Chapter 2: A Mathematical Toolkit

Practice Problems

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Express the following measurements in scientific notation

1. **a.** 5800 m

   5.8×10^{3} m

   b. 450 000 m

   4.5×10^{5} m

   c. 302 000 000 m

   3.02×10^{8} m

   d. 86 000 000 000 m

   8.6×10^{10} m

2. **a.** 0.000 508 kg

   5.08×10^{-4} kg

   b. 0.000 000 45 kg

   4.5×10^{-7} kg

   c. 0.003600 kg

   3.600×10^{-3} kg

   d. 0.004 kg

   4×10^{-3} kg

3. **a.** 300 000 000 s

   3×10^{8} s

   b. 186 000 s

   1.86×10^{5} s

   c. 93 000 000 s

   9.3×10^{7} s

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4. Convert each of the following length measurements to its equivalent in meters.

   a. 1.1 cm

   $$(1.1 \text{ cm})\frac{(1 \times 10^{-2} \text{ m})}{(1 \text{ cm})} = 1.1 \times 10^{-2} \text{ m}$$

   b. 76.2 pm

   $$(76.2 \text{ pm})\frac{(1 \times 10^{-12} \text{ m})}{(1 \text{ pm})} = 76.2 \times 10^{-12} \text{ m}$$

   $$= 7.62 \times 10^{-11} \text{ m}$$

   c. 2.1 km

   $$(2.1 \text{ km})\frac{(1 \times 10^{3} \text{ m})}{(1 \text{ km})} = 2.1 \times 10^{3} \text{ m}$$

   d. 0.123 Mm

   $$(0.123 \text{ Mm})\frac{(1 \times 10^{6} \text{ m})}{(1 \text{ Mm})} = 0.123 \times 10^{6} \text{ m}$$

   $$= 1.23 \times 10^{5} \text{ m}$$

5. Convert each of these mass measurements to its equivalent in kilograms.

   a. 147 g

   $$1 \text{ kg} = 1 \times 10^{3} g \text{ so } 147 g \left[\frac{1 \text{ kg}}{1 \times 10^{3} g}\right]$$

   $$= 147 \times 10^{-3} \text{ kg}$$
   $$= 1.47 \times 10^{-1} \text{ kg}$$

   b. 11 μg

   $$1 \mu g = 1 \times 10^{-6} g \text{ and } 1 \text{ kg}$$
   $$= 1 \times 10^{3} g \text{ so}$$

   $$11 \mu g \left[\frac{1 \times 10^{-6} g}{1 \mu g}\right]\left[\frac{1 \text{ kg}}{1 \times 10^{3} g}\right]$$

   $$= 11 \times 10^{-6} \times 10^{-3} \text{ kg}$$
   $$= 1.1 \times 10^{-8} \text{ kg}$$

c. 7.23 Mg

$$7.23\ \text{Mg}\left[\frac{1\times 10^{6}g}{1\ \text{Mg}}\right]\left[\frac{1\ \text{kg}}{1\times 10^{3}g}\right]$$

$= 7.23 \times 10^{3}$ kg

d. 478 mg

$$478\ \text{mg}\left[\frac{1\times 10^{-3}g}{1\ \text{mg}}\right]\left[\frac{1\ \text{kg}}{1\times 10^{3}g}\right]$$

$= 4.78 \times 10^{-4}$ kg

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Solve the following problems. Express your answers in scientific notation.

6. a. 5×10^{-7} kg + 3×10^{-7} kg

8×10^{-7} kg

b. 4×10^{-3} kg + 3×10^{-3} kg

7×10^{-3} kg

c. 1.66×10^{-19} kg + 2.30×10^{-19} kg

3.96×10^{-19} kg

d. 7.2×10^{-12} kg − 2.6×10^{-12} kg

4.6×10^{-12} kg

7. a. 6×10^{-8} m^2 − 4×10^{-8} m^2

2×10^{-8} m^2

b. 3.8×10^{-12} m^2 − 1.90×10^{-11} m^2

-1.52×10^{-11} m^2

c. 5.8×10^{-9} m^2 − 2.8×10^{-9} m^2

3.0×10^{-9} m^2

d. 2.26×10^{-18} m^2 − 1.80×10^{-18} m^2

0.46×10^{-18} m^2 = 4.6×10^{-19} m^2

8. a. 5.0×10^{-7} mg + 4×10^{-8} mg

5.0×10^{-7} mg + 4×10^{-8} mg
$= 5.0 \times 10^{-7}$ mg + 0.4×10^{-7} mg
$= 5.4 \times 10^{-7}$ mg

b. 6.0×10^{-3} mg + 2×10^{-4} mg

6.0×10^{-3} mg + 2×10^{-4} mg
$= 6.0 \times 10^{-3}$ mg + 0.2×10^{-3} mg
$= 6.2 \times 10^{-3}$ mg

c. 3.0×10^{-2} pg − 2×10^{-6} ng

3.0×10^{-2} pg − 2×10^{-6} ng
$= 3.0 \times 10^{-2} \times 10^{-12}$g − $2 \times 10^{-6} \times$
$= 3.0 \times 10^{-14}$g − 0.2×10^{-14}g
$= 2.8 \times 10^{-14}$g

d. 8.2 km − 3×10^{2} m

8.2 km − 3×10^{2} m
$= 8.2 \times 10^{3}$ m − 0.3×10^{3} m
$= 7.9 \times 10^{3}$ m

