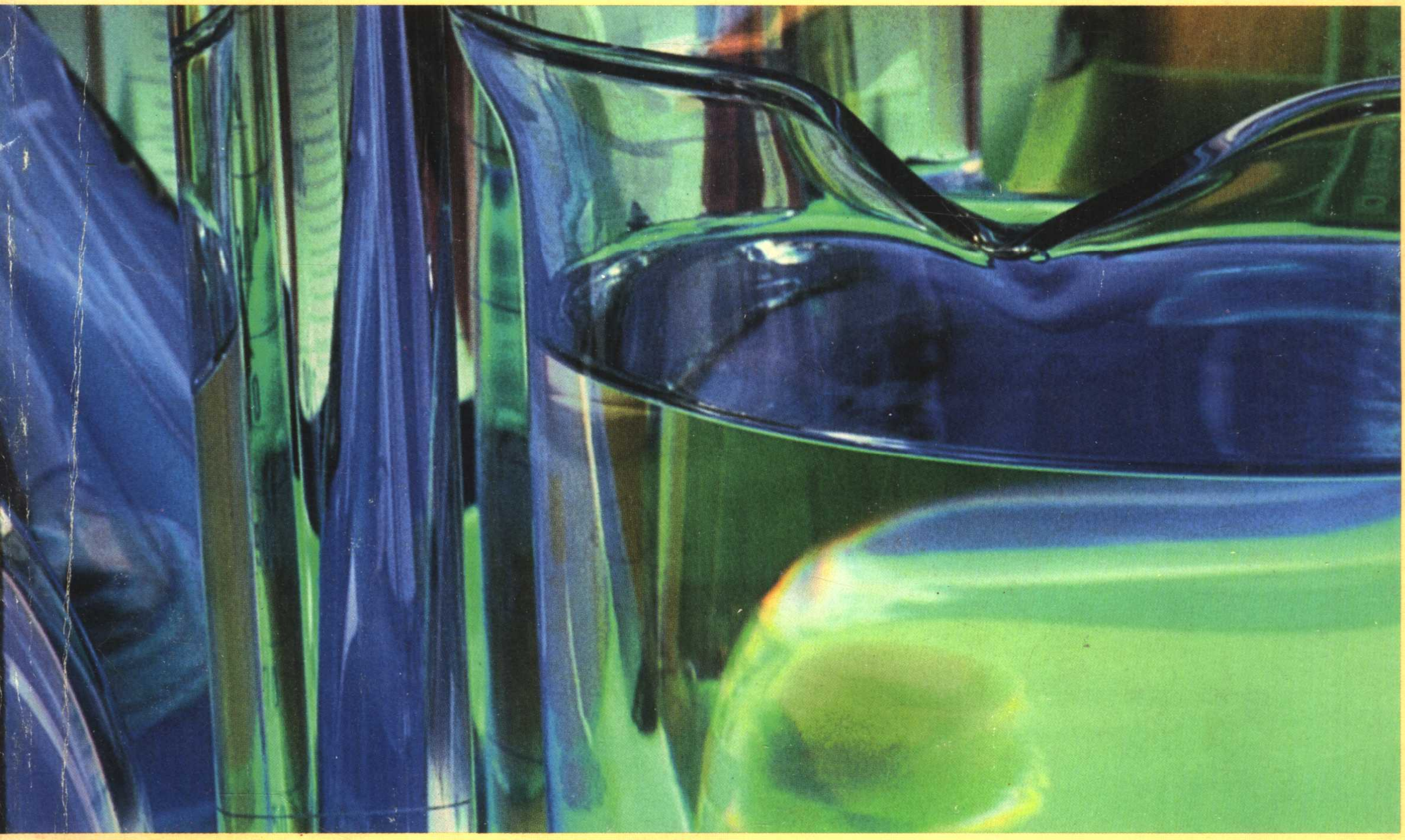
# Solutions Guide

James F. Hall



for

**Introductory Chemistry** by Steven S. Zumdahl

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# Solutions Guide

*for*

## Introductory Chemistry

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D. C. Heath and Company
Lexington, Massachusetts Toronto

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## *Preface*

This book contains detailed solutions for the even-numbered end-of-chapter problems in your textbook. It is intended to supplement and complement your textbook, not to replace it.

