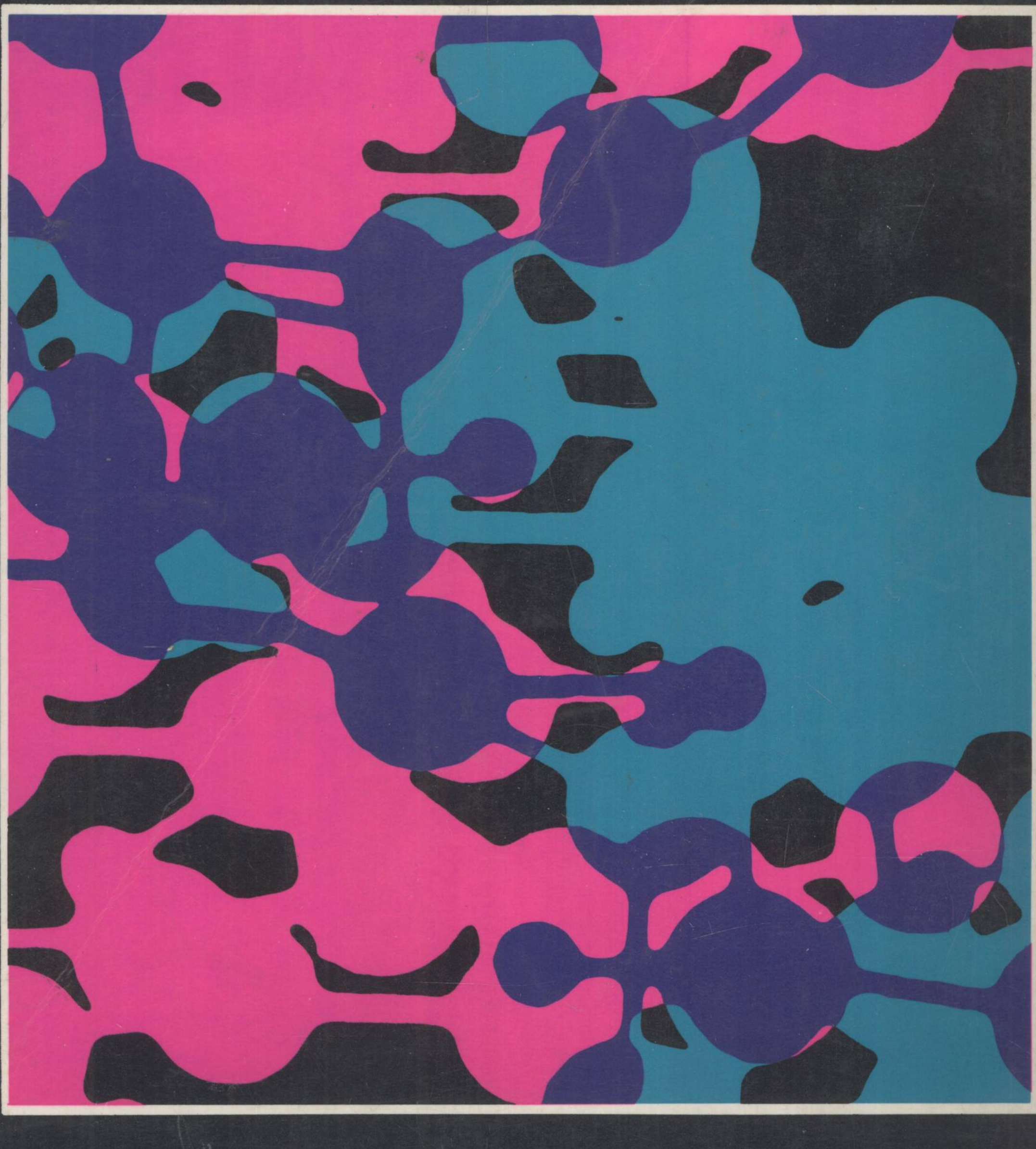
Student Solution Supplement

General Chemistry

JERRY MARCH / STANLEY WINDWER



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Jerry March and Stanley Windwer
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Preface

This book contains fully worked-out answers to nearly all the problems in our book *General Chemistry.* We have not supplied answers to the first question in each chapter, since this would have needlessly increased the size of the book. The first question in each chapter asks for definitions of new terms, and these definitions can be found in the text by consulting the index. In almost all cases, the words in question are printed in bold color and stand out from the text.

In order to test our problems we tried them out on several students at Adelphi University who had taken general chemistry. We wish to express our thanks to these students, who kindly volunteered to serve as our guinea pigs. They are David Bloom, Camille Contessa, Lou Duchin, Howard Futerman, Graciella Krikun, Louise Leotta, Phillip Lowe, Pamela Pederson, and Kenneth Reinert. We would also like to thank the secretaries who typed the manuscript: Carolyn Palubinskas, Cathleen Forte, Jo-Ann Krautheimer, and Dorothy March. As any typist can tell by looking at any typical page, this kind of typing is very hard to do, and these secretaries did it very well.

Garden City, New York

Jerry March
Stanley Windwer

To the Student

Problem solving has always been a very important part of the general chemistry course. For many aspects of chemistry you will be able to understand the material fully only after you have solved problems on it. In most cases your instructor will assign problems and of course you will want to do those. However, the text contains more problems that most instructors assign, and it will generally be to your advantage to do other problems as well, especially in those areas in which you are having some difficulty.