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Find the value of each of the following qu

9. a. $(2 \times 10^{4}\ \text{m})(4 \times 10^{8}\ \text{m})$

$(2 \times 10^{4}\ \text{m})(4 \times 10^{8}\ \text{m}) = 8 \times 10^{4+}$
$= 8 \times 10^{12}$ m^2

b. $(3 \times 10^{4}\ \text{m})(2 \times 10^{6}\ \text{m})$

$(3 \times 10^{4}\ \text{m})(2 \times 10^{6}\ \text{m}) = 6 \times 10^{4+}$
$= 6 \times 10^{10}$ m^2

c. $(6 \times 10^{-4}\ \text{m})(5 \times 10^{-8}\ \text{m})$

$(6 \times 10^{-4}\ \text{m})(5 \times 10^{-8}\ \text{m})$
$= 30 \times 10^{-4-8}$ m^2
$= 3 \times 10^{-11}$ m^2

d. $(2.50 \times 10^{-7}\ \text{m})(2.50 \times 10^{16}\ \text{m})$

$(2.50 \times 10^{-7}\ \text{m})(2.50 \times 10^{16}\ \text{m})$
$= 6.25 \times 10^{-7+16}$ m^2
$= 6.25 \times 10^{9}$ m^2

10. a. $\dfrac{6\times 10^{8}\ \text{kg}}{2\times 10^{4}\ \text{m}^3}$

$\dfrac{6\times 10^{8}\ \text{kg}}{2\times 10^{4}\ \text{m}^3} = 3 \times 10^{8-4}$ kg/m^3

$= 3 \times 10^{4}$ kg/m^3

Practice Problems

b. $\frac{6 \times 10^8 \text{ kg}}{2 \times 10^{-4} \text{ m}^3}$

$\frac{6 \times 10^8 \text{ kg}}{2 \times 10^{-4} \text{ m}^3} = 3 \times 10^{8-(-4)} \text{ kg/m}^3$

$= 3 \times 10^{12} \text{ kg/m}^3$

c. $\frac{6 \times 10^{-8} \text{ m}}{2 \times 10^4 \text{ s}}$

$\frac{6 \times 10^{-8} \text{ m}}{2 \times 10^4 \text{ s}} = 3 \times 10^{-8-4} \text{ m/s}$

$= 3 \times 10^{-12} \text{ m/s}$

d. $\frac{6 \times 10^{-8} \text{ m}}{2 \times 10^{-4} \text{ s}}$

$\frac{6 \times 10^{-8} \text{ m}}{2 \times 10^{-4} \text{ s}} = 3 \times 10^{-8-(-4)} \text{ m/s}$

$= 3 \times 10^{-4} \text{ m/s}$

11. a. $\frac{(3 \times 10^4 \text{ kg})(4 \times 10^4 \text{ m})}{6 \times 10^4 \text{ s}}$

$\frac{(3 \times 10^4 \text{ kg})(4 \times 10^4 \text{ m})}{6 \times 10^4 \text{ s}}$

$= \frac{12 \times 10^{4+4} \text{ kg} \cdot \text{m}}{6 \times 10^4 \text{ s}}$

$= 2 \times 10^{8-4} \text{ kg} \cdot \text{m/s} = 2 \times 10^4 \text{ kg} \cdot \text{m/s}$

The evaluation may be done in several other ways. For example

$\frac{(3 \times 10^4 \text{ kg})(4 \times 10^4 \text{ m})}{6 \times 10^4 \text{ s}}$

$= (0.5 \times 10^{4-4} \text{ kg/s})(4 \times 10^4 \text{ m})$
$= (0.5 \text{ kg/s})(4 \times 10^4 \text{ m})$
$= 2 \times 10^4 \text{ kg} \cdot \text{m/s}$

b. $\frac{(2.5 \times 10^6 \text{ kg})(6 \times 10^4 \text{ m})}{5 \times 10^{-2} \text{s}^2}$

$\frac{(2.5 \times 10^6 \text{ kg})(6 \times 10^4 \text{ m})}{5 \times 10^{-2} \text{s}^2}$

$= \frac{15 \times 10^{6+4} \text{ kg} \cdot \text{m}}{5 \times 10^{-2} \text{s}^2}$

$= 3 \times 10^{10-(-2)} \text{ kg} \cdot \text{m/s}^2$
$= 3 \times 10^{12} \text{ kg} \cdot \text{m/s}^2$

Practice Problems

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12. State the number of significant digits in each measurement.

a. 2804 m 4

b. 2.84 m 3

c. 0.0029 m 2

d. 0.003 068 m 4

e. 4.6×10^5 m 2

f. 4.06×10^5 m 3

13. State the number of significant digits for each measurement.

a. 75 m 2

b. 75.00 mm 4

c. 0.007 060 kg 4

d. 1.87×10^6 ml 3

e. 1.008×10^8 m 4

f. 1.20×10^{-4} m 3

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14. Add 6.201 cm, 7.4 cm, 0.68 cm, and 12.0 cm.

