**Chapter 1**

**Science and Measurements**

## SOLUTIONS TO ODD-NUMBERED END OF CHAPTER PROBLEMS (SOLUTIONS TO EVEN-NUMBERED PROBLEMS FOLLOW BELOW)

1.1 *Which drawing correctly shows the relationship between pounds and kilograms?*





1 kilogram is heavier than 1 pound (1 kilogram = 2.205 lb).

1.3 *Is the statement “What goes up must come down” a scientific law or scientific*

*theory? Explain.*

A law. It describes what is observed but does not explain why it happens.

1.5 *How is a theory different from a hypothesis?*

A hypothesis is a tentative explanation based on presently known facts while a theory is an experimentally tested explanation that is consistent with existing experimental evidence and accurately predicts the results of future experiments.

1.7 *Define the terms “matter” and “energy.”*

Matter is anything that has mass and occupies space. Energy is the ability to do work or heat up something.

1.9 *On a hot day, a glass of iced tea is placed on a table.*

*a. What are some of the physical properties of the ice?*

Ice is water in the solid state. It is clear and colorless, hard, and feels cold to the touch.

*b. What change in physical state would you expect to take place if the iced tea sits in the sun for a while?*

The ice would slowly melt and turn into liquid water if the iced tea is left to sit in the sun for a while (melting).

1.11 *Give an example of a physical change that involves starting with a liquid and ending up with a gas.*

Some examples of physical changes are: a puddle of water evaporating from the ground, rubbing alcohol evaporating from the skin, spilled gasoline evaporating from the ground.

1.13 *What is potential energy?*

Potential energy is stored energy.

1.15 *Describe a situation where an object’s potential energy varies as a result of changes in its position.*

As a Ferris wheel goes around, the potential energy of a rider changes relative to their position. When the rider is at the very top of the wheel, the potential energy is highest. As the wheel goes around, the potential energy of the rider decreases as the bottom of the wheel is approached. At the lowest point, the potential energy is lowest.

1.17 *A battery-powered remote control toy car sits at the bottom of a hill. The car begins to move and is steered up the hill.*

*a. Describe the changes to the car’s kinetic energy.*

Kinetic energy is the energy associated with moving objects while potential energy is stored energy. Before the car starts to move up the hill, its kinetic energy is zero. As it begins its motion, the car gains kinetic energy.

*b. Describe the changes to the car’s potential energy that are related to its position.*

At the bottom of the hill, the car has lower potential energy. As the car moves uphill, the car gains potential energy.

1.19 *Suppose that you are camping in the winter. To obtain drinking water, you use a propane-fueled camp stove to melt snow.*

1. *Is the melting of snow a physical change? Explain.*

Melting snow is a physical change because the chemical composition does not change.

1. *When propane burns, the gases carbon dioxide and water vapor are formed. Is the burning of propane a physical change? Explain.*

Burning propane is a chemical change because new substances are produced.

1. *Describe the potential energy change that takes place for propane as it burns in the stove.*

The potential energy stored in the propane is lowered as the propane burns.

1. *Describe the kinetic energy change that takes place for water as the snow melts.*

As the snow melts, the water molecules move faster and so their kinetic energy increases.

1.21 *a. What is heat of fusion?*

Heat of fusion is the energy required for a substance to melt or the energy absorbed as a solid is converted to a liquid.

*b. What is heat of vaporization?*

Heat of vaporization is the energy required for a substance to evaporate or the energy absorbed as a liquid is converted to a gas.

1.23 *If you immerse your arm in a bucket of ice water, your arm gets cold. Where does the heat energy from your arm go and what process is the energy used for?*

The heat energy from the arm goes to the ice water and is used to melt the ice.

1.25 *True or false? IF heat is continually added to a pan of boiling water, the temperature of water continually rises until all of the water has boiled away.*

False. The temperature of the water remains constant until all of the liquid water has boiled away.

1.27 *Based on your experience or the information in Table 1.1, which is larger?*

*a. 1 yd or 1 m*

1 m. One meter is slightly larger than 1 yard because 1 yard is 3 feet and 1 meter is 3.281 feet. Therefore, 1 meter is 1.094 yard.

*b. 1 lb or 1 g*

1 lb. One kilogram is 2.205 pounds. Therefore one pound is 453.5 grams.

*c. 1 cup or 1 mL*

1 cup. One cup is 8 fluid ounces. One fluid ounce is 29.6 milliliter. Therefore, 1 cup is 237 mL.

1.29 *Based on your experience or the information in Table 1.2, which is larger?*

*a. 1 mg or 1 g?*

1 mg. One mg equals 1000 g.

*b. 1 grain or 1 mg?*

1 gr. One grain equals 65 mg.

*c. 1 T or 1 tsp?*

1 T. One T equals 15 mL which equals 3 tsp. Therefore, 1T = 3 tsp.

*d. 1 T or 1 fl oz?*

1fl oz. One fl oz equals 2T.

1.31 *Convert each number into scientific notation.*

*a. 1,300* 1.3 x 103

*b. 6,901,000* 6.901 x 106

*c. 0.00013* 1.3 x 10-4

*d. 0.0000006901* 6.901 x 10-7

1.33 *Convert each number into ordinary notation.*

*a. 7 x 10-2* 0.07

*b. 7 x 102* 700

*c. 8.3 x 108* 830,000,000

*d. 8.3 x 10-8* 0.000000083

1.35 *a. In the year 2000, the world population is estimated to have been about 6 x 109. Convert this value into ordinary notation.*

6,000,000,000

*b. In the year 1000, the world population is estimated to have been about 3 x 106. Convert this value into ordinary notation.*

3,000,000

1.37 *Express each value using an appropriate metric prefix.*

*a. one-thousandth of a meter* 1 millimeter

*b. one million meters* 1 megameter

*c. one billion meters* 1 gigameter

1.39 *Express each distance in scientific notation and ordinary (decimal) notation, without using metric prefixes (example: 6.2 cm = 6.2 x 10-2 m = 0.062 m)*

*a. 1.5 km* = 1.5 x 103 m = 1,500 m

*b*. *5.67 mm* = 5.67 x 10-3 m = 0.00567 m

*c.* *5.67 nm* = 5.67 x 10-9  m = 0.00000000567 m

*d. 0.3 cm* = 3 x 10-3 m = 0.003 m

1.41 *Which is the greater amount of energy?*

*a. 1 kcal or 1 kJ?*  1 kcal. One calorie is larger than one joule (1 cal = 4.184 J), so 1 kcal (1000 cal) is larger than 1 kJ (1000 J).