There are various ways to approach problems in chemistry. Many years of experience have convinced us that the best way is the one we will now describe. This is the way in which you will get the most benefit from doing them. (1) Try to do the problem without looking up anything—don't consult either the textbook or your class notes (except for things like atomic weights, physical constants, etc.) (2) If you think that you have probably solved it, look in the answer book and check. If you have done it correctly, fine. Go on to the next problem. If not, examine the answer in the book, and see if (a) you understand it now, and (b) where you went wrong and why. (3) If you cannot make any progress on the problem without looking up anything, then, after a reasonable time, turn to those parts of the textbook and/or your class notes where the material is discussed, and see if you can solve the problem now. If you think you can, do step (2) now. (4) If you still don't know how to do it after looking through the textbook and your class notes, then, after a reasonable time, look up the answer in this book and try to understand it now. If you really think you do understand it, and could now do a similar problem, then (5) try to find a similar or a related problem and do it. If you don't understand the answer even after looking it up in this book, then (6) ask your instructor for help. If you are reasonably conscientious and really try, it will probably not be necessary to get as far as step (6) very often.

The procedure we have outlined takes some time, but it pays rich dividends. Not only will it increase your grade in the course, but it will prepare you well for future courses in chemistry and other sciences. If you look up the answer in this book without trying to do the problem first (that is, without going through steps (1) to (3)), you will be largely wasting your time. You will now have the answer to that particular problem, but it is very unlikely that you will have a real understanding of the material.

Many students will occasionally find that they have calculated the right answer but the method used is not the one shown in the solutions manual. There is nothing wrong with this if the method is a correct one. In many cases there are more than one correct ways to do a problem, although we generally give only one, for lack of space.

Solving chemistry problems is work; often hard work, but, surprisingly, many people find it quite enjoyable. We hope that you will be one of these, and that as your knowledge of chemistry increases, your enjoyment of it does also.

Chapter 1

1-2 Evidence. Scientists devise experiments to test a theory, and if it passes all the tests, it is usually accepted. That does not necessarily make it correct, since it often happens that new evidence is found later which conflicts with the theory. In such a case, the theory must be modified or discarded.

1-3 See page 3 of the text.

1-4 $84.7 \text{ gal} \times 4 \frac{\text{qt}}{\text{gal}} \times 2 \frac{\text{pints}}{\text{qt}} \times 16 \frac{\text{oz}}{\text{pint}} = 1.08 \times 10^4 \text{ ounces}$

$84.7 \text{ liters} \times 1000 \frac{\text{ml}}{\text{liter}} = 8.47 \times 10^4 \text{ ml}$

1-5 (a) $21.5 \text{ cm} \times \frac{1 \text{ m}}{100 \text{ cm}} \times 10 \frac{\text{dm}}{\text{m}} = 2.15 \text{ dm}$

$21.5 \text{ cm} \times \frac{1 \text{ m}}{100 \text{ cm}} \times 10^9 \frac{\text{nm}}{\text{m}} = 2.15 \times 10^8 \text{ nm}$

(b) $6.44 \text{ mg} \times \frac{1 \text{ g}}{1000 \text{ mg}} \times \frac{1 \text{ megagram}}{10^6 \text{ g}} = 6.44 \times 10^{-9} \text{ megagram}$

$6.44 \text{ mg} \times \frac{1 \text{ g}}{1000 \text{ mg}} \times 10^6 \frac{\text{micrograms}}{\text{g}} = 6.44 \times 10^3 \text{ micrograms}$

(c) $13.5 \text{ ml} \times \frac{1 \text{ liter}}{1000 \text{ ml}} \times \frac{1 \text{ kiloliter}}{1000 \text{ liters}} = 1.35 \times 10^{-5} \text{ kiloliter}$

$13.5 \text{ ml} \times \frac{1 \text{ liter}}{1000 \text{ ml}} \times 100 \frac{\text{centiliters}}{\text{liter}} = 1.35 \text{ centiliters}$

(d) $2.3 \times 10^7 \text{ micrometers} \times \frac{1 \text{ m}}{10^6 \text{ micrometers}} = 23 \text{ m}$

$2.3 \times 10^7 \text{ micrometers} \times \frac{1 \text{ m}}{10^6 \text{ micrometers}} \times 10^{10} \frac{\text{Å}}{\text{m}} = 2.3 \times 10^{11} \text{ Å}$

(e) $4.1 \times 10^{-5} \text{ kg} \times 1000 \frac{\text{g}}{\text{kg}} = 4.1 \times 10^{-2} \text{ g}$

$4.1 \times 10^{-5} \text{ kg} \times 1000 \frac{\text{g}}{\text{kg}} \times 1000 \frac{\text{mg}}{\text{g}} = 41 \text{ mg}$

(f) $8.2 \times 10^4 \text{ cm}^3 \times 1 \frac{\text{ml}}{\text{cm}^3} = 8.2 \times 10^4 \text{ ml}$

$8.2 \times 10^4 \text{ cm}^3 \times \frac{1 \text{ liter}}{1000 \text{ cm}^3} = 82 \text{ liters}$

(g) $2.54\ \text{Å} \times \frac{1\ \text{m}}{10^{10}\ \text{Å}} \times 10^9\ \frac{\text{nm}}{\text{m}} = 2.54 \times 10^{-1}\ \text{nm}$