26.3 cm (rounded from 26.281 cm)

15. Subtract

a. 8.264 g from 10.8 g.

2.5 g (rounded from 2.536 g)

b. 0.4168 m from 475 m.

475 m (rounded from 474.5832 m)

16. Perform the following multiplications.

a. 131 cm × 2.3 cm

3.0×10^2 cm^2 (the result 301.3 cm^2 expressed to two significant digits. Note that the expression in the form 300 cm^2 would not indicate how many of the digits are significant.)

Practice Problems

b. 3.2145 km × 4.23 km

13.6 km² (the result 13.597335 expressed to three significant digits)

17. Perform the following divisions.

a. 20.2 cm ÷ 7.41 s

2.73 cm/s (the result 2.726045...cm/s expressed to three significant digits)

b. 3.1416 cm ÷ 12.4 s

0.253 cm/s (the result 0.253354...cm/s expressed to three significant digits)

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18. Solve the following equation for b.

$y = mx + b$

$mx + b = y,\ b = y - mx$

19. Solve the following equations for v.

a. $d = vt$

$vt = d,\ v = \frac{d}{t}$

b. $t = \frac{d}{v}$

$t = \frac{d}{v},\ tv = d,\ v = \frac{d}{t}$

c. $a = \frac{v^2}{2d}$

$\frac{v^2}{2d} = a,\ v^2 = 2ad,\ v = \pm\sqrt{2ad}$

d. $\frac{v}{a} = \frac{b}{c}$

$\frac{v}{a} = \frac{b}{c},\ v = \frac{ab}{c}$

Practice Problems

20. Solve each of these equations for E.

a. $f = \frac{E}{s}$

$\frac{E}{s} = f,\ E = fs$

b. $m = \frac{2E}{v^2}$

$\frac{2E}{v^2} = m,\ 2E = mv^2,\ E = \frac{mv^2}{2}$

c. $\frac{E}{c^2} = m$

$\frac{E}{c^2} = m,\ E = mc^2$

21. Solve the equation $v^2 = v_0^2 + 2ad$ for

$v_0^2 + 2ad = v^2,\ 2ad = v^2 - v_0^2,\ d = \frac{(v^$

22. Solve each of these equations for a.

a. $v = v_0 + at$

$at = v - v_0;\ a = \frac{v - v_0}{t}$

b. $y = v_0t + \frac{1}{2}at^2$

$\frac{1}{2}at^2 = y - v_0t;\ a = \frac{2(y - v_0t)}{t^2}$

c. $v^2 = v_0^2 + 2ay$

$2ay = v^2 - v_0^2;\ a = \frac{v^2 - v_0^2}{2y}$

d. $v = \sqrt{2as}$

$v^2 = 2as;\ a = \frac{v^2}{2s}$

Practice Problems

23. Identify the answers to these exercises using consistent units.

a. Find the area of a rectangle 2 mm by 30 cm.

$A = (0.2\text{ cm})(30\text{ cm}) = 6\text{ cm}^2$

b. Find the perimeter of a rectangle 25 cm by 2.00 m.

$P = 0.25\text{ m} + 0.25\text{ m} + 2.00\text{ m} + 2.00\text{ m}$
$= 4.50\text{ m}$

24. Find which of the following equations are incorrect.

a. area = (length)(width)(height)

incorrect; area has units m^2 and (length)(width)(height) has units m^3

b. $\text{time} = \dfrac{\text{distance}}{\text{speed}}$

correct since $\dfrac{\text{distance}}{\text{speed}}$ has units $\dfrac{\text{m}}{(\text{m/s})} = \text{s}$

c. distance = (speed)(time)^2

incorrect since (speed)(time)^2 has units $(\text{m/s})(\text{s})^2 = m \cdot s$

Chapter Review Problems

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1. Express the following numbers in scientific notation.

a. 5 000 000 000 000 000 000 000 000 m

5×10^{24} m

b. 0.000 000 000 000 000 000 166 m

1.66×10^{-19} m

c. 2 033 000 000 m

2.033×10^{9} m

d. 0.000 000 103 0 m

1.030×10^{-7} m

2. Convert each of the following measurements into meters.

a. 42.3 cm

$$\frac{42.3\text{ cm}}{1}\left[\frac{1 \times 10^{-2}\text{ m}}{1\text{ cm}}\right] = 0.423\text{ m}$$

b. 6.2 pm

$$\frac{6.2\text{ pm}}{1}\left[\frac{1 \times 10^{-12}\text{ m}}{1\text{ pm}}\right] = 6.2 \times 10^{-12}\text{ m}$$

c. 21 km

$$\frac{21\text{ km}}{1}\left[\frac{1 \times 10^{3}\text{ m}}{1\text{ km}}\right] = 2.1 \times 10^{4}\text{ m}$$

d. 0.023 mm

$$\frac{0.023\text{ mm}}{1}\left[\frac{1 \times 10^{-3}\text{ m}}{1\text{ mm}}\right] = 2.3 \times 10^{-5}\text{ m}$$

e. 214 μm

$$\frac{214\ \mu\text{m}}{1}\left[\frac{1 \times 10^{-6}\text{ m}}{1\ \mu\text{m}}\right] = 2.14 \times 10^{-4}\text{ m}$$

f. 570 nm

$$570\text{ nm}\left[\frac{1 \times 10^{-9}\text{ m}}{1\text{ nm}}\right] = 5.70 \times 10^{-7}\text{ m}$$

