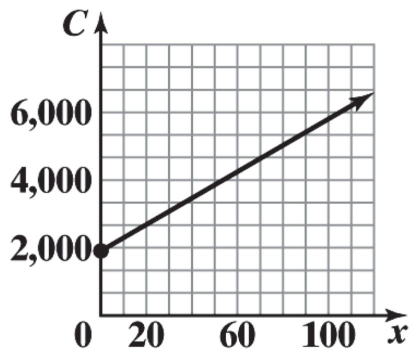
**66.** Let $y$ be daily cost of producing $x$ tennis rackets. Then we have two points for $(x, y)$:
(50, 3,855) and (60, 4,245).

(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

$$y - 3{,}855 = \frac{(4{,}245 - 3{,}855)}{(60 - 50)}(x - 50)$$

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.

**68.** 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,

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

or $R = 1.5C + 3$

(B) For $R = \$240$ we have

$240 = 1.5C + 3$

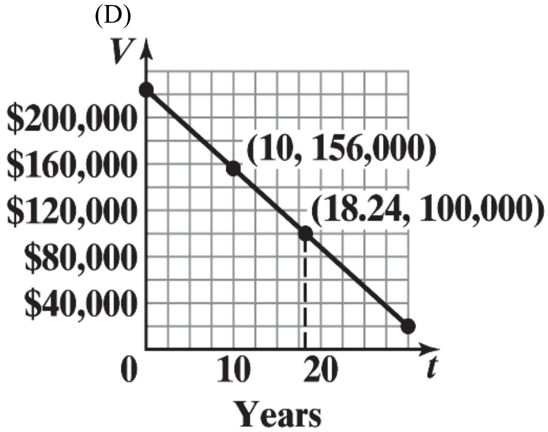
or $C = \dfrac{240 - 3}{1.5} = \$158$

**70.** 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:

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

(D)




(B) For $t = 10$

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

(C) For $V = \$100{,}000$

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

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

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

**72.** 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

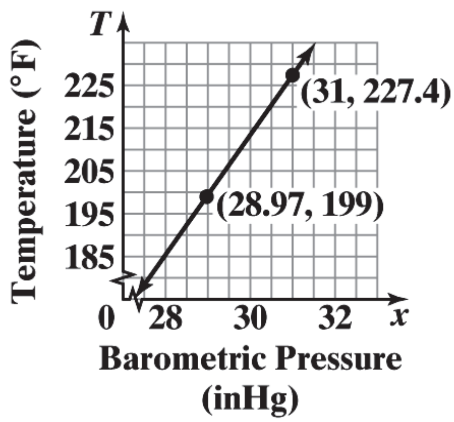
$T = 14(31) - 206.6 = 227.4^{\circ}\text{F}$

(C) For $T = 199^{\circ}$F, we have

$199 = 14x - 206.6$

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

(D)




**74.** 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

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

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

**76.** (A) $I = mt + b$

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

At $t = 20$, $I = 53{,}000 = m(20) + 30{,}000$

$20m = 53{,}000 - 30{,}000$

$20m = 23{,}000$

$m = 1150$

Therefore, $I = 1150t + 30{,}000$.

(B) At $t = 40$, $I = 1150(40) + 30{,}000 = 76{,}000$

The median income in 2030 will be $76,000.

**78.** (A) $f = mt + b$

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

At $t = 10$,

$$21.5 = 10m + 25.7$$
$$10m = -4.2$$
$$m = -0.42$$

Therefore, $f = -0.42t + 25.7$ .

(B) Solve $-0.42t + 25.7 < 12$ for $t$

$$-0.42t < -13.7$$
$$t > 32.6$$

: The percentage of male smokers will fall below 12% in 2032.

**80.** (A) For $(x, p)$ we have two representations: (9,800, 1.94) and (9,400, 1.82).
The slope is

$$m = \frac{(1.94 - 1.82)}{(9{,}800 - 9{,}400)} = 0.0003$$

Using one of the points, say (9,800, 1.94), we find $b$:

$1.94 = (0.0003)(9{,}800) + b$

or $b = -1$

So, the desired equation is: $p = 0.0003x - 1$.