Think of this book as the last chapter of an Agatha Christie mystery story. Just as you wouldn't turn initially to the last few pages of a mystery to find out "whodunit," you should not look at the solutions in this book until you have tried to solve the end-of-chapter problems yourself. To learn chemistry, *you* have to push a pencil around on paper.

When you study chemistry, first go over your lecture notes and read through your textbook to see if there is any factual material or terminology you don't understand. Then work through the example problems your professor has done in class and the examples in the textbook, paying close attention to the method of solution used for each problem. Then try again to work through the *same* classroom and textbook examples yourself *without* looking at the solutions. Once you feel comfortable with the example problems, you can tackle the end-of-chapter problems.

You will notice that the end-of-chapter problems (and the solutions in this book) are divided into the same topic sections as the textbook. This should enable you to find the specific material you want to study or review. Problems within a section are arranged in no particular order of difficulty, and no "extra hard" problems are given. If you have truly understood your classroom work and your reading of the textbook, you should be able to solve *all* the end-of-chapter problems without any difficulty.

One topic that causes many students concern is the matter of significant figures, and the determination of the number of digits to which a solution to a problem should be reported. When solving problems, we typically do *not* round off intermediate answers, but only report the *final answer* to the appropriate number of significant figures. If several intermediate answers were rounded off in a long problem of many steps, there might be a loss of precision in the final answer due to truncation errors. The solutions in this book report all intermediate answers to *one more digit than appropriate for the final answer*. The final answer to each problem is then given to the correct number of significant figures based on the data provided in the problem. *Be aware, however, that the calculator you use to solve these problems may express intermediate answers to many more digits than are given in the solutions (calculators typically express results to eight decimal places)*. If your intermediate answers do not correspond exactly to what is given in this book, check to see if the ideas mentioned above apply.

Good luck in your study of chemistry!

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# Chapter One Chemistry: An Introduction

## Introduction

2. There are, of course, *many* examples of how we make use of chemistry in our everyday life, perhaps without our even realizing that we are applying chemical principles to a problem or situation. For example, a homeowner may use an oven or drain cleaner without realizing that the cleaner works by means of a simple chemical reaction. An automobile mechanic may use a battery charger to put a "quick charge" on your car's battery without realizing that the charger causes a chemical reaction to occur in the battery. For the three occupations mentioned in the question (physician, pharmacist, farmer), some suggestions of how the person makes use of chemistry are given:

    physician: understanding biochemical processes in the cell
    pharmacist: understanding drug interactions
    farmer: understanding use of fertilizers and pesticides

## 1.1 What Is Chemistry?

4. Many beginning students would define chemistry as "this complicated and difficult subject that I am being required to take." Although at an advanced level chemistry may indeed be complicated and difficult, the basic *fundamentals* of chemistry can be understood by anyone. A knowledge of the basics of chemistry is essential for even beginning study in many fields. For example, for many students, biology is their favorite science subject in school. However, a detailed knowledge of biology is virtually impossible without a corresponding knowledge of chemistry.

## 1.2 Solving Problems Using a Scientific Approach

6. In order to analyze a situation scientifically, three things must be done: (1) the situation must be *observed* and the problem involved stated clearly; (2) possible *solutions* to the problem must be formulated; (3) the possible solutions must be tested by *experiment*.

    (1) The best way to drive to school on Friday morning. You notice that traffic is heavy at around 8:30 A.M. as office workers leave their homes (observation). You consider leaving home 15 minutes earlier to avoid this congestion (hypothesis). You try leaving 15 minutes earlier, and find that the traffic is much lighter (experiment).

    (2) Having two examinations on the same day. You realize you have two exams on the same day, one in English (in which you are doing very well) and one in math (in which you are barely holding your own) (observation). You consider studying only one hour for the English test, and devoting the rest of your time to math in the hopes that you will score passing grades on both exams (hypothesis). You divide up your study time in this manner, and do well on both exams (experiment).

    (3) Stalling your car while your little brother is aboard. You've stalled out at the busiest intersection in town with your bratty little brother in the car; you know you can't leave him in the car

while you go for help because he'll get into trouble, and yet you don't want to take him with you because he'll whine the whole time (observation). You decide to put on your emergency flashers and wait where you are for a minute or two in case you just flooded the carburetor (hypothesis). You wait two minutes, and the car starts up like a charm (experiment).

