1.5 The attractive force of gravity for objects near the earth’s surface increases as you get closer to the center of the earth. Suppose you are transported from a deep mine to the top of a tall mountain.
   a. How would your mass be changed by the move?
   b. How would your weight be changed by the move?

Solution
   a. Mass is independent of gravity so your mass would not change.
   b. Weight depends on gravity, which decreases with distance from the earth’s center; your weight would be less on the mountaintop.

1.9 Classify the following properties as physical or chemical. Explain your reasoning in each case. a) Iron melts at 1535°C; b) Alcohol is very flammable; c) The metal used in artificial hip joint implants is not corroded by body fluids; d) A 1 in. cube of aluminum weighs less than a 1 in. cube of lead; e) An antacid neutralizes stomach acid.

Solution
   a) Physical. Melting is determined by heating the iron until it liquefies.
   b) Chemical. Flammability is the ability to burn in air.
   c) Chemical. Corrosion is the combination of a metal with air.
   d) Physical. Weighing an object does not cause a chemical change, so the weight and the volume are physical properties.
   e) Chemical. The fact that the acid has been neutralized implies it is no longer an acid. Thus its composition has been changed.

1.11 A sample of liquid alcohol is frozen to a solid, then allowed to melt back to a liquid. Have the alcohol molecules been changed by the process? Explain your answer.

Solution
   The alcohol is reversibly changed from a liquid to a solid and back again. It is the same material regardless of state. Changes in phase are physical changes.

1.15 Under the appropriate conditions, hydrogen peroxide can be changed to water and oxygen gas. Use the terms homoatomic and heteroatomic to classify molecules of hydrogen peroxide. Explain your reasoning.

Solution
Heteroatomic. A single molecule decomposes to make two different molecules and the name, hydrogen peroxide, includes the names of two kinds of elements.

1.23 Classify each of the following as homogeneous or heterogeneous.
   a) muddy flood water  b) gelatin dessert  c) normal urine  d) smog-filled air
e) an apple  f) mouthwash  g) petroleum jelly

Solution
   a) heterogeneous  b) homogeneous  c) homogeneous
d) heterogeneous  e) heterogeneous  f) homogeneous
g) homogeneous

1.35 One foot is approximately equal to 30.5 cm. Express this length in millimeters and meters.

Solution

\[
30.5 \text{ ft} \times \frac{1 \text{ in}}{100 \text{ mm}} \times \frac{1000 \text{ mm}}{1 \text{ in}} = 305 \text{ mm} \quad 30.5 \text{ ft} \times \frac{1 \text{ m}}{100 \text{ ft}} = 0.305 \text{ m}
\]

1.43 The weather report says the temperature is 23 °F. What is this temperature on the Celsius scale? On the Kelvin scale?

Solution

\[
^\circ\text{C} = \frac{5}{9} \times (23 - 32) = -5.0 \, ^\circ\text{C} \quad K = 273 + (-5) = 268 \, K
\]

1.49 Write each of the following numbers using scientific notation.
   a) Two thousand  b) 5162  c) 0.00493
d) 91.88  e) 2.7 million  f) 500

Solution

   a) \(2 \times 10^3\)  b) \(5.162 \times 10^3\)  c) \(4.93 \times 10^{-3}\)
d) \(9.188 \times 10^1\)  e) \(2.7 \times 10^6\)  f) \(5.00 \times 10^2\)

1.57 Express each number below using scientific notation, then carry out the multiplication. Express each answer using scientific notation.
   a) \((835)(0.0045)\)  b) \((300)(245)\)
c) \((68.3)(421)\)  d) \((32.9)(0.115)\)

Solution

   a) \((8.35 \times 10^2)(4.5 \times 10^{-3})\) = 3.8
   b) \((3.00 \times 10^2)(2.45 \times 10^2)\) = 7.35 \times 10^4
   c) \((6.83 \times 10^1)(4.21 \times 10^2)\) = 2.88 \times 10^4
d) \((3.29 \times 10^1)(1.15 \times 10^{-1})\) = 3.78

1.61 Perform the following calculations and express each answer using scientific notation.
Solution

a) \(2.2 \times 10^4\) 

b) \(3.4 \times 10^{-2}\) 

c) \(8.9 \times 10^4\) 

d) \(1.0 \times 10^{-4}\) 

e) \(9.1 \times 10^{-5}\)

1.65 Write the following measured quantities as you would record them, using the correct number of significant figures based on the device used to make the measurements.

a) A length of two and one-half cm measured with a measuring telescope with smallest scale markings of 0.1 mm.

b) An initial reading of exactly 0 for a buret with scale markings of 0.1 mL.

c) A length of four and one-half cm measured with a ruler that has a smallest marking of 0.1 cm

d) An atmospheric pressure of exactly 690 torr measured with a barometer that has smallest markings of 1 torr.