(B) Here the two representations of $(x, p)$ are: (9,300, 1.94)
and (9,500, 1.82). The slope is

$$m = \frac{(1.94 - 1.82)}{(9{,}300 - 9{,}500)} = -0.0006$$

Using one of the points, say (9,300, 1.94) we find $b$:

$1.94 = -0.0006(9{,}300) + b$

or $b = 7.52$

So, the desired equation is: $p = -0.0006x + 7.52$.

(C) To find the equilibrium point, we need to solve
$0.0003x - 1 = -0.0006x + 7.52$ for $x$. Observe that

$0.0009x = 8.52$ or

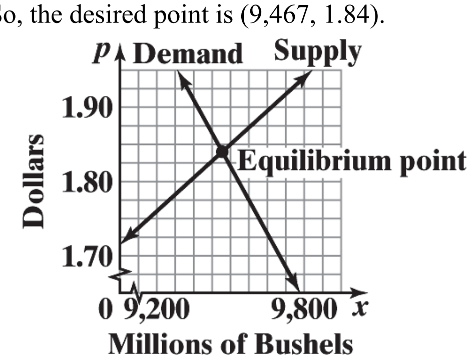
$$x = \frac{8.52}{0.0009} = 9{,}467$$

Substituting $x = 9{,}467$ in either of the equations in (A) or (B) we obtain

$p = .0003(9{,}467) - 1 \approx 1.84$

So, the desired point is (9,467, 1.84).

(D)



**82.** 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.

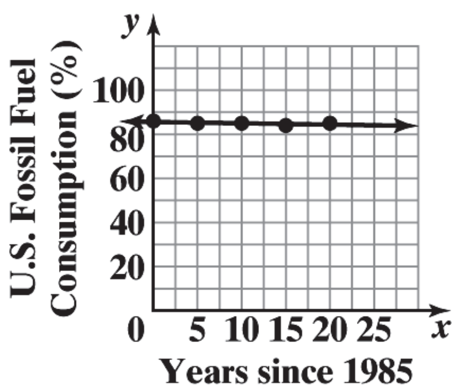
**8.** We have two representations of $(t, s)$: (0, 1,403) and (20, 1,481).
So, the line passing through these points has the following equation:

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

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 −0.09% per year.

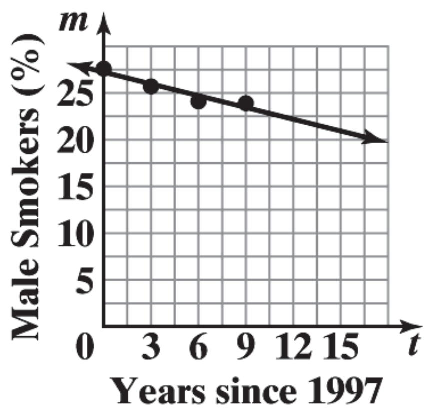
(C) For $x = 40$ (2025 is 40 years from 1985), we have
$$y = -0.09(40) + 85.8 \approx 82.2.$$
i.e. 82.2% of total consumption.

(D) Solve $-0.09x + 85.8 < 80$ for $x$:

$$-0.09x + 85.8 < 80$$
$$-0.09x < 80 - 85.8 = -5.8$$
$$x > 64.\overline{4}$$

Fossil fuel consumption will be less than 80% of total energy consumption in 2050.

**12.**



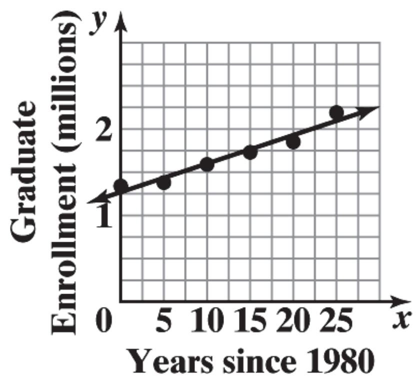

(B) Solve $-0.44t + 27.28 < 15$ for $t$:

$-0.44t < 15 - 27.28 = -12.28$

$t > 27.91$

The first year in which the percentage of male smokers will be less than 15% is 2025.