*b.* *4.184 cal or 1 J?* 4.184 cal. One calorie is larger than one joule (1 cal = 4.184 J), so 4.184 cal is larger than 1 J.

1.43 *a. How many meters are in 1 km?*

The prefix kilo (k) stands for 103. Therefore, 1 km = 1 x 103 m.

*b. How many meters are in 5 km?*

The prefix kilo (k) stands for 103. Therefore, 5 km = 5 x 103 m.

*c.* *How many meters are in 10 km?*

The prefix kilo (k) stands for 103. Therefore, 10 km = 10 x 103 m or 1 x 104 m.

1.45 *You are at the state fair and pay a dollar for the chance to throw three baseballs in an attempt to knock over a pyramid of bowling pins. After your three tosses, the pins remain standing. Which of the following statements about your throws might be correct?*

1. *They were precise and accurate.*
2. *They were neither precise nor accurate.*
3. *They were precise but not accurate.*

Either b or c could be correct since the pins remain standing. Your throws may or may not have been precise.

1.47 *How many significant figures does each number have? Assume that each is a measured value.*

*a.* *1000000.5*  All the zeroes count because they are between nonzero digits.

8

*b.* *887.60* The ending zero counts because there is a decimal point.

5

*c.* *0.668* Zeroes at the beginning of a number are not significant.

3

*d.* *45* All non-zero digits are significant.

2

*e.* *0.00045* Zeroes at the beginning of a number are not significant.

2

*f.* *70.* The ending zero counts because there is a decimal point.

2

1.49 *Solve each calculation, reporting each answer with the correct number of significant figures. Assume that each value is a measured value.*

*a.* *14 x 3.6*

In multiplication and division, the answer is rounded to have the same number of significant figures as the measurement with the fewest significant figures. Since

both measured values have two significant figures, the calculator answer (50.4) rounds to 50. or 5.0 x 101 . The decimal point is necessary to indicate that the zero is significant.

5.0 x 101

*b. 0.0027 ÷ 6.7784*

The same rule applies as in part a. Dividing 0.0027 (2 significant figures) by 6.7784 (5 significant figures) gives 0.000398324, which rounds to 0.00040 or

4.0 x 10-4 (2 significant figures).

4.0 x 10-4

*c.* *12.567 + 34*

When adding or subtracting, the answer should have the same number of decimal places as the quantity with the fewest decimal places.

12. 567 Three decimal places

34 Zero decimal places

46.567 Rounds to 47 (0 decimal places)

47

*d.* *(1.2 x 103 x 0.66) + 1.0*

When more than one operation is involved, calculate the part in parentheses first and round it to the appropriate significant figures and then perform the next part of the calculation. In the first calculation, both numbers have two significant figures, so the answer (1.2 x 103 x 0.66 = 792) is rounded to two significant figures (790).

790 10s place is significant

1.0 10ths place is significant

1. Rounds to 790 with the 10s place significant

7.9 x 102

1.51 *A microbiologist wants to know the circumference of a cell being viewed through a microscope. Estimating the diameter of the cell to be 11 m and knowing that circumference = π x diameter (we will assume that the cell is round, even though that is usually not the case), the microbiologist uses a calculator and gets the answer 34.55751919 m. Taking significant figures into account, what answer should actually be reported? (π = 3.141592654…..).*

In the calculation  x diameter, the diameter (11 m) has the fewest number of significant figures (2). The answer (34.55751414… m) is reported with two significant figures.

35 m

1.53 *Give the two conversion factors that are based on each equality.*

*a. 12 eggs = 1 dozen*  or 

*b. 1 x 103 m = 1 km*  or 

*c. 0.946 L = 1 qt*  or 

1.55 Convert

*a. 48 eggs into dozen*

12 eggs = 1 dozen



*b. 250 m into kilometers*

1 x 103 m = 1 km



*c. 2.7 L into quarts*

0.946 L = 1 qt



1.57 *Convert*

a. *92 µg into grams.*

1 g = 1 x 10-6 g



b. *27.2 ng into milligrams.*

1 ng = 1 x 10-9 g; 1 mg = 1 x 10-3 g.



c. *0.33 kg into milligrams.*

1 kg = 1 x 103 g; 1 mg = 1 x 10 -3 g



d. *7.27 mg into micrograms.*

1 mg = 1 x 10-3 g; 1g = 1 x 10-6 g



1.59 Convert

*a. 1 cm into kilometers*

1 cm = 1 x 10-2 m; 1 km = 1 x 103 m



*b. 25 pm into micrometers*

1 pm = 1 x 10-12 m; 1 m = 1 x 10-6 m



*c. 3.0 x 10-4 mm into decimeters*

1 mm = 1 x 10-3 m; 1 dm = 1 x 10-1 m



*d. 8.5 x 10-3 mm into nanometers*

1 mm = 1 x 10-3 m; 1 nm = 1 x 10-9 m



1.61 *Convert your weight from pounds to kilograms.*

Answers will vary depending on your weight. Below is a sample setup.

If your weight is 175 lb then

175 lb x 1 kg = 79.4 kg

2.205 lb

In general, answer: Your pound weight x 1 kg .

2.205 lb

1.63 Convert

*a. 91°F into degrees Celsius*



*b. 53°C into degrees Fahrenheit*

°F = (1.8 x °C) + 32 = (1.8 x 53°C) + 32 = 127°F

*c. 0°C into kelvins*

K = °C + 273 = 0°C + 273 = 273 K

*d. 309 K into degrees Celsius*

°C = K –273 = 309 K – 273 = 36°C

1.65 *In 2011, 51,303 people completed the 12 km Bloomsday race in Spokane, WA. What is the distance of this race in miles?*

12 km = distance of the race

1 mi = 1.609 km



1.67 *Stavudine is an antiviral drug that has been tested as a treatment for AIDS. The daily recommended dosage of stavudine is 1.0 mg/kg of body weight. How many grams of this drug should be administered to a 150 lb patient?*

First, convert 150 lb to kg using the equivalence 2.205 lb = 1 kg. Then, use 1.0 mg/kg as a conversion factor to calculate the number of milligrams required by the patient. To convert the final answer to grams, use 1000 mg = 1 g.