$2.54\ \text{Å} \times \frac{1\ \text{m}}{10^{10}\ \text{Å}} \times 10^3\ \frac{\text{mm}}{\text{m}} = 2.54 \times 10^{-7}\ \text{mm}$

$2.54\ \text{Å} \times \frac{1\ \text{m}}{10^{10}\ \text{Å}} \times 10^2\ \frac{\text{cm}}{\text{m}} = 2.54 \times 10^{-8}\ \text{cm}$

1-6 density = mass/volume; mass = 13.456 g; volume = 10.66 ml

$$d = \frac{13.456\ \text{g}}{10.66\ \text{ml}} = 1.262\ \text{g/ml}$$

$$1.262\ \frac{\text{g}}{\text{ml}} \times 1\ \frac{\text{ml}}{\text{cm}^3} = 1.262\ \text{g/cm}^3$$

$$1.262\ \frac{\text{g}}{\text{ml}} \times 10^3\ \frac{\text{ml}}{\text{liter}} = 1.262 \times 10^3\ \text{g/liter}$$

1-7 $d = \frac{m}{V} \qquad V = \frac{m}{d}$

$V = \frac{251.8\ \text{g}}{9.75\ \text{g/ml}} = 25.8\ \text{ml}$

1-8 (a) $m = dV = 1.11\ \frac{\text{g}}{\text{ml}} \times 100\ \text{ml} = 111\ \text{g}$

(b) $V = \frac{m}{d} = \frac{0.23\ \text{kg}}{1.11\ \text{g/ml}} \times 1000\ \frac{\text{g}}{\text{kg}} = 207\ \text{ml}$

1-9 (a) $13.6\ \frac{\text{g}}{\text{ml}} \times 1000\ \frac{\text{ml}}{\text{liter}} \times \frac{1\ \text{kg}}{1000\ \text{g}} = 13.6\ \text{kg/liter}$

(b) $13.6\ \frac{\text{g}}{\text{ml}} \times 1000\ \frac{\text{ml}}{\text{liter}} = 1.36 \times 10^4\ \text{g/liter}$

(c) $13.6\ \frac{\text{g}}{\text{ml}} \times \frac{1\ \text{kg}}{1000\ \text{g}} = 1.36 \times 10^{-2}\ \text{kg/ml}$

(d) $V = \frac{m}{d} = \frac{144.4\ \text{g}}{13.6\ \text{g/ml}} = 10.6\ \text{ml}$

(e) $m = dV = 13.6\ \text{g/ml} \times 100.0\ \text{ml} = 1.36 \times 10^3\ \text{g}$

1-10 $12.0\ \text{in} \times 2.54\ \frac{\text{cm}}{\text{in}} = 30.5\ \text{cm}$

$5.20\ \text{in} \times 2.54\ \frac{\text{cm}}{\text{in}} = 13.2\ \text{cm}$

$3.10\ \text{in} \times 2.54\ \frac{\text{cm}}{\text{in}} = 7.87\ \text{cm}$

$V = 30.5\ \text{cm} \times 13.2\ \text{cm} \times 7.87\ \text{cm} = 3.17 \times 10^3\ \text{cm}^3 = 3.17 \times 10^3\ \text{ml}$

$m = dV = 19.3\ \frac{\text{g}}{\text{ml}} \times 3.17 \times 10^3\ \text{ml} = 6.12 \times 10^4\ \text{g}$

1-11 $d = \frac{m}{V} \qquad m = dV$

$$m = 4.93\ \frac{\text{g}}{\text{ml}} \times 43.2\ \text{ml} = 213\ \text{g}$$

$$213\ \text{g} \times \frac{1\ \text{kg}}{1000\ \text{g}} = 0.213\ \text{kg}$$

1-12 Density is mass divided by volume. To find the density of the mixture, we must first find the mass of the mixture and then divide by the volume of the mixture.

$$\text{volume of butter} = \frac{1.00\ \text{g}}{0.860\ \text{g/ml}} = 1.16\ \text{ml butter}$$

$$\text{volume of sand} = \frac{1.00\ \text{g}}{2.28\ \text{g/ml}} = 0.439\ \text{ml sand}$$

$$\text{total volume} = 1.16\ \text{ml} + 0.439\ \text{ml} = 1.60\ \text{ml}$$

$$\text{total mass} = 1.00\ \text{g} + 1.00\ \text{g} = 2.00\ \text{g}$$

$$\text{density} = \frac{2.00\ \text{g}}{1.60\ \text{ml}} = 1.25\ \text{g/ml}$$

1-13 $1.0000\ \frac{\text{g}}{\text{cm}^3} \times \frac{1\ \text{lb}}{453.59\ \text{g}} \times 1000\ \frac{\text{cm}^3}{\text{liter}} \times 28.316\ \frac{\text{liters}}{\text{ft}^3} = 62.426\ \text{lb/ft}^3$