Solution

a) A marking of 0.1 mm would be 0.01 cm. The reading should be 2.500 cm.

b) 0.00 mL

c) 4.50 cm

d) 690.0 torr

1.73 Perform the following calculations and use the correct number of significant figures in your answers. Assume all numbers are the results of measurements.

a) \(2.1 + 5.07 + 0.119\) 

b) \(0.051 + 8.11 + 0.02\) 

c) \(4.337 - 3.211\) 

d) \((2.93 \times 10^{-1}) + (6.2 \times 10^{-2})\) 

e) \(471.19 - 365.09\) 

f) \(17.76 - 0.0497\)

Solution

a) 7.289 (round to tenths) = 7.3

b) 8.181 (round to hundredths) = 8.18

c) 1.126 (keep 3 decimal places)

d) 0.293 + 0.062 = 0.355 (keep 3 decimal places)

e) 106.10 (keep 2 decimal places)

f) 17.7103 (round to hundredths) = 17.71

1.81 A metric cookbook calls for a baking temperature of 200°C. Your oven settings are in degrees Fahrenheit. What Fahrenheit setting should you use?

Solution

\[ ^\circ F = \frac{5}{9} ^\circ C + 32 \]

\[ \frac{5}{9} (200) + 32 = 392 ^\circ F \]
1.89 After drying, 140 lbs of grapes yield 28.0 lbs of raisins. What percentage of the grapes’ mass was lost during the drying process?

Solution
\[
\frac{(140 - 28.0) \text{lbs}}{140 \text{ lbs}} \times 100 = 80.0\% 
\]

1.99 Calculate the mass in grams of 125 mL of acetone \((d = 0.791 \text{ g/mL})\)

Solution
Mass = Density x Volume
\[
\text{mass} = 125 \text{ mL} \times \frac{0.791 \text{ g}}{1 \text{ mL}} = 98.875 \text{ g} 
\]
Rounding to 3 places 98.9 grams

1.101 Classify each of the following as an element, compound or mixture: a) Blood; b) Water; c) Oxygen; d) Air

Solution
a) mixture b) compound c) element d) mixture

1.103 Do the following calculations:

a) How many square meters of carpeting are needed to carpet a room that is 25.0 m long and 36 m wide?

b) What is the width of a rectangle that has an area of 63 cm\(^2\) and a length of 9.0 cm?

c) How many cubic meters of soil would be needed to completely fill a flower box that is 3.0 m long, 40 cm wide and 50 cm deep?

Solution
a) \((25.0 \text{ m})(36 \text{ m}) = 900 \text{ m}^2\). Use \(9.0 \times 10^2 \text{ m}^2\) for proper sig. fig.

b) \((63 \text{ cm}^2) / (9.0 \text{ cm}) = 7.0 \text{ cm}\)

c) \((3.0 \text{ m})(0.40 \text{ m})(0.50 \text{ m}) = 0.60 \text{ m}^3\)

1.111 A 175 lb patient is to undergo surgery and will be given an anesthetic intravenously. The safe dosage of anesthetic is 12 mg/kg of body weight. Determine the maximum dose of anesthetic that should be used.

Solution
\[
\frac{175 \text{ lbs}}{2.2 \text{ lbs}} = 79.5 \text{ kg body weight} 
\]

\[
\frac{79.5 \text{ kg body weight}}{1 \text{ kg body weight}} \times 12 \text{ mg anesthetic} = 954 \text{ mg anesthetic} 
\]

1.116 Liquid mercury metal freezes to a solid at a temperature of \(-38.9^\circ\text{C}\). Suppose you wanted to measure a temperature that is at least as low as \(-45^\circ\text{C}\). Can you use a mercury thermometer? If not, propose a way to make the measurement.
The material in the thermometer must be a liquid. At -38.9°C, the mercury would become a solid. The mercury thermometer cannot be used to read -45°C. A different liquid would have to be used in the thermometer.

**1.119** A chemist is brought a small figurine. The owner wants to know if it is made of silver but does not want it damaged during the analysis. The chemist decides to determine the density, knowing that silver has a density of 10.5 g/ml. The figurine is put into a graduated cylinder that contains 32.6 ml of water. The reading while the figurine is in the water is 60.1 ml. The mass of the figurine is 240.8 g. Is the figurine made of silver? Explain your reasoning.

**Solution**

The calculated density of the figurine is less than the value for silver. This does not conclusively prove the figurine is made of another metal. The figurine could be pure silver but hollow. It also might be an alloy of silver and another, less dense metal.

**2.3** Write formulas for the following molecules using elemental symbols from Table 2.1 and subscripts. Compare these formulas to those of Exercise 2.1.

a) A diatomic molecule of fluorine gas.

b) A diatomic molecule of hydrogen chloride (one hydrogen atom and one chlorine atom).

c) A triatomic molecule of ozone (a molecular form of the element oxygen).

d) A molecule of methane (one carbon atom and four hydrogen atoms).

