

Section 1.3 Business and Scientific Problems

1. *Verbal Model:* $\boxed{\text{Selling price}} = \boxed{\text{Cost}} + \boxed{\text{Markup}}$

Labels: Selling price = 64.33
Cost = 45.97
Markup = x

Equation: $64.33 = 45.97 + x$
 $x = 64.33 - 45.97$
 $x = \$18.36$

Verbal Model: $\boxed{\text{Markup}} = \boxed{\frac{\text{Markup rate}}{\text{Cost}}} \cdot \boxed{\text{Cost}}$

Labels: Markup = 18.36
Markup rate = x
Cost = 45.97

Equation: $18.36 = x \cdot 45.97$
 $\frac{18.36}{45.97} = x$
 $40\% = x$

5. *Verbal Model:* $\boxed{\text{Selling price}} = \boxed{\text{Cost}} + \boxed{\text{Markup}}$

Labels: Selling price = 26,922.50
Cost = x
Markup = 4672.50

Equation: $26,922.50 = x + 4672.50$
 $26,922.50 - 4672.50 = x$
 $\$22,250.00 = x$

Verbal Model: $\boxed{\text{Markup}} = \boxed{\frac{\text{Markup rate}}{\text{Cost}}} \cdot \boxed{\text{Cost}}$

Labels: Markup = 4672.50
Markup rate = x
Cost = 22,250.00

Equation: $4672.50 = x \cdot 22,250.00$
 $\frac{4672.50}{22,250.00} = x$
 $21\% = x$

3. *Verbal Model:* $\boxed{\text{Selling price}} = \boxed{\text{Cost}} + \boxed{\text{Markup}}$

Labels: Selling price = 250.80
Cost = x
Markup = 98.80

Equation: $250.80 = x + 98.80$
 $250.80 - 98.80 = x$
 $\$152.00 = x$

Verbal Model: $\boxed{\text{Markup}} = \boxed{\frac{\text{Markup rate}}{\text{Cost}}} \cdot \boxed{\text{Cost}}$

Labels: Markup = 98.80
Markup rate = x
Cost = 152.00

Equation: $98.80 = x \cdot 152.00$
 $\frac{98.80}{152.00} = x$
 $65\% = x$

7. *Verbal Model:* $\boxed{\text{Markup}} = \boxed{\frac{\text{Markup rate}}{\text{Cost}}} \cdot \boxed{\text{Cost}}$

Labels: Markup = x
Markup rate = 85.2%
Cost = 225.00

Equation: $x = 85.2\% \cdot 225.00$
 $x = \$191.70$

Verbal Model: $\boxed{\text{Selling price}} = \boxed{\text{Cost}} + \boxed{\text{Markup}}$

Labels: Selling price = x
Cost = 225.00
Markup = 191.70

Equation: $x = 225.00 + 191.70$
 $x = \$416.70$

9. Verbal Model: $\boxed{\text{Sale price}} = \boxed{\text{List price}} - \boxed{\text{Discount}}$

Labels: Sale price = 25.74
List price = 49.95
Discount = x

Equation: $25.74 = 49.95 - x$
 $x = 49.95 - 25.74$
 $x = \$24.21$

Verbal Model: $\boxed{\text{Discount}} = \boxed{\text{Discount rate}} \cdot \boxed{\text{List price}}$

Labels: Discount = 24.21
Discount rate = x
List price = 49.95

Equation: $24.21 = x \cdot 49.95$
 $\frac{24.21}{49.95} = x$
 $48.5\% \approx x$

13. Verbal Model: $\boxed{\text{Discount}} = \boxed{\text{Discount rate}} \cdot \boxed{\text{List price}}$

Labels: Discount = x
Discount rate = 65%
List price = 95.00

Equation: $x = 65\% \cdot 95.00$
 $x = \$61.75$

Verbal Model: $\boxed{\text{Sale price}} = \boxed{\text{List price}} - \boxed{\text{Discount}}$

Labels: Sale price = x
List price = 95.00
Discount = 61.75

Equation: $x = 95.00 - 61.75$
 $x = \$33.25$

11. Verbal Model: $\boxed{\text{Sale price}} = \boxed{\text{List price}} - \boxed{\text{Discount}}$

Labels: Sale price = x
List price = 300.00
Discount = 189.00

Equation: $x = 300.00 - 189.00$
 $x = \$111.00$

Verbal Model: $\boxed{\text{Discount}} = \boxed{\text{Discount rate}} \cdot \boxed{\text{List price}}$