1-14 (a) $F = \frac{9}{5}(5.5) + 32 = 9.9 + 32 = 41.9°\text{F}$

(b) $F = \frac{9}{5}(-273) + 32 = -491 + 32 = -459°\text{F}$

(c) $F = \frac{9}{5}(27) + 32 = 49 + 32 = 81°\text{F}$

(d) $F = \frac{9}{5}(100) + 32 = 180 + 32 = 212°\text{F}$

(e) $F = \frac{9}{5}(5000) + 32 = 9000 + 32 = 9032°\text{F}$

1-15 (a) $C = \frac{5}{9}(98.6 - 32) = \frac{5}{9}(66.6) = 37.0°\text{C}$

(b) $C = \frac{5}{9}(100 - 32) = \frac{5}{9}(68) = 38°\text{C}$

(c) $C = \frac{5}{9}(0 - 32) = \frac{5}{9}(-32) = -18°\text{C}$

(d) $C = \frac{5}{9}(-100 - 32) = \frac{5}{9}(-132) = -73.3°\text{C}$

(e) $C = \frac{5}{9}(-400 - 32) = \frac{5}{9}(-432) = -240°\text{C}$

(f) $C = \frac{5}{9}(1000 - 32) = \frac{5}{9}(968) = 538°C$

(g) $C = \frac{5}{9}(32 - 32) = \frac{5}{9}(0) = 0°C$

1-16 If the number of degrees C equals the number of degrees F, then at that temperature °F = °C, and we can write

$$C = \frac{9}{5}C + 32$$

$$5C = 9C + 160$$

$$-4C = 160$$

$$C = -40°$$

therefore, −40°C = −40°F.

1-17 **(a)** 4 **(b)** 2 **(c)** 4 **(d)** 5 **(e)** Ambiguous case; there may be anywhere from 1 to 5, but without further information we cannot be sure. **(f)** 5 **(g)** 4 **(h)** 1 **(i)** 7 **(j)** 3 **(k)** 6 **(l)** Ambiguous case; it may be 4 or 5, but without further information we cannot tell if the 0 is significant.

1-18 **(a)** 2 **(b)** 4 **(c)** 1 **(d)** 4 **(e)** 4 **(f)** 3

1-19 **(a)** 26 **(b)** 3.3 **(c)** 0.037 **(d)** 47000 **(e)** 0.79 **(f)** 3.8

1-20 For the first number, 6.87, we do not know the fourth place. The number could be anywhere from 6.865 to 6.874. For the second number, we know the fourth place. It is 0, and not any other number.

1-21 **(a)** It is extremely unlikely that any large library would know that it has *exactly* 5,000,000 volumes. It must be an approximate figure. Therefore, the addition of a single book, or even of a few books, would not change the estimate. The library still has 5,000,000 volumes, not 5,000,001.
(b) Similarly, the rock was *approximately* 27 million years old in 1970, so that in 1979 it is still approximately 27 million years old, and not 27,000,009.
(c) The person who supplied this number to the newspaper could not possibly have known it to 10 significant figures, since the amount of money a murder victim would have earned if he had lived can only be estimated, not known exactly. It is probable that the person who calculated it multiplied several numbers with only a few significant figures, but did not check to see that the product must not have more significant figures than the least precise value. The estimate should probably have been given as $1 billion or $1.1 billion.

1-22 **(a)** 324.2 m × 4 = 1297 m   The answer is 1297 meters. The number has 4 significant figures because 324.2 has 4 significant figures. The number 4 is not a measured number, but a counted one, and so has an infinite number of significant figures.   **(b)** $(324.2\ m)^2 = 1.051 \times 10^5\ m^2$ area

1-23 **(a)** 0.52   **(b)** 1.50×10^4 **(c)** 0.64   **(d)** 2×10^3 or 1.7×10^3

1-24 **(a)** 2991 **(b)** 4.8 **(c)** 0.000162 **(d)** 0.04 **(e)** 43000 or 4.3×10^4

1-25

(a)
$$\begin{array}{r|l} 44.3 & 031 \\ 4.2 & 02 \\ 100012.2 & \\ 1.4 & 3 \\ .0 & 0001 \\ \hline 100062.1 & \end{array}$$

(b)
$$\begin{array}{r|l} 100 & \\ 4. & 2 \\ . & 01 \\ 100. & 034 \\ \hline 204 & \end{array}$$

(c)
$$\begin{array}{r|l} 96. & 6 \\ 100. & 73 \\ 10. & 0396 \\ 190 & \\ 7 & \\ \hline 404 & \end{array}$$

1-26

(a)
$$\begin{array}{r} 31264 \\ 0.141 \\ \hline 31264 \end{array}$$

(b)
$$\begin{array}{r} 31264 \\ -\quad 0.141 \\ \hline 31264 \end{array}$$

(c) Addition or subtraction of any number or from to a number very much larger than itself does not change the larger number.

1-27

(a) $14 \text{ tons} \times 907.180 \dfrac{\text{kg}}{\text{ton}} = 1.3 \times 10^4 \text{ kg}$

$13{,}000 \text{ kg} \times \dfrac{1 \text{ megagram}}{1000 \text{ kg}} = 13 \text{ megagrams}$

(b) $37 \text{ Å} \times 10^{-8} \dfrac{\text{cm}}{\text{Å}} \times \dfrac{1 \text{ in}}{2.54 \text{ cm}} = 15 \times 10^{-8} \text{ in} = 1.5 \times 10^{-7} \text{ in}$

(c) $13.5 \text{ km} \times \dfrac{1 \text{ mile}}{1.609 \text{ km}} = 8.39 \text{ miles}$

$8.39 \text{ miles} \times 5280 \dfrac{\text{ft}}{\text{mile}} = 4.43 \times 10^4 \text{ ft}$

(d) $95 \text{ miles} \times 1.609 \dfrac{\text{km}}{\text{mile}} = 1.5 \times 10^2 \text{ km}$

$150 \text{ km} \times 1000 \dfrac{\text{m}}{\text{km}} = 1.5 \times 10^5 \text{ m}$

