**91.** (a) **—CONTINUED—**

If $t = 1$: $1200 = 2w + 2w$

$1200 = 4w$

$300 = w$

$300 = l$

If $t = 1.5$: $1200 = 2w + 2(1.5w)$

$1200 = 5w$

$240 = w$

$360 = l$

If $t = 2$: $1200 = 2w + 2(2w)$

$1200 = 6w$

$200 = w$

$400 = l$

If $t = 3$: $1200 = 2w + 2(3w)$

$1200 = 8w$

$150 = w$

$450 = l$

If $t = 4$: $1200 = 2w + 2(4w)$

$1200 = 10w$

$120 = w$

$480 = l$

If $t = 5$: $1200 = 2w + 2(5w)$

$1200 = 12w$

$100 = w$

$500 = l$

(b) Since the length is $t$ times the width and the perimeter is fixed, as $t$ gets larger, the length gets larger and the area gets smaller. The maximum area occurs when the length and width are equal.

**93.** $5500 = 207t + 4962$

$5500 - 4962 = 207t + 4962 - 4962$

$538 = 207t$

$\frac{538}{207} = \frac{207t}{207}$

$2.6 \approx t$

From the graph, 1993 is the year in which expenditures reached \$5500.

**95.** A conditional equation is an equation whose solution set is not the entire set of real numbers. An identity is an equation whose solution set is all real numbers.

**97.** Evaluating an expression means finding its value when its variables are replaced by real numbers. Solving an equation means finding all values of the variable for which the equation is true.

**99.** Equivalent equations have the same solution set. For example, $3x + 4 = 10$ and $3x - 6 = 0$ are equivalent.

**101.** False. Multiplying both sides of an equation by zero does not yield an equivalent equation.

## Section 1.2 Linear Equations and Problem Solving

**1.** *Verbal Model:* $\boxed{\text{Number}} + \boxed{30} = \boxed{82}$

*Label:* Number $= x$

*Equation:* $x + 30 = 82$

$x + 30 - 30 = 82 - 30$

$x = 52$

**3.** *Verbal Model:* $\boxed{\text{Annual salary}} = 26 \cdot \boxed{\text{Amount of each paycheck}} + \boxed{\text{Bonus}}$