Labels: Discount = 189.00
Discount rate = x
List price = 300.00

Equation: $189.00 = x \cdot 300.00$
 $\frac{189.00}{300.00} = x$
 $63\% = x$

15. Verbal Model: $\boxed{\text{Sale price}} = \boxed{\text{List price}} - \boxed{\text{Discount}}$

Labels: Sale price = 893.10
List price = x
Discount = 251.90

Equation: $893.10 = x - 251.90$
 $893.10 + 251.90 = x$
 $\$1145.00 = x$

Verbal Model: $\boxed{\text{Discount}} = \boxed{\text{Discount rate}} \cdot \boxed{\text{List price}}$

Labels: Discount = 251.90
Discount rate = x
List price = 1145.00

Equation: $251.90 = x \cdot 1145.00$
 $\frac{251.90}{1145.00} = x$
 $22\% = x$

17. Verbal Model: $\boxed{\text{Selling price}} = \boxed{\text{Cost}} + \boxed{\text{Markup}}$

Labels: Selling price = 85
 Cost = 62.95
 Markup = x

Equation: $85 = 62.95 + x$
 $x = 85 - 62.95$
 $x = \$22.05$

19. Verbal Model: $\boxed{\text{Selling price}} = \boxed{\text{Cost}} + \boxed{\text{Markup}}$

Labels: Selling price = 25
 Cost = 15
 Markup = x

Equation: $25 = 15 + x$
 $10 = x$

Verbal Model: $\boxed{\text{Markup}} = \boxed{\text{Markup rate}} \cdot \boxed{\text{Cost}}$

Labels: Markup = 10
 Markup rate = x
 Cost = 15

Equation: $10 = x \cdot 15$
 $\frac{10}{15} = x$
 $66\frac{2}{3}\% = x$

21. Verbal Model: $\boxed{\text{Sale price}} = \boxed{\text{List price}} - \boxed{\text{Discount}}$

Labels: Sale price = 50
 List price = 75
 Discount = x

Equation: $50 = 75 - x$
 $x = 75 - 50$
 $x = \$25$

23. Verbal Model: $\boxed{\text{Sale price}} = \boxed{\text{List price}} - \boxed{\text{Discount}}$

Labels: Sale price = 16
 List price = 20
 Discount = x

Equation: $16 = 20 - x$
 $x = 20 - 16$
 $x = \$4$

Verbal Model: $\boxed{\text{Discount}} = \boxed{\text{Discount rate}} \cdot \boxed{\text{List price}}$

Labels: Discount = 4
 Discount rate = x
 List price = 20

Equation: $4 = x \cdot 20$
 $\frac{4}{20} = x$
 $20\% = x$

25. Verbal Model: $\boxed{\text{Total cost}} = \boxed{\text{Cost of first minute}} + \boxed{\text{Cost of additional minutes}}$

Labels: Total cost = 5.15
 Cost of first minute = 0.75
 Cost of additional minutes = $0.55x$

Equation: $5.15 = 0.75 + 0.55x$
 $4.40 = 0.55x$
 $8 = x$

Length of call = 9 minutes

25. —CONTINUED—

Verbal Model: $\boxed{\text{Discount}} = \boxed{\text{Discount rate}} \cdot \boxed{\text{List price}}$

Labels: Discount = x
Discount rate = 60%
List price = 5.15

Equation: $x = 60\% \cdot 5.15$
 $x = \$3.09$

Verbal Model: $\boxed{\text{Selling price}} = \boxed{\text{List price}} - \boxed{\text{Discount}}$

Labels: Selling price = x
List price = 5.15
Discount = 3.09

Equation: $x = 5.15 - 3.09$
 $x = \$2.06$

27. Verbal Model: $\boxed{\text{Cost}} + \boxed{\text{Markup}} = \boxed{\text{Selling price}}$

Labels: Cost = x
Markup = $0.10x$
Selling price = 59.565
(Each tire costs \$19.855, so three tires cost \$59.565.)