3. Rank the following mass measurements from smallest to largest: 11.6 mg, 1021 μg, 0.000 006 kg, 0.31 mg.

$$\frac{11\text{ mg}}{1}\left[\frac{1 \times 10^{-3}\text{ g}}{1\text{ mg}}\right] = 1.1 \times 10^{-2}\text{ g}$$

$$\frac{1021\ \mu\text{g}}{1}\left[\frac{1 \times 10^{-6}\text{ g}}{1\mu\text{g}}\right] = 1.021 \times 10^{-3}\text{ g}$$

$$\frac{0.000\ 006\ \text{kg}}{1}\left[\frac{10^3\ \text{g}}{1\ \text{ky}}\right] = 6 \times 10^{-3}\ \text{g}$$

$$\frac{0.31\ \text{mg}}{1}\left[\frac{1 \times 10^{7-}\ \text{g}}{1\ \text{mg}}\right] = 3.1 \times 10^{-4}\ \text{g}$$

0.31 mg, 1021 μg, 0.000 006 kg, 11 mg

4. Add or subtract as indicated.

a. $5.80 \times 10^9\ \text{s} + 3.20 \times 10^9\ \text{s}$

$5.80 \times 10^9\ \text{s} + 3.20 \times 10^8\ \text{s} = 6.12 \times 10^9\ \text{s}$

b. $4.87 \times 10^{-6}\ \text{m} - 1.93 \times 10^{-6}\ \text{m}$

$4.87 \times 10^{-6}\ \text{m} - 1.93 \times 10^{-6}\ \text{m}$
$= 2.94 \times 10^{-6}\ \text{m}$

c. $3.14 \times 10^{-5}\ \text{kg} + 9.36 \times 10^{-5}\ \text{kg}$

$3.14 \times 10^{-5}\ \text{kg} + 9.36 \times 10^{-5}\ \text{kg}$
$= 12.50 \times 10^{-5}\ \text{kg} = 1.250 \times 10^{-4}\ \text{kg}$

d. $8.12 \times 10^7\ \text{g} - 6.20 \times 10^6\ \text{g}$

$8.12 \times 10^7\ \text{g} - 6.20 \times 10^6\ \text{g}$
$= 7.50 \times 10^7\ \text{g}$

5. State the number of significant digits in each measurement.

a. 248 m 3

b. 0.000 03 m 1

c. 64.01 m 4

d. 80.001 m 5

6. State the number of significant digits in the following measurements.

a. 2.40×10^6 kg 3

b. 6×10^8 kg 1

c. 4.07×10^{16} m 3

Chapter Review Problems

7. Many labels give metric equivalents of English quantities. Examples are: 12 fluid ounces (9345.66 mL), 353 ft (107.59 m), 2.0 inches (50.80 mm). Report each metric equivalent using the correct number of significant digits.

9.4×10^3 mL, 108 m, 51 mm

8. Add or subtract as indicated and state the answer with the correct number of significant digits.

a. 16.2 m + 5.008 m + 13.48 m

16.2 m
5.008 m
13.48 m
34.688 m = 34.7 m

b. 5.006 m + 12.0077 m + 8.0084 m

5.006 m
12.0077 m
8.0084 m
25.0221 m = 25.022 m

c. 78.05 cm^2 – 32.046 cm^2

78.05 cm^2
−32.046 cm^2
46.004 cm^2 = 46.00 cm^2

d. 15.07 kg – 12.0 kg

15.07 kg
−12.0 kg
3.07 kg = 3.1 kg

9. Multiply or divide as indicated watching significant digits.

a. $(6.2 \times 10^{18}\ \text{m})(4.7 \times 10^{-10}\ \text{m})$

$2.9 \times 10^9\ \text{m}^2$

b. $(5.6 \times 10^{-7}\ \text{m}) \div (2.8 \times 10^{-12}\ \text{s})$

2.0×10^5 m/s

c. $(8.1 \times 10^{-4}\ \text{km})(1.6 \times 10^{-3}\ \text{km})$

$1.3 \times 10^{-6}\ \text{km}^2$

d. $(6.5 \times 10^5 \text{ kg}) \div (3.4 \times 10^3 \text{ m}^3)$

$1.9 \times 10^2 \text{ kg/m}^3$

10. Tom did the following problems on his calculator, reporting results shown. Give the answer to each using the correct number of significant digits.

a. 5.32 mm + 2.1 mm = 7.4200000 mm

7.4 mm

b. 13.597 m × 3.65 m = 49.6290500 m^2

49.6 m^2

c. 83.2 kg − 12.804 kg = 70.3960000 kg

70.4 kg

11. A rectangular floor has a length of 15.72 m and a width of 4.40 m. Calculate the area of the floor to the best possible value using these measurements.