1.69 *Ivermectin is used to treat dogs that have intestinal parasites. The effective dosage of this drug is 10.5 g/kg of body weight. How much ivermectin should be given to a 9.0 kg dog?*



1.71 *The tranquilizer Valium is sold in 2.0 mL syringes that contain 50.0 mg of drug per 1.0 mL of liquid (50.0 mg/1.0 mL). If a physician prescribes 25 mg of this drug, how many milliliters should be administered?*

Note that the size of the syringes does not have anything to do with the solution of the problem, since it asks for milliliters needed and not the number of syringes.



1.73 *a.* *A vial contains 25 mg/mL of a particular drug. To administer 15 mg of the drug, how many milliliters should be drawn from the vial?*

Use the drug concentration in the vial 25 mg/mL (that is, 25 mg of the active drug is contained in every 1.0 mL of the vial content) as a conversion factor. To calculate how many milliliters of the drug should be dispensed to administer a dose of 15 mg:



*b. A patient is to receive 50 cc of a drug mixture intravenously over a 1 hr time period. What is the appropriate IV drip rate in gtt/min?*

This problem is multi-step and requires more than one conversion factor to complete. Use the conversion factor

15 drops (gtt) = 1 milliliter (mL).

To use this relationship, we first have to convert 50 cc to mL using the equality 1 cc = 1 mL. Because the problem asks for gtt/min, we also have to convert hour to minute.

Combining all of these steps results in the following calculation:



1.75 *A dose of 3 mg/kg/day (3 mg of drug per kilogram of body weight per day) of Phenobarbital is to be given to a 24 kg patient once a day. Phenobarbital is sold in 35 mg tablets. How many tablets (rounded to the nearest one tablet) should be given to the patient per day?*

The recommended dosage in mg of drug for a patient that has 24 kg of body weight per day is:

Using the ratio 35 mg of drug per one tablet, calculate the number of tablets required to deliver 70 mg of the drug:

1.77 *The antipsychotic drug thioridazine is administered at 0.5 mg/kg/day in three divided doses. The drug is sold in 10 mg tablets. How many tablets should be given per dose to a 180 lb patient?*

First, convert the weight of the patient from lb to kg:

Per day, the recommended dosage (mg of drug) for this kg of body weight is:

Using the ratio 10 mg of drug per one tablet, calculate the number of tablets required to deliver 41 mg of the drug:

Per dose, the recommended number of tablets is:

1.79 *At 20 °C, what is the mass in grams of (See Table 1.7)*

*a. 2.0 mL of water?*

*b. 2.0 mL of whole blood?*

*c. 15.3 cm3 of salt?*

*d. 71.2 cm3 of lead?*

To solve for the mass in grams, use the density as a conversion factor:

*a. 2.0 mL of water?*



*b. 2.0 mL of whole blood?*



*c. 15.3 cm3 of salt?*



*d. 71.2 cm3 of lead?*



1.81 *At 20 °C what is the volume in milliliters occupied by (See Table 1.7)*

*a. 15.2 g of water ?*

*b. 2.0 kg of kerosene ?*

*c. 9.2 x 10-2 g of isopropyl alcohol*

*d. 75 g chloroform*

To solve for the volume in milliliters, use the density as a conversion factor:

*a. 15.2 g of water ?*



*b. 2.0 kg of kerosene ?*



*c. 9.2 x 10-2 g of isopropyl alcohol*



*d. 75 g chloroform*



1.83 *A patient has 25.0 mL of blood drawn and this volume of blood has a mass of 26.5 g. What is the density of the blood?*

Density is expressed in g/mL. Therefore, the density is found by dividing the mass of the blood by its volume.



1.85 *What is the specific gravity of whole blood at 20oC? (See Table 1.7.)*

The specific gravity relates the density of a substance to that of water at the same temperature:



At 20°C, the density of water is 1.00 g/mL and the density of whole blood is 1.06 g/mL.



1.87 *Calculate the number of calories of heat energy required for each (See Table 1.8)*

*a. to warm 35.0 g of water from 21.0 °C to 29.0 °C*

Use the specific heat of water, 1.000 cal/g○C (Table 1.8), to convert mass and temperature change into calories. The temperature change is 8.0 °C (29.0 °C– 21.0 °C)



*b. to warm 17.5 g of water from 18.0 °C to 54.0 °C*



1.89 *Calculate the number of calories of heat energy required for each (See Table 1.8)*

*a. to warm 35.0 mL of water from 21.0 °C to 29.0 °C*

First, use the density of water to convert mL of water to g of water.



Then, use the specific heat of water, 1.000 cal/g○C (Table 1.8), to convert mass and temperature change into calories. The temperature change is 8.0 °C (29.0 °C– 21.0 °C)



*b. to warm 17.5 mL of water from 18.0 °C to 54.0 °C*





1.91 *How much will the temperature change when 750 g of each of the following materials absorbs 1.25 x 104 cal of heat energy?*

To do these calculations, substitute all the known values into the conversion equation using specific heat and solve for the unknown (temperature change)

*a. iron (specific heat = 0.11 cal/g°C)*





*b. stainless steel (specific heat = 0.12 cal/g°C)*





*c. aluminum (specific heat = 0.89 J/g°C)*

First, convert 1.25 x 104 cal to J using the relationship given in Table 1.1.







1.93 *Cadmium has a density of 8.65 g/cm3 and beryllium, the lightest metal, has a density of 1.85 g/cm3.*

1. *What volume (in cubic centimeters) is occupied by 25.0 g of cadmium?*

Use the density of the metal as a conversion factor to convert mass to volume.

1. *What volume (in cubic centimeters) is occupied by 25.0 g of beryllium?*
2. *What is the mass (in pounds) of a cube of cadmium with a dimension of 5 inches on a side?*

First, convert the dimension 5 inches to centimeters:

Then, calculate the volume of the cube in cm3

volume of the cube = length x length x length = 12.7 cm x 12.7 cm x 12.7 cm

volume of the cube = 2050 cm3

Now, use the density as a conversion factor to convert the volume to mass in g:

Now, convert g to lb:

1. *What is the mass (in pounds) of a cube of beryllium with a dimension of 5 inches on a side?*

The calculations are similar to part c. above. Because the dimensions of the cube are the same, the beryllium cube will have the same volume:

volume of the cube = 2050 cm3

1.95 *At 20 °C, what is the volume, in milliliters, occupied by*

1. *14.5 g of isooctane?*

Use the density of isooctane given in the text, 0.69 g/mL at 20 °C, as a conversion factor to convert the mass given to the volume of isooctane.