8. Answer will depend on student experience.

## 1.3 The Scientific Method

10. a. quantitative - a number (measurement) is indicated explicitly
    b. qualitative - only a qualitative description is given
    c. quantitative - a numerical measurement is indicated
    d. qualitative - only a qualitative description is given
    e. quantitative - a number (measurement) is implied
    f. qualitative - a qualitative judgment is given
    g. quantitative - a numerical quantity is indicated

12. A natural law is a *summary of observed, measurable behavior* that occurs repeatedly and consistently. A theory is our attempt to *explain* such behavior.

## 1.4 Learning Chemistry

14. Most applications of chemistry are oriented toward the interpretation of observations and the solving of problems. Although memorization of some facts may *aid* in these endeavors, it is the ability to combine, relate, and synthesize information that is most important in the study of chemistry.

16. In real life situations, the problems and applications likely to be encountered are not simple textbook examples. One must be able to observe an event, hypothesize a cause, and then test this hypothesis. One must be able to carry what has been learned in class forward to new, different situations.

## Chapter Two Measurements and Calculations

### 2.1 Scientific Notation

2. The decimal point must be moved three places, giving three as the power of ten needed.

4. Because 0.0021 is less than one, the exponent will be *negative*. Because 4540 is greater than one, the exponent will be *positive*.

6. a. 3; negative

   b. 3; negative

   c. 8; positive

   d. 6; negative

   e. 2; positive

   f. 4; positive

   g. 1; positive

   h. 4; negative

8. a. The decimal point must be moved two places to the left, so the exponent is positive 2; $529 = 5.29 \times 10^2$

   b. The decimal point must be moved eight places to the left, so the exponent is positive 8; $240{,}000{,}000 = 2.4 \times 10^8$

   c. The decimal point must be moved seventeen places to the left, so the exponent is positive 17; $301{,}000{,}000{,}000{,}000{,}000 = 3.01 \times 10^{17}$

   d. The decimal point must be moved four places to the left, so the exponent is positive 4; $78{,}444 = 7.8444 \times 10^4$

   e. The decimal point must be moved four places to the right, so the exponent is negative 4; $0.0003442 = 3.442 \times 10^{-4}$

   f. The decimal point must be moved ten places to the right, so the exponent is negative 10; $0.000000000902 = 9.02 \times 10^{-10}$

   g. The decimal point must be moved two places to the right, so the exponent is negative 2; $0.043 = 4.3 \times 10^{-2}$

   h. The decimal point must be moved two places to the right, so the exponent is negative 2; $0.0821 = 8.21 \times 10^{-2}$

10. a. The decimal point must be moved five places to the left; $2.98 \times 10^{-5} = 0.0000298$

    b. The decimal point must be moved nine places to the right; $4.358 \times 10^9 = 4{,}358{,}000{,}000$

c. The decimal point must be moved six places to the left;
$1.9928 \times 10^{-6} = 0.0000019928$

d. The decimal point must be moved 23 places to the right;
$6.02 \times 10^{23} = 602{,}000{,}000{,}000{,}000{,}000{,}000{,}000$

e. The decimal point must be moved one place to the left;
$1.01 \times 10^{-1} = 0.101$

f. The decimal point must be moved three places to the left;
$7.87 \times 10^{-3} = 0.00787$

g. The decimal point must be moved seven places to the right;
$9.87 \times 10^{7} = 98{,}700{,}000$

h. The decimal point must be moved two places to the right;
$3.7899 \times 10^{2} = 378.99$

i. The decimal point must be moved one place to the left;
$1.093 \times 10^{-1} = 0.1093$

j. The decimal point must be moved zero places;
$2.9004 \times 10^{0} = 2.9004$

k. The decimal point must be moved four places to the left;
$3.9 \times 10^{-4} = 0.00039$

l. The decimal point must be moved eight places to the left;
$1.904 \times 10^{-8} = 0.00000001904$

12. To say that scientific notation is in *standard* form means that you have a number between 1 and 10, followed by an exponential term. The numbers given in this problem are *not* between 1 and 10 as written.