Equation: $x + 0.10x = 59.565$
 $1.10x = 59.565$
 $x = \$54.15$

29. Verbal Model: $\boxed{\text{Sales tax}} = \boxed{\text{Sales tax rate}} \cdot \boxed{\text{Cost}}$

Labels: Sales tax = x
Sales tax rate = 6%
Cost = 4450

Equation: $x = 6\% \cdot 4450$
 $x = \$267$

Verbal Model: $\boxed{\text{Total bill}} = \boxed{\text{Cost}} + \boxed{\text{Sales tax}}$

Labels: Total bill = x
Cost = 4450
Sales tax = 267

Equation: $x = 4450 + 267$
 $x = \$4717$

Verbal Model: $\boxed{\text{Amount financed}} = \boxed{\text{Total bill}} - \boxed{\text{Down payment}}$

Labels: Amount financed = x
Total bill = 4717
Down payment = 1000

Equation: $x = 4717 - 1000$
 $x = \$3717$

31. Verbal Model: $\boxed{\text{Total bill}} = \boxed{\text{Bill for parts}} + \boxed{\text{Bill for labor}}$

Labels: Total bill = 216.37
Bill for parts = 136.37
Bill for labor = $32x$
Number of hours of labor = x

Equation: $216.37 = 136.37 + 32x$
 $80 = 32x$
 $\frac{80}{32} = x$
2.5 hours = x

33. Verbal Model: $\boxed{\text{Total bill}} = \boxed{\text{Bill for parts}} + \boxed{\text{Bill for labor}}$

Labels: Total bill = 380
Bill for parts = 275
Bill for labor = $35x$
Number of hours of labor = x

Equation: $380 = 275 + 35x$
 $105 = 35x$
 $\frac{105}{35} = x$
3 hours = x

35. *Verbal Model:* $\boxed{\text{Amount of solution 1}} + \boxed{\text{Amount of solution 2}} = \boxed{\text{Amount of final solution}}$

Labels: Percent of solution 1 = 20%
 Gallons of solution 1 = x
 Percent of solution 2 = 60%
 Gallons of solution 2 = $100 - x$
 Percent of final solution = 40%
 Gallons of final solution = 100

Equation: $0.20x + 0.60(100 - x) = 0.40(100)$

$$\begin{aligned} 0.20x + 60 - 0.60x &= 40 \\ -0.40x &= -20 \\ x &= 50 \text{ gallons at } 20\% \\ 100 - x &= 50 \text{ gallons at } 60\% \end{aligned}$$

37. *Verbal Model:* $\boxed{\text{Amount of solution 1}} + \boxed{\text{Amount of solution 2}} = \boxed{\text{Amount of final solution}}$

Labels: Percent of solution 1 = 15%
 Quarts of solution 1 = x
 Percent of solution 2 = 60%
 Quarts of solution 2 = $24 - x$
 Percent of final solution = 45%
 Quarts of final solution = 24

Equation: $0.15x + 0.60(24 - x) = 0.45(24)$

$$\begin{aligned} 0.15x + 14.4 - 0.60x &= 10.8 \\ -0.45x &= -3.6 \\ x &= 8 \text{ quarts at } 15\% \\ 24 - x &= 16 \text{ quarts at } 60\% \end{aligned}$$

39. *Verbal Model:* $\boxed{\text{Cost of seed 1}} + \boxed{\text{Cost of seed 2}} = \boxed{\text{Cost of final seed mix}}$

Labels: Number of pounds of seed 1 = x
 Cost per pound of seed 1 = 12
 Number of pounds of seed 2 = $100 - x$
 Cost per pound of seed 2 = 20
 Number of pounds of final seed mix = 100
 Cost per pound of final seed mix = 14

Equation: $12x + 20(100 - x) = 14(100)$

$$\begin{aligned} 12x + 2000 - 20x &= 1400 \\ -8x &= -600 \\ x &= 75 \text{ pounds at } \$12 \text{ per pound} \\ 100 - x &= 25 \text{ pounds at } \$20 \text{ per pound} \end{aligned}$$

41. *Verbal Model:* $\boxed{\text{Total sales}} = \boxed{\text{Adult sales}} + \boxed{\text{Children sales}}$

Labels: Total sales = 2200
 Number of adult tickets = $3x$
 Price of adult tickets = 6
 Number of children tickets = x
 Price of children tickets = 4

Equation: $2200 = 6(3x) + 4x$

$$\begin{aligned} 2200 &= 18x + 4x \\ 2200 &= 22x \end{aligned}$$

100 children tickets = x

43. *Verbal Model:* $\boxed{\text{Original antifreeze solution}} - \boxed{\text{Some antifreeze solution}} + \boxed{\text{Pure antifreeze}} = \boxed{\text{Final antifreeze solution}}$

Labels: Number of gallons of original antifreeze = 5
 Percent of antifreeze in original mix = 40%
 Number of gallons antifreeze withdrawn = x
 Number of gallons of pure antifreeze = x
 Percent of pure antifreeze = 100%
 Number of gallons of final solution = 5
 Percent of antifreeze in final solution = 50%