**Solution**

a) $\text{F}_2$  b) HCl  c) $\text{O}_3$  d) $\text{CH}_4$

**2.7** Tell what is wrong with each of the following molecular formulas and write the correct formula.

a) $\text{H}_3\text{PO}_3$ (phosphorous acid)

b) $\text{SiCl}_4$ (silicon tetrachloride)

c) $\text{SO}_2$ (sulfur dioxide)

d) $2\text{HO}$ (Hydrogen peroxide-two hydrogen atoms and two oxygen atoms)

**Solution**

a) Numerals should be subscripts ($\text{H}_3\text{PO}_3$).

b) The symbol for silicon is Si ($\text{SiCl}_4$).

c) Combine oxygen using a subscript ($\text{SO}_2$).

d) Use subscripts, not coefficients, for number of atoms ($\text{H}_2\text{O}_2$).
2.13 Determine the number of electrons and protons contained in an atom of the following elements: a) sulfur b) As c) element number 24

Solution
a) 16 electrons, 16 protons  
b) 33 electrons, 33 protons  
c) 24 electrons, 24 protons

2.15 Determine the number of protons, number of neutrons, and number of electrons in atoms of the following isotopes: a) $^{29}_{12}$Mg b) $^{13}_{6}$C c) $^{39}_{19}$K

Solution
a) 12 p, 13 n, 12 e⁻  
b) 6 p, 7 n, 6 e⁻  
c) 18 p, 23 n, 18 e⁻

2.29 Determine the molecular weights of the following in u: a) fluorine (F₂); b) carbon disulfide (CS₂); c) sulfurous acid (H₂SO₃); d) ethyl alcohol (C₂H₅O); e) ethane (C₂H₆)

Solution
a) 2 x 18.9984 u = 37.9968 u  
b) (1 x 12.011 u) + (2 x 32.066 u) = 76.143 u  
c) (2 x 1.0079 u) + (1 x 32.066 u) + (3 x 15.9994 u) = 82.080 u  
d) (2 x 12.011 u) + (6 x 1.0079 u) + (1 x 15.9994 u) = 46.069 u  
e) (2 x 12.011 u) + (6 x 1.0079 u) = 30.069 u

2.31 The molecular weight is determined for a gas that is known to be an oxide of nitrogen. The value obtained experimentally was 43.98 u. Which of the following is most likely to be the formula of the gas? NO, N₂O, NO₂

Solution
The molecular weights for the three gases are:
NO = 14.01+16.00 = 30.01 u  
N₂O = (2x14.01)+16.00 = 44.02 u  
NO₂ = 14.01+(2x16.00) = 46.01 u  
The gas is N₂O

2.39 Calculate the atomic weight of silicon on the basis of the following percentage composition and atomic weights of the naturally occurring isotopes. Compare the calculated value to the atomic weight listed for silicon in the periodic table.
silicon-28 = 92.21% (27.9769 u), silicon-29 = 4.70% (28.9765 u), silicon-30 = 3.09% (29.9738 u)

Solution
Atomic weight
= 92.21% of 27.9769 u + 4.70% of 28.9765 u + 3.09% of 29.9738 u  
= (0.9221 x 27.9769) + (0.0470 x 28.9765) + (0.0309 x 29.9738)  
= 28.086 (round to hundredths) = 28.09 u  
Actual weight from periodic table = 28.09 u
2.53 How many moles of $N_2O_5$ contain the same number of nitrogen atoms as 3 mol of NO$_2$?

Solution
3 mol NO$_2$ contains 3 mol N atoms. 1.5 mol N$_2$O$_5$ also contain 3 mol N.

2.55 Determine the mass percentage of nitrogen in NH$_3$ and N$_2$H$_4$.

Solution
NH$_3$: 17.03 g NH$_3$ contains 14.01 g N & 3.02 g H.

$\%N = \frac{14.01}{17.03} \times 100 = 82.27 \%N$

N$_2$H$_4$: 32.05 g N$_2$H$_4$ contains 28.01g N & 4.03 H.

$\%N = \frac{28.01}{32.05} \times 100 = 87.39 \%N$

2.67 Which of the following statements is (are) true for isotopes of the same element? a) They have the same number of protons as neutrons. b) They have the same number of protons and different numbers of electrons. c) They have the same atomic number and different atomic weights.

Solution
a) False. Isotopes will have the same number of protons but a differing number of neutrons.
b) False. A neutral atom as the same number of protons and electrons, which is independent of the number of neutrons.
c) True. This is an alternate way of stating that isotopes have the same number of protons but a differing number of neutrons.

2.77 Answer the question of Figure 2.6. How many CS$_2$ molecules would be required to contain 0.25 mol of sulfur atoms?

Solution
$1.5 \text{ mol } \text{CS}_2 \times \frac{2 \text{ mol } S}{1 \text{ mol } \text{CS}_2} = 3.0 \text{ mol } S$

$0.25 \text{ mol } S \times \frac{1 \text{ mol } \text{CS}_2}{2 \text{ mol } S} \times \frac{6.02 \times 10^{23} \text{ CS}_2 \text{ molecules}}{1 \text{ mol } \text{CS}_2} = 7.5 \times 10^{22} \text{ CS}_2 \text{ molecules}$