a. $102.3 \times 10^{-5} = (1.023 \times 10^{2}) \times 10^{-5} = 1.023 \times 10^{-3}$

b. $32.03 \times 10^{-3} = (3.203 \times 10^{1}) \times 10^{-3} = 3.203 \times 10^{-2}$

c. $59933 \times 10^{2} = (5.9933 \times 10^{4}) \times 10^{2} = 5.9933 \times 10^{6}$

d. $599.33 \times 10^{4} = (5.9933 \times 10^{2}) \times 10^{4} = 5.9933 \times 10^{6}$

e. $5993.3 \times 10^{3} = (5.9933 \times 10^{3}) \times 10^{3} = 5.9933 \times 10^{6}$

f. $2054 \times 10^{-1} = (2.054 \times 10^{3}) \times 10^{-1} = 2.054 \times 10^{2}$

g. $32{,}000{,}000 \times 10^{-6} = (3.2 \times 10^{7}) \times 10^{-6} = 3.2 \times 10^{1}$

h. $59.933 \times 10^{5} = (5.9933 \times 10^{1}) \times 10^{5} = 5.9933 \times 10^{6}$

14. a. $1/10^2 = 1 \times 10^{-2}$

b. $1/10^{-2} = 1 \times 10^2$

c. $55/10^3 = \dfrac{5.5 \times 10^1}{1 \times 10^2} = 5.5 \times 10^{-2}$

d. $(3.1 \times 10^6)/10^{-3} = \dfrac{3.1 \times 10^6}{1 \times 10^{-3}} = 3.1 \times 10^9$

e. $(10^6)^{1/2} = 1 \times 10^3$

f. $(10^6)(10^4)/(10^2) = \dfrac{(1 \times 10^6)(1 \times 10^4)}{(1 \times 10^2)} = 1 \times 10^8$

g. $1/0.0034 = \dfrac{1}{3.4 \times 10^{-3}} = 2.9 \times 10^2$

h. $3.453/10^{-4} = \dfrac{3.453}{1 \times 10^{-4}} = 3.453 \times 10^4$

## 2.2 Units

16. grams

18. a. mega-
b. milli-
c. nano-
d. mega-
e. centi-
f. micro-

## 2.3 Measurements of Length, Volume, and Mass

20. 100 km (see inside back cover of textbook)

22. centimeter

24. 1 kg (100 g = 0.1 kg)

26. 10 cm (1 cm = 10 mm)

28. d (1 L is slightly more than 1 qt)

30. d (the other units would give very large numbers for the distance)

32. Table 2.6 indicates that the diameter of a quarter is 2.5 cm.

$$1 \text{ m} \times \frac{100 \text{ cm}}{1 \text{ m}} \times \frac{1 \text{ quarter}}{2.5 \text{ cm}} = 40 \text{ quarters}$$

## 2.4 Uncertainty in Measurement

34. significant figures

36. The scale of the ruler shown is only marked to the nearest *tenth* of a centimeter; writing 2.850 would imply that the scale was marked to the nearest *hundredth* of a centimeter (and that the zero in the thousandths place had been estimated).

## 2.5 Significant Figures

38.
 a. one
 b. one
 c. four
 d. two
 e. infinite (definition)
 f. one

### Rounding Off Numbers

40. final

42.
 a. 0.0000324
 b. 7,210,000
 c. $2.10 \times 10^{-7}$
 d. 550,000 (better as $5.50 \times 10^5$ to show the first zero is significant)
 e. 200. (the decimal shows the zeroes are significant)

44.
 a. 0.5005
 b. 127
 c. 15.40
 d. 23.098

46. decimal

48. three (based on there being three significant figures in 343)

50. none (10,434 has its last significant figure in the units place)

52.
 a. 2149.6 (the answer can only be given to the first decimal place, since 149.2 is only known to the first decimal place)

 b. $5.37 \times 10^3$ (each of the numbers being added is known to the same level of precision). Since the power of ten is the same for each number, the calculation can be performed directly.

 c. Before performing the calculation, the numbers have to be converted so that they contain the same power of ten.
 $4.03 \times 10^{-2} - 2.044 \times 10^{-3} =$
 $4.03 \times 10^{-2} - 0.2044 \times 10^{-2} =$
 $3.83 \times 10^{-2}$ (the answer can only be given to three significant figures since $4.03 \times 10^{-2}$ is only known to three significant figures).