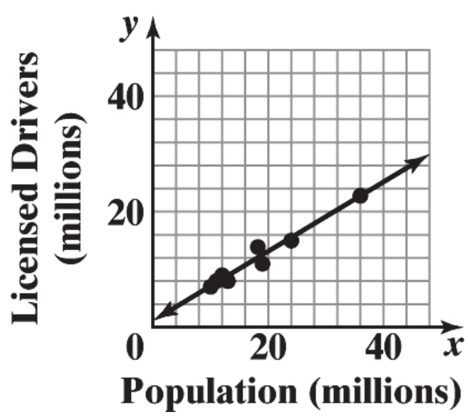
**14.**




(B) For 2025, $x = 45$ and $y(45) = 0.048(45) + 1.14 \approx 3.3$, so there will be about 3,300,000 graduate students enrolled in 2016.

(C) Graduate student enrollment is increasing at a rate of 0.048 million (or 48,000) students per year.

**16.**



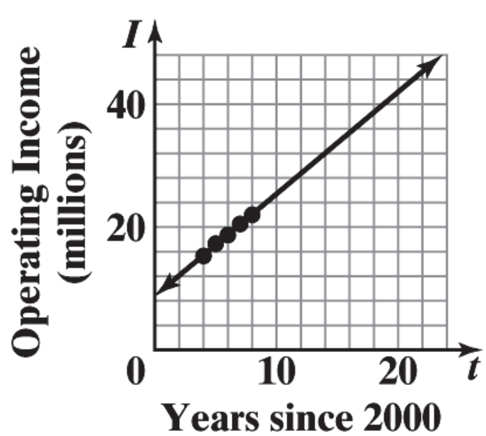

(B) At $x = 5.3$, $y = 0.63(5.3) + 0.31 = 3.649$. There were approximately 3,649,000 licensed drivers in Minnesota in 2010.

(C) Solve $0.63x + .031 = 4.1$ for $x$:

$0.63x = 3.79, \quad x \approx 6.016$

The population of Wisconsin 2010 was approximately 6,016,000.

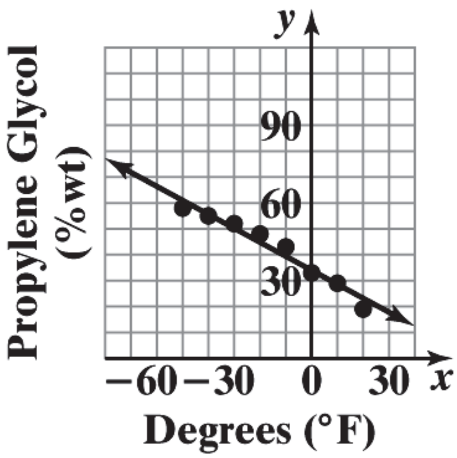
**18.**




(B) For 2022, $t = 24$ and from the model $I = 1.21(24) + 12.06 \approx 41.1$.

Wal-Marts operating income in 2024 will be approximately $\$41.1$ billion.

**20.**




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

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

**22.** (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 $x = \dfrac{25 + 5.14}{1.66} \approx 18$ in.

**24.** $y = 5.85x + 36.32$, slope: $m = 5.85$

(A) Annual revenue is increasing at a rate of \$5.85 billion per year.

(B) For 2024, $x = 24$ and $y = 5.85(24) + 36.32 \approx 176.72$.
So, the predicted annual revenue is approximately \$177 billion.

**26.** Residential service: $y = -32.1x + 687$ , cellular service: $y = 64.8x + 201$

(A) Annual expenditure per consumer unit on residential telephone service is decreasing at a rate of \$32.10 per year. Annual expenditure per consumer unit on cellular service is increasing at a rate of \$64.80 per year.

(B) For 2020, $x = 20$. For residential service we have:
$y = -32.1(20) + 719 = \$77.00$

For cellular service we have,
$y = 64.8(20) + 136 = \$1432$

(C) For 2025, the models predict annual expenditure per consumer unit to be −\$83.50 on residential service and \$1,756 on cellular service. The residential model clearly gives an unreasonable prediction for 2025. The cellular model prediction seems overly high.

**28.** Men: $y = -0.294x + 119.503$
Women: $y = -0.156x + 128.473$

The graphs of these lines indicate that the women will not catch up with the men. To see this algebraically, if we set the equations equal to each other and solve, then we obtain $x = -65$, 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.

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