*Labels:* Annual salary $= 30{,}500$

Amount of each paycheck $= x$

Bonus $= 2300$

*Equation:* $30{,}500 = 26x + 2300$

$30{,}500 - 2300 = 26x + 2300 - 2300$

$28{,}200 = 26x$

$\frac{28{,}200}{26} = \frac{26x}{26}$

\$1084.62 $= x$

**5.** Percent: 30%

Parts out of 100: 30

Decimal: 0.30

Fraction: $\frac{30}{100} = \frac{3}{10}$

**7.** Percent: 7.5%

Parts out of 100: 7.5

Decimal: 0.075

Fraction: $\frac{75}{1000} = \frac{3}{40}$

**9.** Percent: 12.5%

Parts out of 100: 12.5

Decimal: 0.125

Fraction: $\frac{1}{8}$

**11.** *Verbal Model:* $\boxed{\text{Compared number}} = \boxed{\text{Percent}} \cdot \boxed{\text{Base number}}$

*Labels:* Compared number $= a$

Percent $= p$

Base number $= b$

*Equation:* $a = p \cdot b$

$a = (0.35)(250)$

$a = 87.5$

**13.** *Verbal Model:* $\boxed{\text{Compared number}} = \boxed{\text{Percent}} \cdot \boxed{\text{Base number}}$

*Labels:* Compared number $= a$

Percent $= p$

Base number $= b$

*Equation:* $a = p \cdot b$

$a = (0.085)(816)$

$a = 69.36$

**15.** *Verbal Model:* $\boxed{\text{Compared number}} = \boxed{\text{Percent}} \cdot \boxed{\text{Base number}}$

*Labels:* Compared number $= a$

Percent $= p$

Base number $= b$

*Equation:* $a = p \cdot b$

$a = (0.004)(150{,}000)$

$a = 600$

**17.** *Verbal Model:* $\boxed{\text{Compared number}} = \boxed{\text{Percent}} \cdot \boxed{\text{Base number}}$

*Labels:* Compared number $= a$

Percent $= p$

Base number $= b$

*Equation:* $a = p \cdot b$

$84 = (0.24)(b)$

$\frac{84}{0.24} = b$

$350 = b$

**19.** *Verbal Model:* $\boxed{\text{Compared number}} = \boxed{\text{Percent}} \cdot \boxed{\text{Base number}}$

*Labels:* Compared number $= a$

Percent $= p$

Base number $= b$

*Equation:* $a = p \cdot b$

$42 = (0.105)(b)$

$\frac{42}{0.105} = b$

$400 = b$

**21.** *Verbal Model:* $\boxed{\text{Compared number}} = \boxed{\text{Percent}} \cdot \boxed{\text{Base number}}$

*Labels:* Compared number $= a$

Percent $= p$

Base number $= b$

*Equation:* $a = p \cdot b$

$96 = (0.008)(b)$

$\frac{96}{0.008} = b$

$12{,}000 = b$

**23.** *Verbal Model:* $\boxed{\text{Compared number}} = \boxed{\text{Percent}} \cdot \boxed{\text{Base number}}$

*Labels:* Compared number $= a$
Percent $= p$
Base number $= b$

*Equation:* $a = p \cdot b$
$1650 = (p)(5000)$
$\frac{1650}{5000} = p$
$33\frac{1}{3}\% = p$

**25.** *Verbal Model:* $\boxed{\text{Compared number}} = \boxed{\text{Percent}} \cdot \boxed{\text{Base number}}$

*Labels:* Compared number $= a$
Percent $= p$
Base number $= b$

*Equation:* $a = p \cdot b$
$2100 = (p)(1200)$
$\frac{2100}{1200} = p$
$175\% = p$

**27.** $\frac{120 \text{ meters}}{180 \text{ meters}} = \frac{12}{18} = \frac{2}{3}$

**29.** $\frac{36 \text{ inches}}{48 \text{ inches}} = \frac{36}{48} = \frac{3}{4}$

**31.** $\frac{40 \text{ milliliters}}{1 \text{ liter}} = \frac{0.04 \text{ liter}}{1}$
$= \frac{4}{100} = \frac{1}{25}$

**33.** $\frac{5 \text{ pounds}}{24 \text{ ounces}} = \frac{80 \text{ ounces}}{24 \text{ ounces}} = \frac{10}{3}$

**35.** $\frac{x}{6} = \frac{2}{3}$
$x = 6 \cdot \frac{2}{3}$
$x = 4$

**37.** $\frac{t}{4} = \frac{3}{2}$
$t = 4 \cdot \frac{3}{2}$
$t = 6$

**39.** $\frac{5}{4} = \frac{t}{6}$
$t = \frac{5}{4} \cdot 6$
$t = \frac{15}{2} = 7\frac{1}{2} = 7.5$

**41.** $\frac{y}{6} = \frac{y-2}{4}$
$4y = 6(y-2)$
$4y = 6y - 12$
$12 = 2y$
$6 = y$

**43.** $\frac{y+1}{10} = \frac{y-1}{6}$
$6(y+1) = 10(y-1)$
$6y + 6 = 10y - 10$
$16 = 4y$
$4 = y$

**45.** *Verbal Model:* $\boxed{\text{Freshmen}} = \boxed{\text{Percent}} \cdot \boxed{\text{Total enrollment}}$

*Labels:* Freshmen $= a$
Percent $= p$
Total enrollment $= b$

*Equation:* $a = p \cdot b$
$a = (0.38)(3000)$
$a = 1140$

**47.** *Verbal Model:* $\boxed{\text{Students failing test}} = \boxed{\text{Percent}} \cdot \boxed{\text{Total students}}$

*Labels:* Students failing test $= a$
Percent $= p$
Total students $= b$

*Equation:* $a = p \cdot b$
$a = (1 - 0.95)(40)$
$a = (0.05)(40)$
$a = 2$

**49.** *Verbal Model:* $\boxed{\text{Number laid off}} = \boxed{\text{Percent}} \cdot \boxed{\text{Number of employees}}$