(e) $385 \text{ ft} \times 12 \dfrac{\text{in}}{\text{ft}} \times \dfrac{1 \text{ m}}{39.37 \text{ in}} = 117 \text{ m}$

(f) $16 \text{ ft}^3 \times 28.316 \dfrac{\text{liters}}{\text{ft}^3} = 4.5 \times 10^2 \text{ liters}$

$4.5 \times 10^2 \text{ liters} \times \dfrac{1 \text{ qt}}{0.9463 \text{ liter}} = 4.8 \times 10^2 \text{ qt}$

(g) $2.5 \times 10^{-2} \text{ liter} \times \dfrac{1 \text{ gal}}{3.785 \text{ liters}} = 6.6 \times 10^{-3} \text{ gal}$

$2.5 \times 10^{-2} \text{ liter} \times \dfrac{1 \text{ ft}^3}{28.316 \text{ liters}} = 8.8 \times 10^{-4} \text{ ft}^3$

(h) $3.6 \times 10^9 \text{ ergs} \times \dfrac{1 \text{ cal}}{4.184 \times 10^7 \text{ ergs}} = 86 \text{ cal}$

$86 \text{ cal} \times 4.184 \dfrac{\text{J}}{\text{cal}} = 3.6 \times 10^2 \text{ J}$

(i) $23.5\text{ atm} \times 760\ \frac{\text{torr}}{\text{atm}} = 1.79 \times 10^4\text{ torr}$

$23.5\text{ atm} \times 101{,}325\ \frac{\text{pascals}}{\text{atm}} = 2.38 \times 10^6\text{ pascals}$

(j) $83\text{ kcal} \times 1000\ \frac{\text{cal}}{\text{kcal}} \times 4.184 \times 10^7\ \frac{\text{ergs}}{\text{cal}} = 3.5 \times 10^{12}\text{ ergs}$

$3.5 \times 10^{12}\text{ ergs} \times \frac{1\text{ J}}{10^7\text{ ergs}} \times \frac{1\text{ Btu}}{1055.056\text{ J}} = 3.3 \times 10^2\text{ Btu}$

1-28 (a) $26.0\text{ miles} \times 1.609\ \frac{\text{km}}{\text{mile}} \times 1000\ \frac{\text{m}}{\text{km}} \times 100\ \frac{\text{cm}}{\text{m}} = 4.18 \times 10^6\text{ cm}$

(b) $100.0\ \frac{\text{miles}}{\text{h}} \times 1.609\ \frac{\text{km}}{\text{mile}} \times 1000\ \frac{\text{m}}{\text{km}} \times \frac{1\text{ h}}{60\text{ min}} = 2682\text{ m/min}$

$2682\ \frac{\text{m}}{\text{min}} \times 100\ \frac{\text{cm}}{\text{m}} \times \frac{1\text{ min}}{60\text{ s}} = 4470\text{ cm/s.}$

(c) $1.34\text{ lb} \times 16\ \frac{\text{oz}}{\text{lb}} = 21.4\text{ oz}$

$1.34\text{ lb} \times 453.59\ \frac{\text{g}}{\text{lb}} = 608\text{ g}$

(d) For a student weighing 127 lb:

$$127\text{ lb} \times 453.59\ \frac{\text{g}}{\text{lb}} \times \frac{1\text{ kg}}{1000\text{ g}} = 57.6\text{ kg}$$

(e) For a student 5′5″ tall (= 65.0 in):

$$65.0\text{ in} \times 2.54\ \frac{\text{cm}}{\text{in}} = 165\text{ cm}$$

(f) $1087\ \frac{\text{ft}}{\text{s}} \times 12\ \frac{\text{in}}{\text{ft}} \times 2.54\ \frac{\text{cm}}{\text{in}} = 3.313 \times 10^4\text{ cm/s}$

The answer has 4 significant figures because 1 in = *exactly* 2.54 cm, so 2.54 has an infinite number of significant figures.

(g) $1200\ \frac{\text{miles}}{\text{h}} \times \frac{5280\text{ ft}}{\text{mile}} \times 12\ \frac{\text{in}}{\text{ft}} \times 2.54\ \frac{\text{cm}}{\text{in}} \times \frac{1\text{ h}}{60\text{ min}} \times \frac{1\text{ min}}{60\text{ s}} =$

5.364×10^4 cm/s (assuming that 1200 has 4 significant figures)

1-29 (a) $73.47\text{ kg} \times 1000\ \frac{\text{g}}{\text{kg}} = 7.347 \times 10^4\text{ g}$

$7.347 \times 10^4\text{ g} \times 1000\ \frac{\text{mg}}{\text{g}} = 7.347 \times 10^7\text{ mg}$

(b) $1.07\text{ cm} \times \frac{1\text{ m}}{100\text{ cm}} = 0.0107\text{ m}$

$1.07\text{ cm} \times 10\ \frac{\text{mm}}{\text{cm}} = 10.7\text{ mm}$

(c) $155.3\ \text{g} \times 1000\ \frac{\text{mg}}{\text{g}} = 1.553 \times 10^5\ \text{mg}$

$155.3\ \text{g} \times \frac{1\ \text{kg}}{1000\ \text{g}} = 0.1553\ \text{kg}$

(d) $2500.0\ \text{mm} \times \frac{1\ \text{m}}{1000\ \text{mm}} = 2.5000\ \text{m}$