1. *5.55 x 105 g of isooctane?*

Again, use the density of isooctane given in the text, 0.69 g/mL at 20 °C, as a conversion factor to convert the mass given to the volume of isooctane.

1. *3.99 lb of isooctane?*

First, convert the mass in lb to g. Then, use the density of isooctane given in the text, 0.69 g/mL at 20 °C, as a conversion factor to convert the mass given to the volume of isooctane.

1.97 *At 20 °C, what is the volume, in gallons, occupied by*

1. *3.11 lb of gasoline?*

First, convert the mass in lb to g. Then, use the density of gasoline given in the text, 0.73 g/mL at 20 °C, as a conversion factor to convert the mass given to the volume of gasoline in mL. Then, convert mL to gallon.

1. *172 lb of gasoline?*

Similar calculations as part a.:

1. *5.43 kg of gasoline?*

First, convert the mass in kg to g. Then, use the density of gasoline given in the text, 0.73 g/mL at 20 °C, as a conversion factor to convert the mass given to the volume of gasoline. Convert mL to gallon.

1.99 *Assume that the building blocks used to make DNA are pennies, each of which is 1.55 mm thick. If 3 billion pennies are stacked on one another, as happens in DNA with its building blocks, how tall would the stack be (in meters)?*

1.101 *In the past 200 years, in what ways have scientific discoveries led to changes in the treatment of diabetes?*

Insulin became available, the purity of insulin was improved, genetically engineered human insulin was put on the market, and oral drugs were developed.

1.103 *a. A 6’ 2” tall adult weighs 180 lbs. What is his BMI? Based on this value, what is his status: underweight, normal, overweight, or obese?*

The formula for BMI is given below, where weight is given in pounds and height is given in inches. First, calculate the total inches in height.



According to Table 1.6, this falls within the “recommended weight” status.

*b. Answer part a, but using your height and weight.*

Answers will vary.

*c. A woman stands 1.65 m tall and weighs 72.7 kg. What is her BMI and what is her status?*

First, convert m to in and then kg to lb. Then use the same formula as above.







This BMI places her in the overweight status.

1.105 *A patient has a temperature of 31°C. Should her clinician be concerned?*

If a patient has a temperature of 31°C, her physician should be concerned because this is considerably lower than average normal temperature (37°C), even after factoring temperature measurement errors (up to 2°C) due to variation in body location from which measurements are made.

1.107 *One of the rule changes that the NCAA made to discourage rapid weight loss was to shorten the time between weigh in and competition from 24 hours to just 2 hours. Why would this discourage athletes from trying to make weight?*

Two hours might not be enough time to rehydrate and to recover from the effects of dehydration.

1.109 *a. Use the density of water (1.00 g/mL) to derive a conversion factor for water that has the units lb/cup.*



*b. If an athlete reduces her body’s water volume by 5.5 cups through restricting fluid intake and sweating in a sauna, how much weight has she lost? Is this a good idea? Explain.*



No. Losing weight through dehydration can adversely affect endurance, strength, energy, and motivation. Extreme dehydration can lead to kidney failure, heart attack, and death.

1.111 *a. Write the two conversion factors that are based on the equality 1 grain = 325 milligrams.*

 and 

*b. Which conversion factor in your answer to part a would be used to convert grains to milligrams?*



*c. One aspirin tablet contains 5.0 grains of aspirin. How many milligrams of aspirin are in two tablets?*



*d. How many grams of aspirin are in two tablets?*



*e. How many micrograms of aspirin are in two tablets?*



## ANSWERS TO EVEN-NUMBERED END OF CHAPTER PROBLEMS

1.2 Which drawing correctly shows the relationship between decigrams and grams?

1 dg

1 g

10 dg

1 g

1 dg

10 g

Answer:

10 dg

1 g

10 dg = 1 g

1 dg = 10-1 g. Therefore, there are 10 dg in 1 g.

SECTION 1.1 THE SCIENTIFIC METHOD

1.4 Centuries before any experiments had been carried out, philosophers had proposed the existence of the atom. Why are the proposals of these philosophers not considered theories?

Answer:

Theories are explanations of observed phenomena based on experimental observations. The philosophers’ proposals on the existence of the atom are not theories because they were not based on experimental observations.

1.6 How is a law different from a hypothesis?

Answer:

A law describes events that are consistently observed and are reproducible. A hypothesis is simply a tentative explanation of an observed phenomenon.

SECTION 1.2 MATTER AND ENERGY

1.8 What are the three states of matter?

Answer:

Solid, liquid, and gas.

1.10 a. List a few of the physical properties of a piece of copper wire.

b. Give examples of some of the physical changes that a piece of copper wire could undergo.

Answer:

1. A piece of copper is wire is brown-gold in color, shiny, malleable, ductile, and can conduct electricity.
2. A piece of copper wire can be cut into shorter pieces, coiled into different shapes, and melted using heat.

1.12 Give an example of a chemical change (change in chemical composition) that involves starting with a liquid and ending up with a gas.

Answer:

Burning gasoline (combustion) is an example. In the combustion of gasoline (or any liquid fuel like propane or butane), the liquid fuel is converted into gaseous carbon dioxide and water vapor.

1.14 What is kinetic energy?

Answer:

Kinetic energy is the energy of motion.

1.16 Describe a situation where an object’s potential energy varies as a result of changes due to its chemical composition.

Answer:

An example is the burning of wood. When wood is burned, it undergoes a change in chemical position and produces heat in the process. Once the wood has completely burned, the remaining solids and the gases expelled can no longer burn to provide heat.

1.18 In the autumn, a leaf falls from a tree.

a. Describe the change to the leaf’s kinetic energy.

b. Describe changes to the leaf’s potential energy that are related to its position.

Answer:

1. The leaf has kinetic energy as it falls but when it hits the ground, its kinetic energy goes to zero.
2. The potential energy of the leaf is highest just as it starts to fall. Its potential energy is lowest once it hits the ground.

1.20 Rather than melting snow on a camp stove as described in the previous problem, you decide to eat handfuls of snow.

1. Describe the change in the potential energy of your body as the snow that you have swallowed is melted.
2. If you are stranded in the woods during the winter, why is it better to obtain water by melting snow than eating it?