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d. Before performing the calculation, the numbers have to be converted so that they contain the same power of ten.
$2.094 \times 10^5 - 1.073 \times 10^6 =$
$2.094 \times 10^5 - 10.73 \times 10^5 =$
$-8.64 \times 10^5$

54. a. $5.57 \times 10^7$ (the answer can only be given to three significant figures because 0.0432 is only known to three significant figures)

b. $2.38 \times 10^{-1}$ (the answer can only be given to three significant figures because 0.00932 is only known to three significant figures)

c. 4.72 (the answer can only be given to three significant figures because 2.94 is only known to three significant figures)

d. $8.08 \times 10^8$ (the answer can only be given to three significant figures because 0.000934 is only known to three significant figures)

56. a. $(2.9932 \times 10^4)[2.4443 \times 10^2 + 1.0032 \times 10^1] =$
$(2.9932 \times 10^4)[24.443 \times 10^1 + 1.0032 \times 10^1] =$
$(1.9932 \times 10^4)[25.446 \times 10^1] =$
$7.6166 \times 10^6$

b. $[2.34 \times 10^2 + 2.443 \times 10^{-1}]/(0.0323) =$
$[2.34 \times 10^2 + 0.002443 \times 10^2]/(0.0323) =$
$[2.34 \times 10^2]/(0.0323) =$
$7.25 \times 10^3$

c. $(4.38 \times 10^{-3})^2 = 1.92 \times 10^{-5}$

d. $(5.9938 \times 10^{-6})^{1/2} = 1(5.9938 \times 10^{-6}) = 2.4482 \times 10^{-3}$

## 2.6 Problem Solving and Dimensional Analysis

58. an infinite number (definition)

60. $\dfrac{1\ \text{L}}{1000\ \text{cm}^3}$ $\dfrac{1000\ \text{cm}^3}{1\ \text{L}}$

62. $\dfrac{1\ \text{lb}}{\$0.79}$

64. a. $8.43\ \text{cm} \times \dfrac{10\ \text{mm}}{1\ \text{cm}} = 84.3\ \text{mm}$

b. $2.41 \times 10^2\ \text{cm} \times \dfrac{100\ \text{cm}}{1\ \text{m}} = 2.41\ \text{m}$

c. $294.5 \text{ nm} \times \frac{1\text{m}}{10^9 \text{ nm}} \times \frac{100 \text{ cm}}{1 \text{ m}} = 2.945 \times 10^{-5} \text{ cm}$

d. $404.5 \text{ m} \times \frac{1 \text{ km}}{1000 \text{ m}} = 0.4045 \text{ km}$

e. $1.445 \times 10^4 \text{ m} \times \frac{1 \text{ km}}{1000 \text{ m}} = 14.45 \text{ km}$

f. $42.2 \text{ mm} \times \frac{1 \text{ cm}}{10 \text{ mm}} = 4.22 \text{ cm}$

g. $235.3 \text{ mm} \times \frac{1000 \text{ mm}}{1 \text{ m}} = 2.353 \times 10^5 \text{ mm}$

h. $903.3 \text{ nm} \times \frac{1 \text{ m}}{10^9 \text{ nm}} \times \frac{10^6 \text{ }\mu\text{m}}{1 \text{ m}} = 0.9033 \text{ }\mu\text{m}$

66. a. $908 \text{ oz} \times \frac{1 \text{ lb}}{16 \text{ oz}} \times \frac{1 \text{ kg}}{2.2046 \text{ lb}} = 25.7 \text{ kg}$

b. $12.8 \text{ L} \times \frac{1 \text{ qt}}{0.94633 \text{ L}} \times \frac{1 \text{ gal}}{4 \text{ qt}} = 3.39 \text{ gal}$

c. $125 \text{ mL} \times \frac{1 \text{ L}}{1000 \text{ mL}} \times \frac{1 \text{ qt}}{0.94633 \text{ L}} = 0.133 \text{ qt}$

d. $2.89 \text{ gal} \times \frac{4 \text{ qt}}{1 \text{ gal}} \times \frac{1 \text{ L}}{1.0567 \text{ qt}} \times \frac{1000 \text{ mL}}{1 \text{ L}} = 1.09 \times 10^4 \text{ mL}$

e. $4.48 \text{ lb} \times \frac{453.59 \text{ g}}{1 \text{ lb}} = 2.03 \times 10^3 \text{ g}$

f. $550 \text{ mL} \times \frac{1 \text{ L}}{1000 \text{ mL}} \times \frac{1.0567 \text{ qt}}{1 \text{ L}} = 0.58 \text{ qt}$