Equation: $0.40(5) - 0.40x + 1.00x = 0.50(5)$

$$\begin{aligned} 2 - 0.40x + 1.00x &= 2.5 \\ 0.60x &= 0.5 \\ x &= \frac{5}{6} \text{ gallon} \end{aligned}$$

45. Verbal Model: $\boxed{\text{Distance}} = \boxed{\text{Rate}} \cdot \boxed{\text{Time}}$

Labels: Distance = d
Rate = 650
Time = 3.5

Equation: $d = 650 \cdot 3.5$
 $d = 2275$ miles

49. Verbal Model: $\boxed{\text{Distance}} = \boxed{\text{Rate}} \cdot \boxed{\text{Time}}$

Labels: Distance = 1000
Rate = r
Time = $\frac{3}{2}$

Equation: $1000 = r \cdot \frac{3}{2}$
 $\frac{1000}{3/2} = r$
 $\frac{2000}{3}$ ft/sec = r

53. Verbal Model: $\boxed{\text{Distance}} = \boxed{\text{Rate}} \cdot \boxed{\text{Time}}$

Labels: Distance = x
Rates = 480 and 600
Time = $\frac{4}{3}$

Equation: $x = 480\left(\frac{4}{3}\right) + 600\left(\frac{4}{3}\right)$
 $x = 1440$ miles

57. Verbal Model: $\boxed{\text{Distance}} = \boxed{\text{Rate}} \cdot \boxed{\text{Time}}$

Labels: Distance = 317
Rate for first part of trip = 58
Time for first part of trip = x
Rate for second part of trip = 52
Time for second part of trip = $5\frac{3}{4} - x$

Equation: $58x = 58 \cdot x$ (1st part of trip)
 $52\left(5\frac{3}{4} - x\right) = 52 \cdot \left(5\frac{3}{4} - x\right)$ (2nd part of trip)
 $317 = 58x + 52\left(5\frac{3}{4} - x\right)$
 $317 = 58x + 299 - 52x$
 $18 = 6x$
3 hours = x (1st part of trip at 58 mph)
 $2\frac{3}{4}$ hours = $5\frac{3}{4} - x$ (2nd part of trip at 52 mph)

47. Verbal Model: $\boxed{\text{Distance}} = \boxed{\text{Rate}} \cdot \boxed{\text{Time}}$

Labels: Distance = 1000
Rate = 110
Time = t

Equation: $1000 = 110 \cdot t$
 $\frac{1000}{110} = t$
 $\frac{100}{11}$ hour = t

51. Verbal Model: $\boxed{\text{Distance}} = \boxed{\text{Rate}} \cdot \boxed{\text{Time}}$

Labels: Distance = 30
Rate = 12
Time = x

Equation: $30 = 12x$
 $\frac{30}{12} = x$
2.5 hours = x

55. Verbal Model: $\boxed{\text{Distance}} = \boxed{\text{Rate}} \cdot \boxed{\text{Time}}$

Labels: Distance = 5000
Rate = 17,000
Time = t

Equation: $5000 = 17,000 \cdot t$
 $\frac{5000}{17,000} = t$
 $\frac{5}{17}$ hour = t
17.65 minutes $\approx t$

59. (a) Printer's rate = 8 pages per minute

(b) Shop's rate = 30 units in 8 hours
 $= \frac{30}{8}$ units per hour
 $= \frac{15}{4}$ units per hour

61. (a) Your rate = $\frac{1}{3}$ job per hour

Friend's rate = $\frac{1}{4}$ job per hour

(b) Verbal Model: $\boxed{\text{Work done}} = \boxed{\text{Work done by you}} + \boxed{\text{Work done by friend}}$