Answer:

1. Some of the potential (stored) energy in the body provides the heat used to melt the snow.
2. The body’s energy reserves can be put to other uses, like keeping warm.

1.22 a. What change in physical state takes place during sublimation?

b. Give an example of a substance that sublimes.

Answer:

1. In sublimation, a substance undergoes a change from the solid state to the gas state.
2. Dry ice, which is frozen carbon dioxide, is an example of a substance that sublimes. Iodine crystals also undergo sublimation.

1.24 Some over-the-counter (nonprescription) wart removers contain ether. When a few drops are placed on a wart, it feels cold as the ether rapidly evaporates. Where does the heat energy from the wart go and what process is the energy used for?

Answer:

The heat energy from the wart is absorbed by the ether molecules causing their average kinetic energy to increase. This enables the ether molecules to separate from each other. The energy is used for the process of evaporation, when liquid ether changes to gaseous ether.

1.26 True or false? A container holding a mixture of ice and water at a temperature of 0 °C (the freezing temperature of water) is placed in a -30 °C freezer. The ice-water mixture stays at a temperature of 0 °C until all the water has frozen.

Answer:

True. The temperature of the water remains constant until all of the liquid water has been converted to ice.

SECTION 1.3 UNITS OF MEASUREMENT

1.28 Based on your experience or the information in Table 1.1, which is larger?

a. 1 pint or 1 L?

b. 1°F or 1°C

c. 1 gal or 1 L?

Answer:

a. 1 L. One quart is slightly smaller than one liter, and one pint is only one-half quart*.*

b. 1°C. One degree Celsius is 1.8 times larger than one degree Fahrenheit.

c. 1 gal. One gallon is four quarts and one quart is just a bit smaller than one liter.

1.30 Based on your experience or the information in Table 1.2, which is larger?

a. 1 gtt or 1 mL

b. 1 T or 1 mL

c. 1 tsp or 1 fl oz

d. 1 mg or 1 gr

Answer:

Use Table 1.2 for the relationships between the units for comparison.

a. 1 mL. One milliliter (mL) contains 15 drops (gtt) or another way to look at it, 1 gtt is 1/15 of one mL. Therefore, 1 mL is greater than 1 gtt.

b. 1 T. One tablespoon (T) contains 15 mL or another way to look at it, 1 mL = 1/15 T. Therefore, 1 T is greater than 1 mL.

c. 1 fl oz. One teaspoon (tsp) is 5 mL. One tablespoon is 15 mL. Therefore, there are 3 teaspoons for every 1 tablespoon. Two tablespoons are equal to 1 fluid ounce (fl oz). Therefore, there are 6 teaspoons in every 1 fluid ounce, and 1 teaspoon is equal to 1/6 of 1 fluid ounce.

d. 1 gr. One grain (gr) is 65 milligrams (mg).

SECTION 1.4 SCIENTIFIC NOTATION, SI, AND METRIC PREFIXES

1.32 Convert each number into scientific notation.

a. 2,000,000,000

b. 850

c. 0.2

d. 0.0085

Answer:

Values written in scientific notation are written as a number between 1 and 10 multiplied by a power of ten. As discussed in the chapter, to convert to scientific notation, the decimal point is shifted to the left for numbers equal to or greater than 10 and shifted to the right for numbers less than 1.

1. 2,000,000,000 **2 x 109**
2. 850 **8.5 x 102**
3. 0.2 **2 x 10-1**
4. 0.0085 **8.5 x 10-3**

1.34 Convert each number into ordinary notation.

a. 4.23 x 10-4

b. 4.23 x 101

c. 9.66 x 10-6

d. 9.66 x 106

Answer:

To convert from scientific notation to ordinary notation, use the exponent to determine how many times to multiply by 10 (for positive exponents) or how many times to divide by 10 (for negative exponents)

* 1. 
  2. 
  3. 
  4. 

1.36 a. Light microscopes can see objects as small as 0.0000002 m in diameter. Convert this value into scientific notation.

b. Electron microscopes can see objects as small as 0.0000000002 m in diameter.

Convert this value into scientific notation.

Answer:

1. 2 x 10-7 m
2. 2 x 10-10 m

1.38 Express each value using an appropriate metric prefix.

a. one thousand grams

b. one-millionth of a gram

c. one-billionth of a gram

Answer:

Refer to the Table of SI and Metric Prefixes to match the multiplier with the appropriate prefix.

1. one thousand grams = 1,000 g = 1 x 103 g = 1 kilogram or 1 kg
2. 
3. 

1.40 Express each mass in scientific notation and ordinary (decimal) notation, without using metric prefixes (example: 5 g = 5 x 10-6 g = 0.000005 g).

a. 24g

b. 0.716 mg

c. 15 dg

d. 412 kg

Answer:

Refer to the Table of SI and Metric Prefixes to match the multiplier with the appropriate prefix.

1. 24 g = 24 x 10-6 g = 2.4 x 10-5 g = 0.000024 g
2. 0.716 mg = 0.716 x 10-3 g = 7.16 x 10-4 g = 0.000716 g
3. 15 dg = 15 x 10-1 g = 1.5 x 100 g = 1.5 g
4. 412 kg = 412 x 103 g = 4.12 x 105 g = 412,000 g

1.42 Which is the greater amount of energy?

a. 100 cal or 100 J

b. 100 Cal or 100 kJ

Answer:

Use the relationships between calorie and joule (1 calorie = 4.184 joules) and between Calorie and calorie (1 Calorie = 1,000 calories).

1. 100 cal is greater than 100 J because 1 cal = 4.184 J
2. 100 Cal is greater than 100 kJ because 1 Cal = 1,000 cal = 4,184 J = 4.184 kJ

1.44 a. How many grams are in 1 kg?

b. How many grams are in 2 kg?

c. How many grams are in 2.5 kg?

Answer:

Kilo means 103, milli means 10-3, and micro means 10-6. Therefore, 1 kilogram = 103 grams = 1000 grams; 1 milligram = 10-3 gram = 0.001 gram; and 1 microgram = 10-6 gram = 0.000001 gram. Use these equivalences to convert the measurements given.