68. $9.3 \times 10^7 \text{ mi} \times \frac{1 \text{ km}}{0.62137 \text{ mi}} = 1.5 \times 10^8 \text{ km}$

$1.5 \times 10^8 \text{ km} \times \frac{1000 \text{ m}}{1 \text{ km}} \times \frac{100 \text{ cm}}{1 \text{ m}} = 1.5 \times 10^{13} \text{ cm}$

70. $1 \times 10^{-10} \text{ m} \times \frac{100 \text{ cm}}{1 \text{ m}} = 1 \times 10^{-8} \text{ cm}$

$1 \times 10^{-10} \text{ cm} \times \frac{1 \text{ in.}}{2.54 \text{ cm}} = 4 \times 10^{-9} \text{in.}$

$1 \times 10^{-10} \text{ cm} \times \frac{1 \text{ m}}{100 \text{ cm}} \times \frac{10^9 \text{ nm}}{1 \text{ m}} = 0.1 \text{ nm}$

## 2.7 Temperature Conversions

72. Celsius

74. 273 K

76. °F

78. $t_C = t_K - 273$

    a. 275 − 273 = 2°C

    b. 445 − 273 = 172°C

    c. 0 − 273 = −273°C

    d. 77 − 273 = −196°C

    e. 10,000. − 273 = 9727°C

    f. 2.3 − 273 = −271°C

80. $t_F = 1.80(t_C) + 32$

    a. 1.80(78.1) + 32 = 173 °F

    b. 1.80(40.) + 32 = 104 °F

    c. 1.80(−273) + 32 = −459 °F

    d. 1.80(32) + 32 = 90 °F

82. a. Celsius temperature = (175 − 32)/1.80 = 79.4 °C

    Kelvin temperature = 79.4 + 273 = 352 K

    b. 255 − 273 = −18 °C

    c. (−45 − 32)/1.80 = −43 °C

    d. 1.80(125) + 32 = 257 °F

## 2.8 Density

84. g/mL    ($g/cm^3$)

86. volume

88. same

90. copper

92. $$\text{density} = \frac{\text{mass}}{\text{volume}}$$

a. $$d = \frac{234\ \text{g}}{2.2\ \text{cm}^3} = 110\ \text{g/cm}^3$$

b. $$m = 2.34\ \text{kg} \times \frac{1000\ \text{g}}{1\ \text{kg}} = 2340\ \text{g}$$

$$v = 2.2\ \text{m}^3 \times \left(\frac{100\ \text{cm}}{1\ \text{m}}\right)^3 = 2.2 \times 10^6\ \text{cm}^3$$

$$d = \frac{2340\ \text{g}}{2.2 \times 10^6\ \text{cm}^3} = 1.1 \times 10^{-3}\ \text{g/cm}^3$$

c. $$m = 1.2\ \text{lb} \times \frac{453.59\ \text{g}}{1\ \text{lb}} = 544\ \text{g}$$

$$v = 2.1\ \text{ft}^3 \times \left(\frac{12\ \text{in}}{1\ \text{ft}}\right)^3 \times \left(\frac{2.54\ \text{cm}}{1\ \text{in}}\right)^3 = 5.95 \times 10^4\ \text{cm}^3$$

$$d = \frac{544\ \text{g}}{5.95 \times 10^4\ \text{cm}^3} = 9.1 \times 10^{-3}\ \text{g/cm}^3$$

d. $$m = 4.3\ \text{ton} \times \frac{2000\ \text{lb}}{1\ \text{ton}} \times \frac{453.59\ \text{g}}{1\ \text{lb}} = 3.90 \times 10^6\ \text{g}$$

$$v = 54.2\ \text{yd}^3 \times \left(\frac{1\ \text{m}}{1.0936\ \text{yd}}\right)^3 \times \left(\frac{100\ \text{cm}}{1\ \text{m}}\right)^3 = 4.14 \times 10^7\ \text{cm}^3$$

$$d = \frac{3.90 \times 10^6\ \text{g}}{4.14 \times 10^7\ \text{cm}^3} = 9.3 \times 10^{-2}\ \text{g/cm}^3$$