$2500.0\ \text{mm} \times \frac{1\ \text{cm}}{10\ \text{mm}} = 250.00\ \text{cm}$

(e) $123.7\ \text{cm}^3 \times 1\ \frac{\text{ml}}{\text{cm}^3} = 123.7\ \text{ml}$

$123.7\ \text{ml} \times \frac{1\ \text{liter}}{1000\ \text{ml}} = 0.1237\ \text{liter}$

(f) $100.0\ \text{ml} \times \frac{1\ \text{liter}}{1000\ \text{ml}} = 0.1000\ \text{liter}$

$100.0\ \text{ml} \times 1\ \frac{\text{cm}^3}{\text{ml}} = 100.0\ \text{cm}^3$

1-30 $4.00\ \frac{\text{dollars}}{\text{lb}} \times \frac{1\ \text{lb}}{453.59\ \text{g}} = 0.00882\ \text{dollar/g}$

$0.00882\ \frac{\text{dollar}}{\text{g}} \times 100\ \frac{\text{cents}}{\text{dollar}} = 0.882\ \text{cent/g}$

1-31 $1.08\ \frac{\text{marks}}{\text{liter}} \times \frac{1\ \text{dollar}}{2.3\ \text{marks}} = 0.470\ \text{dollar/liter}$

$0.470\ \frac{\text{dollar}}{\text{liter}} \times 3.785\ \frac{\text{liters}}{\text{gallon}} = 1.78\ \text{dollars/gallon}$

1-32 For each heel:

$$\text{diameter} = 1.60\ \text{in} \times 2.54\ \frac{\text{cm}}{\text{in}} = 4.06\ \text{cm}$$

$$\text{radius} = \frac{4.06\ \text{cm}}{2} = 2.03\ \text{cm}$$

$$\text{area} = \pi(2.03\ \text{cm})^2 = 12.9\ \text{cm}^2$$

area of both heels $= 12.9\ \text{cm}^2 \times 2 = 25.8\ \text{cm}^2$

$$\frac{5.12 \times 10^7\ \text{dyn}}{25.8\ \text{cm}^2} = 1.98 \times 10^6\ \text{dyn/cm}^2$$

1-33 Only the smaller number is given: **(a)** $0.000011 = 1.1 \times 10^{-5}$
(b) $100000 = 1 \times 10^5$ **(c)** 0.0001 **(d)** 7.9×10^4 **(e)** 8.4×10^{-7}
(f) $1024 = 1.024 \times 10^3$ **(g)** 10^{-24} **(h)** 9.9×10^{-4}
(i) $6.02 \times 10^{23} = 60{,}200 \times 10^{19}$

1-34 **(a)** 1.00×10^2 **(b)** 1.34×10^{-4} **(c)** 7.430×10^3 **(d)** 1.10×10^2
(e) 3.49×10^{-8} **(f)** 6.395×10^2 **(g)** 4.732×10^0 **(h)** 7×10^0
(i) 4×10^{14} (assuming that only one figure is significant; if two, then it would be 4.0×10^{14}, etc.) **(j)** 2.2222×10^3

1-35 **(a)** 3.755×10^9 **(b)** 5.62×10^4 **(c)** 3.4×10^{-2} **(d)** 8.36×10^{-3}
(e) 7.7213×10^1

1-36 **(a)**

$$\begin{array}{r|ll} 2.77 & 5 & \times 10^8 \\ 0.02 & 14 & \times 10^8 \\ 132.84 & 4 & \times 10^8 \\ 0.65 & & \times 10^8 \\ \hline 136.29 & & \times 10^8 \end{array} = 1.3629 \times 10^{10}$$

(b)

$$\begin{array}{rl} 1.6 & \times 10^{-16} \\ -121.4 & \times 10^{-16} \\ \hline -119.8 & \times 10^{-16} \end{array} = -1.198 \times 10^{-14}$$

(c)

$$\begin{array}{r|ll} 1.1 & 06 & \times 10^{-6} \\ 37.5 & & \times 10^{-6} \\ 287.3 & 2 & \times 10^{-6} \\ \hline 325.9 & & \times 10^{-6} \end{array} = 3.259 \times 10^{-4}$$

(d) $78 \times 10^7 = 7.8 \times 10^8$ **(e)** $20 \times 10^2 = 2.0 \times 10^3$
(f) $31.5 \times 10^{-4} = 3.15 \times 10^{-3}$ **(g)** $64 \times 10^{-10} = 6.4 \times 10^{-9}$
(h) $28 \times 10^{-8} = 2.8 \times 10^{-7}$ **(i)** $0.531 \times 10^7 = 5.31 \times 10^6$ **(j)** 2.5×10^{-3}
(k) $0.58 \times 10^{-6} = 5.8 \times 10^{-7}$ **(l)** $0.913 \times 10^{12} = 9.13 \times 10^{11}$
(m) 1.8×10^{-12} **(n)** $0.44 \times 10^{11} = 4.4 \times 10^{10}$
(o) $0.333 \times 10^{15} = 3.33 \times 10^{14}$ **(p)** 2.8×10^{-1}

1-37 **(a)** 1.74×10^5

(b)

$$\begin{array}{r|l} 0.01 & 27 \\ 14.32 & \\ \hline 14.33 & \\ -100 & \\ \hline -86 & \end{array}$$