1. 1 kg = 1 x 103 g
2. 2 kg = 2 x 103 g
3. 2.5 kg = 2.5 x 103 g

SECTION 1.5 MEASUREMENTS AND SIGNIFICANT FIGURES

1.46 A scientist buys a thermometer and tests it by measuring the melting point of a particular substance.

a. What results would show that the thermometer is not precise?

b. What results would show that the thermometer is not accurate?

Answer:

1. The thermometer is not precise if several measurements of the melting point are made and the resulting values are not close to each other.
2. The thermometer is not accurate if the measured values of the melting point are not close to the true value of the melting point.

1.48 How many significant figures does each number have? Assume that each is a measured value.

a. 1.466

b. 3.5895

c. 600.2

d. 4.55 x 103

e. 0.001

f. 2 x 101

g. 2.0 x 101

Answer:

Use the rules given in Table 1.5 for determining the number of significant figures in a given measurement. The significant figures are underlined for each number below.

|  |  |
| --- | --- |
| a. 1.466 | 4 sig. figs. |
| b. 3.5895 | 5 sig. figs. |
| c. 600.2 | 4 sig. figs. |
| d. 4.55 x 103 | 3 sig. figs. |
| e. 0.001 | 1 sig. fig. |
| f. 2 x 101 | 1 sig. fig. |
| g. 2.0 x 101 | 2 sig. figs. |

1.50 Solve each calculation, reporting each answer with the correct number of significant figures. Assume that each value is a measured quantity.

a. 0.114 x 5.2377

b. 3.11 x 14.5

c. 123.667 - 78.9

d. (6.21 + 0.04) x 16.72

Answer:

Calculations should not change the degree of uncertainty in the given values. When multiplying or dividing numbers, the answer should be rounded off to the same number of significant figures as the measurement with the least number of significant figures. In addition or subtraction, the answer should carry the same number of decimal places as the measurement with the fewest decimal places.

(sf = significant figures)

a. 0.114 (3 sf) x 5.2377 (5 sf) = 0.597 (3 sf)

b. 3.11 (3 sf) x 14.5 (3 sf) = 45.1 (3 sf)

c. 123.667 (3 decimal places)

- 78.9 (1 decimal place)

44.8 (1 decimal place)

d. (6.21 + 0.04) x 16.72 = (6.25) x 16.72 = 105 (3 sf)

1.52 Given that area =  x radius2 and radius = diameter/2, what is the area of the cell described in Problem 1.51? Report your answer with the correct number of significant figures.

Answer:

area =  x radius2

 = 3.14

radius = diameter/2 = 11 μm/2 = 5.5 μm

area = 3.14 x (5.5 μm)2 = 95 μm2

SECTION 1.6 CONVERSION FACTORS AND THE FACTOR LABEL METHOD

1.54 Give the two conversion factors that are based on each equality.

a. 2 T = 1 oz

b. 15 gtt = 1 mL

c. 1 mg = 1000 g

Answer:

To obtain the first conversion factor, we divide each side of the equality by one of the terms. We divide each side by the other term to obtain the second conversion factor.

a. 

b. 

c. 

1.56 Convert

a. 15 T into fluid ounces

b. 45 gtt into milliliters

c. 0.33 mg into micrograms

Answer:

Determine the equality that relates the unit of the known value and the unit that is required. Create a conversion factor based on the equality. Use the factor-label method to perform the unit conversion.

a. 15 T = ? fl oz 2 T = 1 fl oz



b. 45 gtt = ? ml 15 gtt = 1 ml



c. 0.33 mg = ? g 1 mg = 10-3 g 10-6 g = 1 g



1.58 Convert

a. 81.2 g into kilograms

b. 81.2 kg into grams

c. 29 g into milligrams

d. 47.66 g into decigrams

Answer:

Determine the equality that relates the unit of the known value and the unit that is required. Create a conversion factor based on the equality. Use the factor-label method to perform the unit conversion.

a. 81.2 g = ? kg 1000 g = 1 kg



b. 81.2 kg = ? g 1000 g = 1 kg



c. 29 g = ? mg 1 g = 10-6 g 10-3 g = 1 mg



d. 47.66 g = ? dg; 1 g = 10-6 g; 10-1 g = 1 dg



1.60 Convert

a. 0.33 L into pints

b. 0.33 gal into liters

c. 1.0 cup into deciliters

d. 1.0 mL into quarts

Answer:

Determine the equality that relates the unit of the known value and the unit that is required. Create a conversion factor based on the equality. Use the factor-label method to perform the unit conversion.

a. 0.33 L = ? pints 0.946 L = 1 qt 1 qt = 2 pt (pints)



b. 0.33 gal = ? liters 1 gal = 4 qt 1 qt = 0.946 L



c. 1.0 cup = ? deciliters 4 cup = 1 qt 1 qt = 0.946 L 10-1 L = 1 dL



d. 1.0 mL into quarts 1 mL = 10-3 L 0.946 L = 1 qt

1.62 Convert your height from feet and inches into meters.

Answer:

Sample calculation for a person whose height is 5’ 7” (5 feet and 7 inches):

height = 5’ 7” = 5 ft + 7 in = 5 ft + = 5 ft + 0.6 ft = 5.6 ft



1.64 Convert

a. 103° F into degrees Celsius

b. 25 °C to Fahrenheit

c. 35 °C into kelvins

d. 405 K into degrees Fahrenheit

Answer:

Use the following conversion formulas:

 °F = (1.8 x °C) + 32 K = °C + 273.15

a. 103° F = ? °C



b. 25 °C = ? °F

°F = (1.8 x °C) + 32 = (1.8 x 25) + 32 = 45 + 32 = 77 °F

c. 35 °C = ? kelvins

K = 35 + 273.15 = 308

d. 405 K = ? °F

First, convert K to °C:

405 = °C + 273.15 °C = 405 - 273.15 = 132 °C

Then, convert to °F:

°F = (1.8 x 132) + 32 = 270 °F

1.66 It is estimated that an accordion player expends 9.2 kJ of energy per minute of playing time. Convert this value into Calories (1 food Calorie = 1000 cal).

Answer:

Since 1 kJ = 1 x 103 J and 1 cal = 4.184 J



1.68 As an alternative to ear tags and lip tattoos, tetracycline (an antibiotic) is used to mark polar bears. The advantages of using tetracycline in this fashion are that it leaves a detectable deposit on the bears’ teeth, it can be administered remotely, and using it doesn’t require that the animal be sedated. If 25 mg/kg is an effective dose, how much tetracycline is needed (in grams) to mark a 1000 kg polar bear?