69.2 m^2

12. A yard is 33.21 m long and 17.6 m wide.

a. What length of fence must be purchased to enclose the entire yard?

Perimeter = $2\ell + 2w$
= 2(33.21 m) + 2(17.6 m)
= 66.42 m + 35.2 m
= 101.6 m

b. What area must be covered if the yard is to be fertilized?

Area = ℓw = (33.21 m)(17.6 m)
= 584 m^2

13. The length of a room is 16.40 m, its width is 4.5 m, and its height is 3.26 m. What volume does the room enclose?

$V = \ell wh$ = (16.40 m)(4.5 m)(3.26 m)
= $2.4 \times 10^2 \text{ m}^3$

Chapter Review Problems

14. The sides of a quadrangular plot of land are 132.68 m, 48.3 m, 132.736 m, and 48.37 m. What is the perimeter of the plot as can best be determined from these measurements?

Perimeter
= 132.68 m + 48.3 m + 132.736 m + 48.37 m
= 362.1 m

15. A water tank has a mass of 3.64 kg when empty and a mass of 51.8 kg when filled to a certain level. What is the mass of the water in the tank?

51.8 kg
−3.64 kg
48.16 kg = 48.2 kg

16. Figure 2–18 shows the mass of three substances for volumes between 0 and 60 cm^3.

a. What is the mass of 30 cm^3 of each substance?

(a) 80 g, (b) 260 g, (c) 400 g.

b. If you had 100 g of each substance, what would their volumes be?

(a) 37 cm^3, (b) 11 cm^3, (c) 7 cm^3.

c. Describe the meaning of the steepness of the lines in this graph (a single word is not a sufficient answer!).

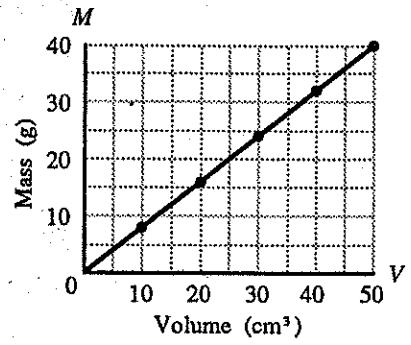
The steepness represents the increased mass of each additional cubic centimeter of the substance.

17. During an experiment, a student measured the mass of 10.0 cm^3 of alcohol. The student then measured the mass of 20.0 cm^3 of alcohol. In this way the data in Table 2–3 were collected.

Table 2–3

Volume (cm^3)	Mass (g)
10.0	7.9
20.0	15.8
30.0	23.7
40.0	31.6
50.0	39.6

a. Plot the values given in the table and draw the curve that best fits all points.



b. Describe the resulting curve.

A straight line

c. Use the graph to write an equation relating the volume to the mass of the alcohol.

$M = mV$, where m is the slope

d. Find the units of the slope of the graph. What is the name given to this quantity?

mass/volume; density

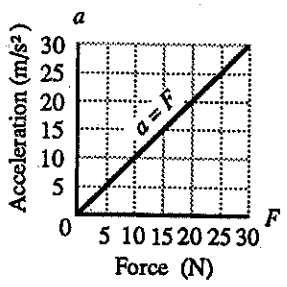
18. During a class demonstration, an instructor placed a 1.0-kg mass on a horizontal table that was nearly frictionless. The instructor then applied various horizontal forces to the mass and measured the rate at which the mass gained speed (was accelerated) for each force applied. The results of the experiment are shown in Table 2–4.

Table 2–4

Force (N)	Acceleration (m/s²)
5.0	4.9
10.0	9.8
15.0	15.2
20.0	20.1
25.0	25.0
30.0	29.9

Chapter Review Problems

a. Plot the values given in the table and draw the curve that best fits all points.



b. Describe, in words, the relationship between force and acceleration according to the graph.

The acceleration varies directly with the force

c. Write the equation relating the force and the acceleration that results from the graph.

$F = ka$

d. Find the units of the slope of the graph.

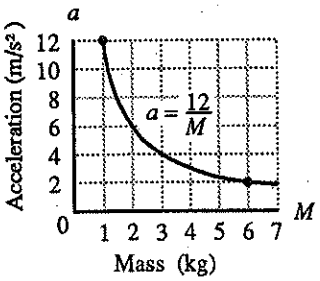
$k = a/F$ so the units of k are $(m/s^2)/N$
$= m/s^2 \cdot N$

19. The teacher who performed the experiment in the previous problem then changed the procedure. The mass was varied while the force was kept constant. The acceleration of each mass was then recorded. The results are shown in Table 2–5.

Table 2–5

Mass (kg)	Acceleration (m/s²)
1.0	12.0
2.0	5.9
3.0	4.1
4.0	3.0
5.0	2.5
6.0	2.0

a. Plot the values given in the table and draw the curve that best fits all points.



b. Describe the resulting curve.

Hyperbola

c. According to the graph, what is the relationship between mass and the acceleration produced by a constant force?