94. $$55\ \text{mL} \times \frac{0.82\ \text{g}}{1\ \text{mL}} = 45\ \text{g}$$

96. $$m = 155\ \text{lb} \times \frac{453.59\ \text{g}}{1\ \text{lb}} = 7.031 \times 10^4\ \text{g}$$

$$v = 4.2\ \text{ft}^3 \times \left(\frac{12\ \text{in}}{1\ \text{ft}}\right)^3 \times \left(\frac{2.54\ \text{cm}}{1\ \text{in}}\right)^3 = 1.189 \times 10^5\ \text{cm}^3$$

$$d = \frac{7.031 \times 10^4\ \text{g}}{1.189 \times 10^5\ \text{cm}^3} = 0.59\ \text{g/cm}^3$$

98. $$5.25\ \text{g} \times \frac{1\ \text{cm}^3}{10.5\ \text{g}} = 0.500\ \text{cm}^3 = 0.500\ \text{mL}$$

$$11.2\ \text{mL} + 0.500\ \text{mL} = 11.7\ \text{mL}$$

100. a. $1.00 \times 10^3\ cm^3 \times \frac{11.34\ g}{1\ cm^3} = 1.13 \times 10^4\ g$

$1.00\ m^3 \times (\frac{100\ cm}{1\ m})^3 \times \frac{11.34\ g}{1\ cm^3} = 1.13 \times 10^7\ g$

b. $1.00 \times 10^3\ cm^3 \times \frac{2.16\ g}{1\ cm^3} = 2.16 \times 10^3\ g$

$1.00\ m^3 \times (\frac{100\ cm}{1\ m})^3 \times \frac{2.16\ g}{1\ cm^3} = 2.16 \times 10^6\ g$

c. $1.00 \times 10^3\ cm^3 \times \frac{0.880\ g}{1\ cm^3} = 8.80 \times 10^2\ g$

$1.00\ m^3 \times (\frac{100\ cm}{1\ m})^3 \times \frac{0.880\ g}{1\ cm^3} = 8.8 \times 10^5\ g$

d. $1.00 \times 10^3\ cm^3 \times \frac{7.87\ g}{1\ cm^3} = 7.87 \times 10^3\ g$

$1.00\ m^3 \times (\frac{100\ cm}{1\ m})^3 \times \frac{7.87\ g}{1\ cm^3} = 7.87 \times 10^6\ g$

## Additional Problems

102. a. $3.011 \times 10^{23} = 301,100,000,000,000,000,000,000$

b. $5.091 \times 10^9 = 5,091,000,000$

c. $7.2 \times 10^2 = 720$

d. $1.234 \times 10^5 = 123,400$

e. $4.32002 \times 10^{-4} = 0.000432002$

f. $3.001 \times 10^{-2} = 0.03001$

g. $2.9901 \times 10^{-7} = 0.00000029901$

h. $4.2 \times 10^{-1} = 0.42$

104. a. centimeters
b. kilometers
c. micrometers
d. millimeters

106. $36.2\ \text{blim} \times \frac{1400\ \text{kryll}}{1\ \text{blim}} = 5.07 \times 10^4\ \text{kryll}$

$170\ \text{kryll} \times \frac{1\ \text{blim}}{1400\ \text{kryll}} = 0.12\ \text{blim}$

$$72.5 \text{ kryll}^2 \times \left(\frac{1 \text{ blim}}{1400 \text{ kryll}}\right)^2 = 3.70 \times 10^{-5} \text{ blim}^2$$

108. $52 \text{ cm} \times \frac{1 \text{ in.}}{2.54 \text{ cm}} = 20 \text{ in.}$

110. $1 \text{ lb} \times \frac{1 \text{ kg}}{2.2 \text{ lb}} \times \frac{\$1}{\text{F5}} \times \frac{11.5\text{F}}{1 \text{ kg}} = \$1$

112. $°X = 1.26°C + 14$

114. $d = \frac{36.8 \text{ g}}{10.5 \text{ L}} = 3.50 \text{ g/L} \quad (3.50 \times 10^{-3} \text{ g/cm}^3)$

116. for ethanol, $100. \text{ mL} \times \frac{0.785 \text{ g}}{1 \text{ mL}} = 78.5 \text{ g}$

for benzene, $100. \text{ mL} \times \frac{0.880 \text{ g}}{1 \text{ mL}} = 88.0 \text{ g}$

total mass, $78.5 + 88.0 = 166.5 \text{ g}$

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