(c)

$$\begin{array}{r|l} 71.6 & \\ -\ 0.2 & 721 \\ \hline 71.3 & \end{array}$$

(d)

$$\begin{array}{r|ll} 4.991 & & \times 10^3 \\ 0.120 & & \times 10^3 \\ \hline 5.1 & 11 & \times 10^3 \\ -80.8 & & \times 10^3 \\ \hline -75.7 & & \times 10^3 \end{array} = -7.57 \times 10^4$$

(e) 1.15×10^{29} **(f)** 2.23×10^{-10} **(g)** $0.880 \times 10^{21} = 8.80 \times 10^{20}$

1-38 **(a)** $\log 10^7 = 7$ **(b)** $\log 10^{-11} = -11$

(c) $70000000 = 7 \times 10^7$
$\log(7 \times 10^7) = \log 7 + \log 10^7$
$\log 7 = 0.8451$
$\log 10^7 = 7$
$\log(7 \times 10^7) = 7.8451$

(d) $0.0000000111 = 1.11 \times 10^{-8}$
$\log(1.11 \times 10^{-8}) = \log 1.11 + \log 10^{-8}$
$\log 1.11 = 0.0453$
$\log 10^{-8} = -8$
$\log(1.11 \times 10^{-8}) = -7.9547$

(e) $\log 1.46 = 0.1644$
$\log 7.44 = 0.8716$
$\log(1.46 \times 7.44) = 0.1644 + 0.8716 = 1.0360$

(f) $\log 10^3 = 3$
$\log 10^5 = 5$
$\log(10^3 \times 10^5) = 3 + 5 = 8$

(g) $\log 10^8 = 8$
$\log 10^{-4} = -4$
$\log(10^8 \times 10^{-4}) = 8 + (-4) = 4$

(h) $\log 10^{-3} = -3$
$\log 10^{-7} = -7$
$\log(10^{-3}/10^{-7}) = -3 - (-7) = 4$

(i) $\log 4.77 = 0.6785$
$\log 7.01 = 0.8457$
$\log 10^8 = 8$
$\log 10^{-9} = -9$
$\log(4.77 \times 10^8)(7.01 \times 10^{-9}) = 0.6785 + 0.8457 + 8 - 9 = 0.5242$

(j) $\log 3.60 = 0.5563$ $\log 9.61 = 0.9827$ $\log 10^{-4} = -4$ $\log 10^7 = 7$

$$\log \frac{3.60 \times 10^{-4}}{9.61 \times 10^7} = 0.5563 - 0.9827 + (-4) - (7) = -11.4264$$

(k) $\log 2.01 = 0.3032$ $\log 10^3 = 3$
$\log 6.02 = 0.7796$ $\log 10^{23} = 23$
$\log 6.71 = 0.8267$ $\log 10^{12} = 12$

$$\log \frac{(2.01 \times 10^3)(6.02 \times 10^{23})}{6.71 \times 10^{12}} = 0.3032 + 0.7796 - 0.8267 + 3 + 23 - 12 = 14.2561$$

(l) $0.021 = 2.1 \times 10^{-2}$
$\log 1.73 = 0.2380$ $\log 10^4 = 4$
$\log 2.1 = 0.3222$ $\log 10^{-2} = -2$
$\log 2.91 = 0.4639$ $\log 10^{-12} = -12$

$$\log \frac{(1.73 \times 10^4)(2.1 \times 10^{-2})}{2.91 \times 10^{-12}} = 0.2380 + 0.3222 - 0.4639 + 4 - 2 - (-12) = 14.0963$$

1-39 (a) 1×10^{14} (b) 1×10^{100} (c) 10 (d) $10^{-3.0}$ (e) 1
(f) 2.09×10^5 (g) 5.89×10^{23} (h) 5.50×10^4 (i) 4.58×10^{-4}
(j) 7.29×10^{-3}

1-40 (a) $\log 3.7 = 0.5682$
$\ln 3.7 = (2.303)(0.5682) = 1.309$

(b) $\log(2.4 \times 10^3) = \log 2.4 + \log 10^3 = 0.3802 + 3 = 3.3802$
$\ln(2.4 \times 10^3) = (2.303)(3.3802) = 7.785$

(c) $\log(7.1 \times 10^{-6}) = \log 7.1 + \log 10^{-6} = 0.8513 + (-6) = -5.1487$
$\ln(7.1 \times 10^{-6}) = (2.303)(-5.1487) = -11.86$

(d) The ln of 0 is undefined (so is the log of 0).

(e) $\log 1.00 = 0$
$\ln 1.00 = 0(2.303) = 0$

1-41 $\frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

(a) $a = 3.75 \quad b = 21.6 \quad c = 1.77$

$$x = \frac{-21.6 + \sqrt{(21.6)^2 - 4(3.75)(1.77)}}{2(3.75)}$$

$$x = \frac{-21.6 + \sqrt{440}}{7.50} \qquad x = \frac{-21.6 - \sqrt{440}}{7.50}$$