Answer:

First, determine the number of milligrams of tetracycline needed and then convert that to grams. Note that 25 mg/kg (25 mg of tetracycline per kilogram of body weight) is used as a conversion factor.





1.70 Chloroquine is used to treat malaria. Studies have shown that an effective dose for children is 3.5 mg per kilogram (3.5 mg/kg) of body weight, every 6 hours. If a child weighs 12 kg, how many milligrams of this drug should be given in a 24 hour period?

Answer:

First determine the number of doses required for a 24-hour period using the information that 1 dose is required every 6 hours.



Next, determine the required mg of drug for 4 doses using the information that 1 dose is equivalent to 3.5 mg drug/kg body weight.



If the child weighs 12 kg, then the required mg drug for a 24-hr period is:



1.72 An antibiotic is sold in 3.0 mL ampoules that contain 60.0 mg of drug (60.0 mg/3.0 mL). How many milliliters of the antibiotic should be withdrawn from the ampoule if 45 mg are to be administered to a patient?

Answer:

45 mg antibiotic = ? mL 60.0 mg of antibiotic = 3.0 mL ampoule



1.74 a. A prescription of antibiotics for a 30 lb child says to give 100 mg three times daily. Is this dosage safe if the proper pediatric dosage range for this drug is 10-30 mg per kilogram of body weight per day?

b. A patient’s cough syrup prescription comes in a 250 mL bottle. For how long will the cough syrup last if he takes two teaspoons three times a day?

Answer:

a. First, convert the weight of the child from lb to kg:



The recommended total daily dose in mg is:



Calculate the mg per kg of body weight equivalent to administering the total daily dose to a 14-kg child.



which is between 10-30 mg per kilogram of body weight per day so it is a safe dose.

b. Convert 250 mL into teaspoons and then use the conversion factor 6 teaspoons/day (equivalent to two teaspoons three times a day).



1.76 To treat migraines, valproic acid can be given at a dosage of 15 mg/kg/day (15 mg of drug per kilogram of body weight per day). Valproic acid is sold in 250 mg capsules. How many capsules per day should a 115 lb patient be prescribed?

Answer:

First, convert the weight of the patient from lb to kg:

Per day, the recommended dosage (mg of drug) for this kg of body weight is:

Using the ratio 250 mg of drug per one capsule, calculate the number of capsules required to deliver 784 mg of the drug:

1.78 A prescription calls for giving a 95 lb patient 5 mg/kg/day (5 mg of drug per kilogram of body weight per day) of an anticonvulsant drug, with the half the dose given in the morning and the other half at night. The drug is sold in 100 mg tablets. How many tablets (rounded to the nearest one tablet) should be given at any given time.

Answer:

First, convert the weight of the patient from lb to kg:

Per day, the recommended dosage (mg of drug) for this kg of body weight is:

Using the ratio 100 mg of drug per one tablet, calculate the number of tablets required to deliver 215 mg of the drug:

Therefore, 1 tablet should be given in the morning and 1 tablet should be given at night.

SECTION 1.7 DENSITY, SPECIFIC GRAVITY, AND SPECIFIC HEAT

1.80 At 20 °C what is the mass in grams of (See Table 1.7)

a. 1.0 L of kerosene?

b. 1.0 gal of isopropyl alcohol?

c. 75.2 cm3 of cork?

d. 5.05 cm3 of lead?

Answer:

Density can be used as a conversion factor that relates mass and volume. Look up the density for each substance and express it as a conversion factor.

a. 1.0 L of kerosene?

The density of kerosene from Table 1.7 is 0.82 g/mL which can be expressed as a conversion factor in two different ways:



Because the volume is given, use the first conversion factor. But first, convert L to mL to be able to use the density conversion factor.



b. 1.0 gal of isopropyl alcohol?

The density of isopropyl alcohol from Table 1.7 is 0.785 g/mL. First, convert gal to L to mL.





c. 75.2 cm3 of cork?

The density of cork from Table 1.7 is 0.25 g/cm3.



d. 5.05 cm3 of lead?

The density of lead from Table 1.7 is 11.35 g/cm3.



1.82 At 20 °C what is the volume in milliliters occupied by (see Table 1.7)

a. 1.50 kg of water?

b. 77.2 g of kerosene?

c. 5.0 mg of isopropyl alcohol?

d. 1.0 lb of water?

Answer:

In each of these cases, the mass is given. Use the density conversion factor in which the mass is in the denominator to solve for the volume.

a. 1.50 kg of water?

The density of water from Table 1.7 is 1.00 g/mL. First, convert the mass in kilogram to gram then use the density conversion factor to calculate the volume.



b. 77.2 g of kerosene?

The density of kerosene from Table 1.7 is 0.82 g/mL.



c. 5.0 mg of isopropyl alcohol?

The density of water from Table 1.7 is 1.00 g/mL. First, convert the mass in mg to g then use the density conversion factor to calculate the volume.



d. 1.0 lb of water?

The density of water from Table 1.7 is 1.00 g/mL. First, convert the mass in lb to g then use the density conversion factor to calculate the volume.



1.84 A patient has 0.050 L of blood drawn and this volume of blood has a mass of 55.0 g. What is the density of the blood?

Answer:

To calculate the density of a substance, divide its mass by its volume.





1.86 What is the specific gravity of kerosene at 20○C? (See Table 1.7.)

Answer:

Specific gravity is the density of a substance divided by the density of water at the same temperature.





1.88 Calculate the number of calories of heat energy required for each (See Table 1.8)

a. to warm 2.60 g of isopropyl alcohol from 15.0 oC to 35.0 oC

b. to warm 17.5 g of isopropyl alcohol from 32.0 oC to 87.0 oC

Answer:

a. Use the specific heat of isopropyl alcohol, 0.612 cal/g○C, to convert mass and temperature change into calories. The temperature change is 20.0 °C (35.0 °C – 15.0 °C).



b. The temperature change is 55.0 °C (32.0 °C – 87.0 °C).



1.90 Calculate the number of calories of heat energy required for each. (See Table 1.8)

a. to warm 2.60 mL of isopropyl alcohol from 21.0°F to 29.0°F

b. to warm 17.5 mL of isopropyl alcohol from 18.0°F to 54. 0°F

Answer:

a. First, convert the volume to mass using density. Use the specific heat to convert mass and temperature change into calories. For isopropyl alcohol, the density is 0.785 g/mL and the specific heat is 0.612 cal/g°C.