*Labels:* Number laid off $= a$

Percent $= p$

Number of employees $= b$

*Equation:* $a = p \cdot b$

$25 = (p)(160)$

$\frac{25}{160} = p$

$15.625\% = p$

**51.** *Verbal Model:* $\boxed{\text{Tip}} = \boxed{\text{Percent}} \cdot \boxed{\text{Cost of meal}}$

*Labels:* Tip $= a$

Percent $= p$

Cost of meal $= b$

*Equation:* $10 - 8.45 = p \cdot 8.45$

$1.55 = p \cdot 8.45$

$\frac{1.55}{8.45} = \frac{p \cdot 8.45}{8.45}$

$0.18 \approx p$

$18\% \approx p$

**53.** *Verbal Model:* $\boxed{\text{Commission}} = \boxed{\text{Percent}} \cdot \boxed{\text{Price of home}}$

*Labels:* Commission $= a$

Percent $= p$

Price of home $= b$

*Equation:* $12{,}250 = p \cdot 175{,}000$

$\frac{12{,}250}{175{,}000} = \frac{p \cdot 175{,}000}{175{,}000}$

$0.07 = p$

$7\% = p$

**55.** *Verbal Model:* $\boxed{\text{Defective parts}} = \boxed{\text{Percent}} \cdot \boxed{\text{Total parts}}$

*Labels:* Defective parts $= a$

Percent $= p$

Total parts $= b$

*Equation:* $a = p \cdot b$

$3 = (0.015)(b)$

$\frac{3}{0.015} = b$

$200 = b$ total parts

**57.** (a) *Verbal Model:* $\boxed{\text{Area of larger floor}} = \boxed{\text{Percent}} \cdot \boxed{\text{Area of smaller floor}}$

*Labels:* Area of larger floor $= a$

Percent $= p$

Area of smaller floor $= b$

*Equation:* $a = p \cdot b$

$320 = (p)(180)$

$\frac{320}{180} = \frac{p(180)}{180}$

$1.7778 \approx p$

$177.78\% \approx p$

(b) *Verbal Model:* $\boxed{\text{Area of smaller floor}} = \boxed{\text{Percent}} \cdot \boxed{\text{Area of larger floor}}$

*Labels:* Area of smaller floor $= a$

Percent $= p$

Area of larger floor $= b$

*Equation:* $a = p \cdot b$

$180 = (p)(320)$

$\frac{180}{320} = \frac{p(320)}{320}$

$0.5625 \approx p$

$56.25\% \approx p$

**59.** *Verbal Model:* [County's population] = [Percent] · [Total population]

*Labels:* County's population = $a$

Percent = $p$

Total population = $b$

*Equation:* $a = p \cdot b$

Monroe:

$457{,}500 = p(1{,}483{,}700)$

$\frac{457{,}500}{1{,}483{,}700} = p$

$0.3084 \approx p$

$30.84\% \approx p$

Spring:

$258{,}700 = p(1{,}483{,}700)$

$\frac{258{,}700}{1{,}483{,}700} = p$

$0.1744 \approx p$

$17.44\% \approx p$

Washington:

$89{,}100 = p(1{,}483{,}700)$

$\frac{89{,}100}{1{,}483{,}700} = p$

$0.0601 \approx p$

$6.01\% \approx p$

West:

$189{,}400 = p(1{,}483{,}700)$

$\frac{189{,}400}{1{,}483{,}700} = p$

$0.1277 \approx p$

$12.77\% \approx p$

Howard:

$167{,}700 = p(1{,}483{,}700)$

$\frac{167{,}700}{1{,}483{,}700} = p$

$0.1130 \approx p$

$11.30\% \approx p$

Clark:

$321{,}300 = p(1{,}483{,}700)$

$\frac{321{,}300}{1{,}483{,}700} = p$

$0.2166 \approx p$

$21.66\% \approx p$

**61.** Using the bar graph, the decrease in the per capita consumption of beef from 1980 to 1995 is approximately 8 pounds. The approximate percent decrease is:

*Verbal Model:* [Amount of decrease] = [Percent] · [Beef consumption in 1980]

*Labels:* Amount of decrease = $a$

Percent = $p$

Beef consumption in 1980 = $b$

*Equation:* $a = p \cdot b$

$8 = p \cdot 70$

$\frac{8}{70} = p \approx 11\%$

**63.** *Verbal Model:* [Total number of pounds of pork consumed] = [Number of pounds of pork consumed per capita] · [Number of persons]

*Equation:* $x = 47 \cdot 250{,}000{,}000$

$x \approx 11{,}750$ million pounds

**65.** $\frac{\text{Tax}}{\text{Pay}} = \frac{12.50}{625} = \frac{125}{6250} = \frac{1}{50}$

**67.** $\frac{\text{Expanded volume}}{\text{Compressed volume}} = \frac{425 \text{ cu cm}}{20 \text{ cu cm}} = \frac{85}{4}$

**69.** $\frac{\text{Area 1}}{\text{Area 2}} = \frac{\pi(4)^2}{\pi(6)^2} = \frac{16\pi}{36\pi} = \frac{4}{9}$

**71.** $\frac{\text{Total price}}{\text{Total units}} = \frac{0.95}{20} = \frac{90}{2000} = \$0.0475$ per ounce

**73.** $\dfrac{\text{Total price}}{\text{Total units}} = \dfrac{1.69}{20} = \dfrac{169}{2000} = \$0.0845$ per ounce

**75.** (a) Unit price $= \dfrac{2.32}{14.5} = \$0.16$ per ounce

(b) Unit price $= \dfrac{0.99}{5.5} = \$0.18$ per ounce

The $14\frac{1}{2}$-ounce bag is a better buy.

**77.** (a) Unit price $= \dfrac{1.69}{4} = \$0.4225$ per ounce

(b) Unit price $= \dfrac{2.39}{6} = \$0.3983$ per ounce

The 6-ounce tube is a better buy.

**79.** Proportion: $\dfrac{x}{7} = \dfrac{4}{5.5}$

$x = 7 \cdot \dfrac{4}{5.5}$

$x = 5\frac{1}{11}$

**81.** Proportion: $\dfrac{x}{6} = \dfrac{2}{4}$

$x = 6 \cdot \dfrac{2}{4}$

$x = 3$

**83.** Proportion: $\dfrac{h}{86} = \dfrac{6}{11}$

$h = \dfrac{6 \cdot 86}{11}$

$h = \dfrac{516}{11}$

$h \approx 46.9$ feet

**85.** Proportion: $\dfrac{5}{105} = \dfrac{x}{360}$

$x = \dfrac{5 \cdot 360}{105}$

$x = \dfrac{1800}{105}$

$x \approx 17.1$ gallons

**87.** *Verbal Model:* $\boxed{\dfrac{\text{Tax}}{\text{Assessed value}}} = \boxed{\dfrac{\text{Tax}}{\text{Assessed value}}}$

*Proportion:* $\dfrac{x}{160{,}000} = \dfrac{1650}{110{,}000}$

$x = 160{,}000 \cdot \dfrac{1650}{110{,}000}$

$x = \$2400$ taxes

**89.** *Verbal Model:* $\boxed{\dfrac{\text{Defective units}}{\text{Total units}}} = \boxed{\dfrac{\text{Defective units}}{\text{Total units}}}$

*Proportion:* $\dfrac{x}{200{,}000} = \dfrac{1}{75}$

$x = 200{,}000 \cdot \dfrac{1}{75}$

$x = 2667$ defective units

**91.** Percent means parts out of 100.

**93.** No, $\frac{1}{2}\% \neq 50\%$.

$0.5\% = 0.005$

$50\% = 0.5$

**95.** No. It is necessary to know one of the following: the total number of students in the class, the number of boys in the class, or the number of girls in the class.

**97.** Mathematical modeling is using mathematics to solve problems that occur in real-life situations. For examples review the real-life problems in the exercise set.