Acceleration varies inversely with the mass.

d. Write the equation relating acceleration to mass given by the data in the graph.

$a = c/M$, c = constant = 12

e. Find the units of the constant in the equation.

$c = Ma$, so the units of c are $(kg)(m/s^2)$
$= kg \cdot m/s^2$

20. Each cubic centimeter of gold has a mass of 19.3 g. A cube of gold measures 4.23 cm on each edge.

a. What is the volume of the cube?

$(4.23\ cm)^3 = 75.7\ cm^3$

b. What is its mass?

M = (density)(V) = $(19.3\ g/cm^3)(75.7\ cm^3)$
$= 1.46 \times 10^3\ g$

21. Solve the equation

$$T = 2\pi\sqrt{\frac{\ell}{g}}$$

for

a. ℓ

$T = 2\pi\sqrt{\frac{\ell}{g}}$, so $\frac{T}{2\pi} = \sqrt{\frac{\ell}{g}}$ square both sides

$\frac{T^2}{4\pi^2} = \frac{\ell}{g}$, so $\ell = \frac{gT^2}{4\pi^2}$

b. g

from above $-\frac{T^2}{4\pi^2} = \frac{\ell}{g}$, so $\frac{gT^2}{4\pi^2} = \ell$,

or $gT^2 = 4\pi^2\ell$, or $g = \frac{4\pi^2\ell}{T^2}$

22. Each cubic centimeter of silver has a mass of 10.5 g.

a. What is the mass of 65.0 cm^3 of silver?

density of silver = D = 10.5 g/cm^3.
Since $D = M/V$,
$M = DV = (10.5\ g/cm^3)(65.0\ cm^3)$
$= 683\ g$

b. When placed on a beam balance, the 65.0 cm^3 piece of silver has a mass of only 616 g. What volume of the piece is hollow?

actual volume of silver
$= V = M/D = (616\ g)/(10.5\ g/cm^3)$
$= 58.7 cm^3$.
Hollow volume = given volume − actual volume
$= 65.0\ cm^3 - 58.7\ cm^3 = 6.3\ cm^3$

23. Assume that a small sugar cube has sides 1.0 cm long. If you had a box containing 1 mole of sugar cubes and lined them up side by side, how long would the line be? 1 mole = 6.02×10^{23} units.

$(6.02 \times 10^{23})(1\text{ cm}) = 6.02 \times 10^{23}$ cm or
$(6.02 \times 10^{23}\text{ cm})/(100\text{ cm/m})(1000\text{ m/km})$
$= 6.02 \times 10^{18}$ km

24. The average distance between Earth and the sun is 1.50×10^8 km.

a. Calculate the average speed, in km/h, of Earth assuming a circular path about the sun. Use the equation $v = \frac{2\pi r}{t}$.

$$v = \frac{2\pi r}{t} = \frac{2\pi(1.50 \times 10^8\text{ km})}{365\text{ dy}\left[\frac{24\text{ k}}{1\text{ dy}}\right]}$$

$$= 1.08 \times 10^5\text{ km/h}$$

b. Convert your answer from km/h to m/s. Show all units.

$$\frac{1.08 \times 10^5\text{ km}}{\text{h}}\left[\frac{1000\text{ m}}{1\text{ km}}\right]\left[\frac{1\text{ h}}{3600\text{ s}}\right]$$

$$= 3.00 \times 10^4\text{ m/s}$$

25. The radius of Earth is 6.37×10^3 km.

a. Find the speed, in km/h, resulting from the rotation of Earth, of a person standing on the equator.

$$v = \frac{2\pi r}{t} = \frac{2\pi(6.37 \times 10^3\text{ km})}{24\text{ h}}$$

$$= 1.67 \times 10^3\text{ km/h}$$

b. Convert your answer to m/s.

$$\frac{1.67 \times 10^3\text{ km}}{\text{h}}\left[\frac{1\text{ h}}{3600\text{ s}}\right]\left[\frac{1000\text{ m}}{1\text{ km}}\right]$$

$$= 464\text{ m/s}$$

Chapter Review Problems

26. A child rides a merry–go–round horse that is 5.4 m from the center. The rides lasts 10 minutes. During this time the ride makes 24 revolutions. Find the speed of the child in meters/second. Use the equation $v = \frac{2\pi r}{t}$.

$$t = \frac{10\text{ min}}{24\text{ rev}} = 0.42\ \frac{\text{min}}{\text{rev}},\text{ and}$$

$$v = \frac{2\pi r}{t} = \frac{2\pi(5.4\text{ m})}{\left[\frac{0.42\text{ min}}{1}\right]\left[\frac{60\text{ s}}{1\text{ min}}\right]} = 1.4\text{ m/s}$$

27. Manipulate the equation v = d/t and find the answers to these problems using consistent units.

a. Find the distance a bike travels in 1.5 minutes, if it is traveling at a constant speed of 20 km/hr.

$$v = \frac{d}{t},$$

$$\text{so } d = vt = \left[\frac{20\text{ km}}{\text{h}}\right]\left[\frac{1\text{ h}}{60\text{ min}}\right]\left[\frac{1.5\text{ min}}{1}\right]$$
$$= 0.50\text{ km}$$

b. How long would it take a car to travel 6000 m if its speed is a constant 30 km/hr?