Labels: Work done = 1

Your rate = $\frac{1}{3}$

Your time = t

Friend's rate = $\frac{1}{4}$

Friend's time = t

Equation: $1 = \left(\frac{1}{3}\right)(t) + \left(\frac{1}{4}\right)(t)$

$$1 = \left(\frac{1}{3} + \frac{1}{4}\right)t$$

$$1 = \left(\frac{7}{12}\right)t$$

$$\frac{1}{7/12} = t$$

$$1\frac{5}{7} \text{ hours} = \frac{12}{7} \text{ hours} = t$$

63. $E = IR$

$$\frac{E}{I} = R$$

65. $S = L - rL$

$$S = L(1 - r)$$

$$\frac{S}{1 - r} = L$$

67. $h = 48t + \frac{1}{2}at^2$

$$h - 48t = \frac{1}{2}at^2$$

$$2(h - 48t) = at^2$$

$$2h - 96t = at^2$$

$$\frac{2h - 96t}{t^2} = a$$

69. Common formula: $V = lwh$

Equation: $V = 3 \cdot 4 \cdot 2$

$$V = 24 \text{ cubic units}$$

71. Common formula: $V = \pi r^2 h$

Equation: $V = \pi(3\frac{1}{2})^2 12$

$$V = 147\pi$$

$$V \approx 461.8 \text{ cubic centimeters}$$

73. Verbal Model: Perimeter = 2 $\boxed{\text{Width}}$ + 2 $\boxed{\text{Height}}$

Labels: Perimeter = 3

Height = x

Width = $0.62x$

Equation: $3 = 2(0.62x) + 2(x)$

$$3 = 1.24x + 2x$$

$$3 = 3.24x$$

$$0.926 \text{ feet} \approx x$$

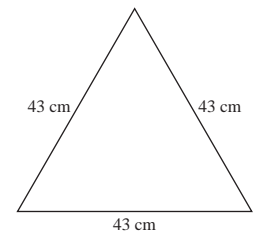
75. Verbal Model: $\boxed{\text{Perimeter}} = \boxed{\text{Side}} + \boxed{\text{Side}} + \boxed{\text{Side}}$

Equation: $129 = x + x + x$

$$129 = 3x$$

$$43 = x$$

$$x = 43 \text{ centimeters}$$



77. Verbal Model: $\boxed{\text{Interest}} = \boxed{\text{Principal}} \cdot \boxed{\text{Rate}} \cdot \boxed{\text{Time}}$

Labels: Interest = I
Principal = 5000
Rate = 9.5%
Time = 6

Equation: $I = (5000)(0.095)(6)$
 $I = \$2850$

79. Verbal Model: $\boxed{\text{Interest}} = \boxed{\text{Principal}} \cdot \boxed{\text{Rate}} \cdot \boxed{\text{Time}}$

Labels: Interest = 500
Principal = P
Rate = 7%
Time = 2

Equation: $500 = (P)(0.07)(2)$
 $500 = P(0.14)$
 $\frac{500}{0.14} = P$
 $\$3571.43 \approx P$

81. Verbal Model: $\boxed{\text{Interest}} = \boxed{\text{Principal}} \cdot \boxed{\text{Rate}} \cdot \boxed{\text{Time}}$

Labels: Interest = 3500
Principal at 10% = x
Principal at 8% = $40,000 - x$
Time = 1

Equation: $3500 = 0.10x + 0.08(40,000 - x)$
 $3500 = 0.10x + 3200 - 0.08x$
 $300 = 0.02x$
 $\frac{300}{0.02} = x$
 $\$15,000 = x$

83. (a) $y = 9.24 + 0.307t, 0 \leq t \leq 7$

From the graph, 1993 was the year when the average hourly wage was \$10.15.

$$10.15 = 9.24 + 0.307t$$

$$0.91 = 0.307t$$

$$2.9641 \approx t$$

$$3 \approx t$$

Yes, the result would be the same, 1993.

(b) The average annual hourly raise for bus drivers during this 8-year period is \$0.307. Determine the average hourly wage for each year using the model. The difference between each two consecutive years is \$0.307.

85. The bus drivers' average salaries were increasing at a greater annual rate at \$0.307 compared to \$0.209 for the cafeteria workers.

87. Markup is the difference between the cost a retailer pays for a product and the price at which the retailer sells the product. Markup rate is the percent increase of the markup.

89. If it takes you t hours to complete a task, you can complete $1/t$ of the task in 1 hour.

91. No, it quadruples. The area of a square of side s is s^2 . If the length of the sides is $2s$, the area is $(2s)^2 = 4s^2$.

Mid-Chapter Quiz for Chapter 1

1. $4x + 3 = 11$

$$4x + 3 - 3 = 11 - 3$$

$$4x = 8$$

$$\frac{4x}{4} = \frac{8}{4}$$

$$x = 2$$

Check:

$$4(2) + 3 \stackrel{?}{=} 11$$

$$8 + 3 \stackrel{?}{=} 11$$

$$11 = 11$$

2. $-3(z - 2) = 0$

$$\frac{-3(z - 2)}{-3} = \frac{0}{-3}$$

$$z - 2 = 0$$

$$z - 2 + 2 = 0 + 2$$

$$z = 2$$

Check:

$$-3(2 - 2) \stackrel{?}{=} 0$$

$$-3(0) \stackrel{?}{=} 0$$

$$0 = 0$$