$$x = \frac{-0.6}{7.50} = -0.08 \qquad x = \frac{-42.6}{7.50} = -5.68$$

(b) $a = 7.4 \quad b = -13 \quad c = -8.55$

$$x = \frac{13 \pm \sqrt{(-13)^2 + 4(7.4)(8.55)}}{2(7.4)}$$

$$x = \frac{13 + 20.5}{14.8} = 2.3 \qquad x = \frac{13 - 20.5}{14.8} = -0.51$$

(c) $a = 1 \quad b = -6 \quad c = -4.33$

$$x = \frac{6 \pm \sqrt{(-6)^2 + 4(4.33)}}{2}$$

$$x = \frac{6 + 7}{2} = 7 \qquad x = \frac{6 - 7}{2} = -0.5$$

(d) $a = 1 \quad b = 7.0 \quad c = -15$

$$x = \frac{-7.0 \pm \sqrt{(7.0)^2 + 4(15)}}{2}$$

$$x = \frac{-7.0 + 10.4}{2} = 1.7 \qquad x = \frac{-7.0 - 10.4}{2} = -8.7$$

(e) $a = 2 \quad b = 0.62 \quad c = -0.033$

$$x = \frac{-0.62 \pm \sqrt{(0.62)^2 + 4(2)(0.033)}}{2(2)}$$

$$x = \frac{-0.62 + 0.804}{4} = 0.045 \qquad x = \frac{-0.62 - 0.804}{4} = -0.36$$

(f) $a = -1 \quad b = 7 \quad c = 49\frac{1}{3}$

$$x = \frac{-7 \pm \sqrt{7^2 - 4(-1)(49\frac{1}{3})}}{-2}$$

$$x = \frac{-7 + 15.7}{-2} = -4.35 \qquad x = \frac{-7 - 15.7}{-2} = 11.35$$

1-42 **(a)** the energy of a coiled spring **(b)** the energy in a storage battery while it is being used **(c)** the potential energy stored in a gallon of petroleum or a ton of coal, which will be released on burning.

1-43 First we convert to metric units:

$$2500\text{ lb} \times 453.59\,\frac{\text{g}}{\text{lb}} = 1.1 \times 10^6\text{ g}$$

$$10.0\,\frac{\text{miles}}{\text{h}} \times 5280\,\frac{\text{ft}}{\text{mile}} \times 12\,\frac{\text{in}}{\text{ft}} \times 2.54\,\frac{\text{cm}}{\text{in}} \times \frac{1\text{ h}}{60\text{ min}} \times \frac{1\text{ min}}{60\text{ s}} = 447\text{ cm/s}$$

$$30.0\,\frac{\text{miles}}{\text{h}} \times 5280\,\frac{\text{ft}}{\text{mile}} \times 12\,\frac{\text{in}}{\text{ft}} \times 2.54\,\frac{\text{cm}}{\text{in}} \times \frac{1\text{ h}}{60\text{ min}} \times \frac{1\text{ min}}{60\text{ s}} = 1340\text{ cm/s}$$

$$\text{acceleration} = \frac{1340\text{ cm/s} - 447\text{ cm/s}}{20.0\text{ s}} = \frac{893\text{ cm/s}}{20.0\text{ s}} = 44.7\text{ cm/s}^2$$

$$F = ma$$

$$F = (1.1 \times 10^6\text{ g})(44.7\text{ cm/s}^2) = 4.9 \times 10^7\text{ g}\cdot\text{cm/s}^2 = 4.9 \times 10^7\text{ dyn}$$

1-44 $\text{K.E.} = \frac{1}{2}mv^2$

$$\text{K.E.} = \tfrac{1}{2}(1.1 \times 10^6\text{ g})(1340\text{ cm/s})^2 = 9.9 \times 10^{11}\text{ g}\cdot\text{cm}^2/\text{s}^2 = 9.9 \times 10^{11}\text{ ergs}$$

$$9.9 \times 10^{11}\text{ ergs} \times \frac{1\text{ J}}{10^7\text{ ergs}} = 9.9 \times 10^4\text{ J}$$

1-45 Assume the distance to be 1.00×10^{-8} cm. We will get the same answer regardless of the distance, since the ratio is what we are looking for.

Electrical attraction:

$$F = K\,\frac{q_1q_2}{r^2} = \frac{(9.00 \times 10^{18}\text{ dyn}\cdot\text{cm}^2/\text{C}^2)(-1.60 \times 10^{-19}\text{ C})(1.60 \times 10^{-19}\text{ C})}{(1.00 \times 10^{-8}\text{ cm})^2}$$

$F = -2.30 \times 10^{-3}$ dyn (absolute value 2.30×10^{-3} dyn)

Gravitational attraction:

$$F = \frac{Gm_1m_2}{r^2} = \frac{(6.67 \times 10^{-8}\text{ dyn}\cdot\text{cm}^2/\text{g}^2)(9.11 \times 10^{-28}\text{ g})(1.67 \times 10^{-24}\text{ g})}{(1.00 \times 10^{-8}\text{ cm})^2}$$

$$F = 1.01 \times 10^{-42}\text{ dyn}$$

$$\frac{F_{\text{coulombic}}}{F_{\text{gravitational}}} = \frac{2.30 \times 10^{-3}\text{ dyn}}{1.01 \times 10^{-42}\text{ dyn}} = 2.30 \times 10^{39}$$

1-46 $F = K\,\dfrac{q_1q_2}{r^2}$

$$r^2 = \frac{Kq_1q_2}{F} = \frac{(9.00 \times 10^{18}\text{ dyn}\cdot\text{cm}^2/\text{C}^2)(1\text{ C})(1\text{ C})}{3.00 \times 10^{12}\text{ dyn}}$$

$$r^2 = 3.00 \times 10^6\text{ cm}^2$$

$$r = \sqrt{3.00 \times 10^6\text{ cm}^2} = 1.73 \times 10^3\text{ cm}$$