Convert the temperatures to °C then calculate the change in temperature.

 

The temperature change is -1.7°C – (-6.1°C) = 4.4°C

Use these values to calculate the energy required:



b. to warm 17.5 mL of isopropyl alcohol from 18.0°F to 54. 0°F



Convert the temperatures to °C then calculate the change in temperature.

 

The temperature change is 12.2°C – (-7.8°C) = 20.0°C

Use these values to calculate the energy required:



1.92 How much will the temperature change when 55.0 g of each of the following material absorbs 125 cal of heat energy?

a. silver (specific heat = 0.056 cal/g ○C)

b. olive oil (specific heat = 0.47 cal/g ○C)

c. table salt (specific heat = 0.86 J/g ○C)

Answer:

a. silver (specific heat = 0.056 cal/g ○C)





b. olive oil (specific heat = 0.47 cal/g ○C)





c. table salt (specific heat = 0.86 J/g ○C)





SECTION 1.8 MEASUREMENTS IN GENERAL CHEMISTRY, ORGANIC CHEMISTRY, AND BIOCHEMISTRY

1.94 Cadmium has a density of 8.65 g/cm3, lead a density of 11.35 g/cm3, and zinc a density of 7.14 g/cm3.

1. A 15.0 cm3 sample of each metal is obtained. What is the mass of each sample, in grams, milligrams, and pounds?
2. A 20.0 in3 sample of each metal is obtained. What is the mass of each sample, in grams, milligrams, and pounds?
3. A 50.0 g sample of each metal is obtained. What is the volume of each sample, in cubic centimeters, cubic millimeters, and cubic inches?
4. A 1.50 lb sample of each metal is obtained. What is the volume of each sample, in cubic centimeters, cubic millimeters, and cubic inches?

Answer:

1. Use the density of each metal as a conversion factor to convert volume to mass.

Cadmium

Lead

Zinc

1. First, convert the volume from in3 to cm3 because the density is given with cm3 as the volume unit. To convert in3 to cm3, the conversion factor needs to be raised to the power of 3 to change inch to in3 and centimeter to cm3.

Then, use the density of each metal as a conversion factor to convert volume to the different mass units.

Cadmium

Lead

Zinc

1. Use the density of each metal as a conversion factor to convert mass to volume. To convert a unit that is cubed to another unit that is cubed, raise the conversion factor(s) to the third power.

Cadmium

Lead

Zinc

1. First, convert the mass from lb to g. Then, use the density of each metal as a conversion factor to convert mass to volume.

Cadmium

Lead

Zinc

1.96 At 20 °C, what is the volume, in milliliters, occupied by

1. 8.49 g of isooctane?
2. 4.71 x 102 g of isooctane?
3. 12.0 lb of isooctane?

Answer:

1. Use the density of isooctane given in the text, 0.69 g/mL at 20 °C, as a conversion factor to convert the mass given to the volume of isooctane.
2. Again, use the density of isooctane given in the text, 0.69 g/mL at 20 °C, as a conversion factor to convert the mass given to the volume of isooctane.
3. First, convert the mass in lb to g. Then, use the density of isooctane given in the text, 0.69 g/mL at 20 °C, as a conversion factor to convert the mass given to the volume of isooctane.

1.98 At 20 °C, what is the volume, in gallons, occupied by

1. 8.99 lb of gasoline?
2. 114 lb of gasoline?
3. 22.6 kg of gasoline?

Answer:

1. First, convert the mass in lb to g. Then, use the density of gasoline given in the text, 0.73 g/mL at 20 °C, as a conversion factor to convert the mass given to the volume of gasoline.
2. Similar calculations as part a.:
3. First, convert the mass in kg to g. Then, use the density of gasoline given in the text, 0.73 g/mL at 20 °C, as a conversion factor to convert the mass given to the volume of gasoline.

1.100 When it is compacted, DNA fits into a cell nucleus that is 80,000 times smaller in diameter than the DNA is long. If the strand in Problem 1.99 were compacted by the same amount, what size package would it fit in?

Answer:

diameter of compacted DNA = 5 x 106 m / 80,000 = 60 m

HEALTH LINK SCIENCE AND MEDICINE

1.102 Until the late 1980s, what was the source of the insulin used to treat diabetes?

Answer:

Insulin was isolated from cattle and pigs until 1982 when genetically engineered human insulin became the source of insulin for treatment of diabetes.

HEALTH LINK BODY MASS INDEX

1.104 September 2006 was the first time that models were banned from a top-level fashion show for being too thin. The organizers of the Madrid Fashion Week defined “too thin” as having a BMI of less than 18. How much would a 5’2” model weigh if she had a BMI of 16?

Answer:





So, solving for weight:





HEALTH LINK BODY TEMPERATURE

1.106 Suppose that you take your temperature orally and see that it is 99.1°F. Does this necessarily mean that you are running a fever? Explain.

Answer:

No. A normal body temperature of approximately 98.6oF is based on the average of temperatures in healthy people. A difference of only 0.5 °F could easily be normal for you.

HEALTH LINK MAKING WEIGHT

1.108 Why does a high urine specific gravity indicate dehydration?

Answer:

The high specific gravity indicates that there is more dissolved material per volume of water in the urine. This is the result of dehydration.

1.110 a. Use the density of water (1.00 g/mL) to derive a conversion factor for water that has the units kg/L.

b. If an athlete reduces his body’s water volume by 0.75 L through restricting fluid intake and sweating in a sauna, how much weight (in kilograms) has he lost?

Answer:

a. 

b. 

LEARNING GROUP PROBLEMS

1.112 a. Write the two conversion factors that are based on the equality 15 drops = 1 milliliter.

b. Which conversion factor in your answer to part a would be used to convert milliliters to drops?

c. 65 drops of water is how many milliliters?

d. 65 drops of water is how many microliters?

e. 65 drops of water is how many tablespoons? (See Table 1.2)

Answer:

a.  and 

b. 

c. 

d. From part c., 65 drops is equivalent to 4.3 mL. Convert 4.3 mL to L



e. 65 drops = 4.3 mL as in part c. From Table 1.2, 15 mL = 1 T