$$v = \frac{d}{t},\text{ so } vt = d,\text{ and } t = \frac{d}{v}$$

$$= \frac{\left[\frac{6000\text{ m}}{1}\right]\left[\frac{1\text{ km}}{1000\text{ m}}\right]}{30\ \frac{\text{km}}{\text{h}}} = 0.20\text{ h}$$

28. Water drips from a faucet into a flask at the rate of two drops every 3 seconds. A cubic centimeter (cm^3) contains 20 drops. What volume of water, in cubic decimeters (dm^3), will be collected in 1 hour?

$$V = \left[\frac{2\text{ drops}}{30\text{ s}}\right]\left[\frac{1\text{ cm}^3}{20\text{ drops}}\right]\left[\frac{\text{dm}^3}{1000\text{ cm}^3}\right]$$

$$= \left[\frac{3600\text{ s}}{1\text{ h}}\right] = 0.12\ \frac{\text{dm}^3}{\text{h}}$$

Chapter Review Problems

29. Tony's Pizza Shop ordered new 23 cm pizza pans (9–inch pans). By mistake, 26 cm (10–inch) pans were delivered. Tony says that the difference is too small to worry about. As Tony's accountant, what would you say knowing materials cost about 0.25 cents per square centimeter?

The area of each pan is given by $A = \pi r^2$ or $\pi\left[\frac{d}{2}\right]^2$, so the difference in area for the pans is

$$\pi\left[\frac{26\text{ cm}}{2}\right]^2 - \left[\frac{23\text{ cm}}{2}\right]^2 = 120\text{ cm}^2$$

$(120\text{ cm}^2)(0.25¢/\text{cm}^2) = \$0.30$
Each pizza costs 30 cents more.

Supplemental Problems

1. Express the following numbers in scientific notation.

   a. 810 000 g 8.1×10^5 g

   b. 0.000634 g 6.34×10^{-4} g

   c. 60 000 000 g 6×10^7 g

   d. 0.0000010 g 1.0×10^{-6} g

2. Convert each of the following time measurements to its equivalent in seconds.

   a. 58 ns 5.8×10^{-8} s

   b. 0.046 Gs 4.6×10^7 s

   c. 9270 ms 9.27 s

   d. 12.3 ks 1.23×10^4 s

Supplemental Problems (Appendix B)

3. Solve the following problems. Express your answers in scientific notation.

   a. 6.2×10^{-4} m + 5.7×10^{-3}

   6.32×10^{-3} m

   b. 8.7×10^8 km – 3.4×10^7 km

   8.36×10^8 km

   c. $(9.21 \times 10^{-5}\text{ cm})(1.83 \times 10^8\text{ cm})$

   $1.69 \times 10^4\text{ cm}^2$

   d. $(2.63 \times 10^{-6}\text{ m}) \div (4.08 \times 10^6\text{ s})$

   6.45×10^{-13} m/s

4. State the number of significant digits in the following measurements.

   a. 3218 kg 4

   b. 60.080 kg 5

   c. 801 kg 3

   d. 0.000534 kg 3

5. State the number of significant digits in the following measurements.

   a. 5.60×10^8 m 3

   b. 3.0005×10^{-6} m 5

   c. 8.0×10^{10} m 2

   d. 9.204×10^{-3} m 4

6. Add or subtract as indicated and state the answer with the correct number of significant digits.

   a. 85.26 g + 4.7 g = 90.0 g

   b. 1.07 km + 0.608 km = 1.68 km

   c. 186.4 kg – 57.83 kg = 128.6 kg

   d. 60.08 s – 12.2 s = 47.9 s

7. Multiply or divide as indicated using significant digits correctly.

   a. $(5 \times 10^8 \text{ m})(4.2 \times 10^7 \text{ m})$

   $2 \times 10^{16} \text{ m}^2$

   b. $(1.67 \times 10^{-2} \text{ km})(8.5 \times 10^{-6} \text{ km})$

   $1.4 \times 10^{-7} \text{ km}^2$

   c. $(2.6 \times 10^4 \text{ kg}) + (9.4 \times 10^3 \text{ m}^3)$

   2.8 kg/m^3

   d. $(6.3 \times 10^{-1} \text{ m}) \div (3.8 \times 10^2 \text{ s})$

   $1.7 \times 10^{-3} \text{ m/s}$

8. A rectangular room is 8.7 m by 2.41 m.

   a. What length of baseboard molding must be purchased to go around the perimeter of the floor?

   $P = 2\ell + 2w$

   $2(8.7 \text{ m}) + 2(2.41 \text{ m}) = 22.2 \text{ m}$

   b. What area must be covered if tiles are layed?

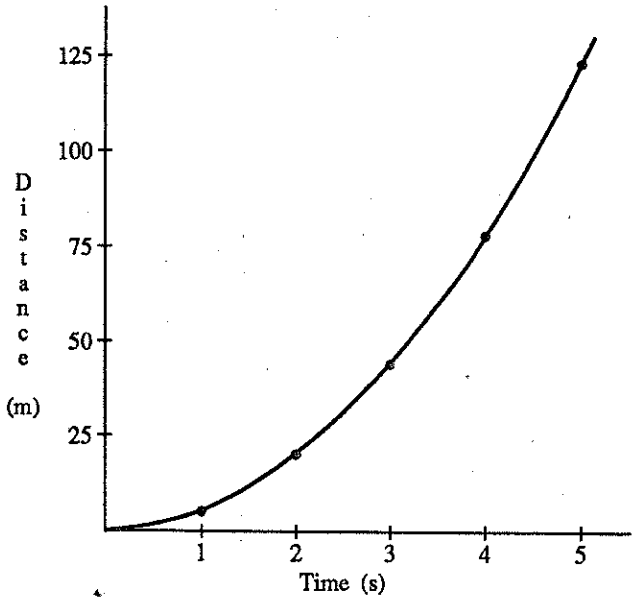
   $A = \ell w = (8.7 \text{ m})(2.41 \text{ m}) = 21 \text{ m}^2$

Supplemental Problems

9. The following data table was established showing the total distances an object fell during various lengths of time.

Time (s)	Distance (m)
1	5
2	20
3	44
4	78
5	123

   a. Plot distance versus time from the values given in the table and draw a curve that best fits all points.



   b. Describe the resulting curve.

   Parabola; curve starts at origin and is concave upward

   c. According to the graph, what is the relationship between distance and time for a free–falling object?

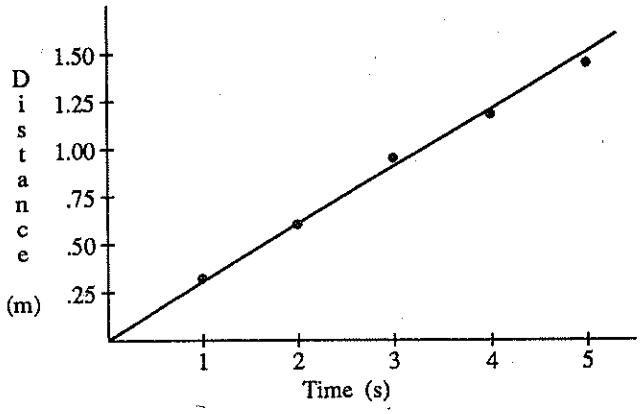
   The distance increases faster and faster with time.

Supplemental Problems

10. The total distance a lab cart travels during specified lengths of time is given in the following table.

Time (s)	Distance (m)
1	0.32
2	0.60
3	0.95
4	1.18
5	1.45

a. Plot distance versus time from the values given in the table and draw the curve that best fits all points.



b. Describe the resulting curve.

Straight Line

c. According to the graph, what type of relationship exists between the total distance traveled by the lab cart and time?

Linear Relationship

d. What is the slope of this graph?

$$M = \frac{\Delta y}{\Delta x} = \frac{1.5 - .60}{5 - 2} = \frac{.90}{3} = .30 \text{ m/s}$$

e. Write an equation relating distance and time for this data.

$d = .30(t)$

11. Solve the equation $F = \frac{mv^2}{r}$

a. For m, $m = \frac{Fr}{v^2}$

b. For r, $r = \frac{Mv^2}{F}$

c. For v, $v^2 = \frac{Fr}{M}$

$$v = \sqrt{\frac{Fr}{M}}$$

12. Solve the equation:

$$\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i}$$

for d_o.

$$\frac{1}{d_o} = \frac{1}{f} - \frac{1}{d_i}$$

$$d_o = \frac{1}{\frac{1}{f} - \frac{1}{d_i}} = \frac{1}{\frac{d_i - f}{d_i f}} = \frac{d_i f}{d_i - f}$$

13. A cube has an edge of length 5.2 cm.

a. Find its surface area.

Area of one side

$A = s^2 = (5.2)^2 = 27 \text{ cm}^2$

Total surface Area

$(27 \text{ cm}^2)(6) = 160 \text{ cm}^2$

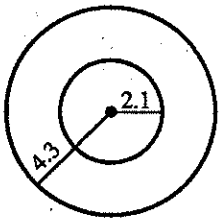
b. Find its volume.

$V = s^3 = (5.2)^3 = 140 \text{ cm}^3$

14. A truck is traveling at a constant velocity of 70 km/hr. Convert the velocity to m/s.

70 km/hr · 1000 m/km · hr/3600 s = 19m/s

15. The density of gold is 19.3 g/cm³. A gold washer has an outside radius of 4.3 cm and an inside radius of 2.1 cm. Its thickness is 0.14 cm. What is the mass of the washer?



Volume of outside cylinder:

$V = \pi R^2 h = \pi(4.3)^2(0.14) = 8.1\ cm^3$

Volume of inside cylinder:

$V = \pi R^2 h = \pi(2.1)^2(0.14) = 1.9\ cm^3$

Volume of washer:

$8.1\ cm^3 - 1.9\ cm^3 = 6.2\ cm^3$

$M = DV = (19.3\ g/cm^3)(6.2\ cm^3) = 120\ g$