Chapter One

Scientific Measurements

Practice Exercises

1. The scientific method is an iterative process of gathering information through making observations and collecting data and then formulating explanations that lead to a conclusion.
2. (a) element (b) mixture, homogeneous (c) compound

(d) mixture, heterogeneous (e) element

1. (a) chemical change (b) physical change

(c) physical change (d) physical change

1. (a) intensive (b) extensive

(c) intensive (d) extensive

1. *V* = , the SI unit for radius, *r*, is meters, the numbers  and π do not have units. Therefore, the SI unit for volume is meter3 or m3.
2. Force equals mass × acceleration (*F = ma*), and acceleration equals change in velocity divided by change in time (*a* = ), and velocity equals distance divided by time (*v* = ). Put the equations together:

*F* = *m*

*F= m*= *m*

The unit for mass is kilogram (kg); the unit for distance is meter (m) and the unit for time is second (s). Substitute the units into the equation above:

Unit for force in SI base units = kg or kg m s–2

1. 
2. 

To convert from °F to K we first convert to °C.



*T*K = (273 °C + *t*C) = (273 °C + 20 °C) = 293 K

1. (a) 21.0233 g + 21.0 g = 42.0233 g: rounded correctly to 42.0 g

(b) 10.0324 g / 11.7 mL = 0.8574 g / mL: rounded correctly to 0.857 g/mL

(c)  = 148.57 cm: rounded correctly to 149 cm

1. (a) 54.183 g – 0.0278 g = 54.155 g

(b) 10.0 g + 1.03 g + 0.243 g = 11.3 g (rounded after adding)

(c) 43.4 in ×  = 3.62 ft (1 and 12 are exact numbers)

(d)  = 0.36 m2

1. 
2. (a) 

(b) 

(c) 

(d) 

1. Density =  = 0.0163 g/mL = 0.0163 g cm–3
2. Density = =2.2 g mL–1 = 2.2 g cm–3
3. Density = 

Density of the object =  = 16.5 g/cm3

The object is not composed of pure gold since the density of gold is 19.3 g/cm3.

1. The density of the alloy is 12.6 g/cm3. To determine the mass of the 0.822 ft3 sample of the alloy, first convert the density from g/cm3 to lb/ft3, then find the weight.

Density in lb/ft3 =  = 787 lb/ft3

Mass of sample alloy = (0.822 ft3) (787 lb/ft3) = 647 lb

1. specific gravity = 

1.090 = 

density of wine = 1.090 × 62.4 lb ft3 = 68.02 lb ft3

mass of wine = 79 gallons × density of wine × 

= 79 gallons ×  = 720 lb

1. specific gravity = 

density of water =  = 1.043 oz/liquid oz

specific gravity of urine = = 0.966

The specific gravity of urine is below the normal range.

**Review Questions**

1. This answer will be student dependent.
2. Observation, testing and explanation.
3. (a) A law is a description of behavior based on the results of many experiments which are true while a theory is a tested explanation of the results of many experiments.

(b) An observation is a statement that accurately describes something we see, hear, taste, feel or smell while a conclusion is a statement that is based on a series of observations.

(c) Data are the observations made while performing experiments.

1. A theory is valid as long as there is no experimental evidence to disprove it. Any experimental evidence that contradicts the theory, and therefore, disproves the theory.
2. Matter has mass and occupies space. All items, except (b) an idea, in the question are examples of matter.
3. (a) An element is a pure substance that cannot be decomposed into something simpler.

(b) A compound is a pure substance that is composed of two or more elements in some fixed or characteristic proportion.

(c) Mixtures result from combinations of pure substances in varying proportions.

(d) A homogeneous mixture has one phase. It has the same properties throughout the sample.

(e) A heterogeneous mixture has more than one phase. The different phases have different properties.

(f) A phase is a region of a mixture that has properties that are different from other regions of the mixture.

(g) A solution is a homogeneous mixture.

1. Changing a compound into its element is a chemical change.
2. (a) F (b) Se (c) Ni (d) Ar

(e) Li (f) P (g) I (h) Ga

(i) Hg (j) Mn

1. (a) sodium (b) zinc (c) silicon

(d) tin (e) magnesium (f) tungsten

(g) cobalt (h) aluminum (i) oxygen

(j) nitrogen

1. (a) This is a heterogeneous mixture.

(b) This is a pure substance and is an element, such as H2, O2, N2 or a halogen.

(c) This is a homogeneous mixture.

(d) This is a pure substance and is a molecule such as H2O.

1. (a) Diagrams (a) and (d) contain pure elements

(b) Diagram (c) contains a compound

(c) Diagram (a) and (b) contain diatomic molecules

1. A physical change does not change the chemical composition of matter. Melting, boiling, change of shape, or mass, and the formation of a mixture are examples of physical changes to matter.

A chemical change changes the chemical composition of matter. Formation of new compounds from the reaction of other substances is an example.

A chemical changes involves the change in composition while a physical change does not change in the composition of matter.

1. The reaction of calcium metal with water is a chemical change resulting in the formation of new compounds, hydrogen gas and calcium hydroxide. It is not stated in the problem, but the water also increases in temperature, which is a physical change.
2. These are all physical changes.
3. A chemical property describes a property that changes the chemical nature of a substance while physical properties describe properties that do not change the chemical nature of a substance. For example, boiling water does not change the chemical composition of water.
4. Extensive properties, such as volume, and size, are properties that depend on the amount of substance or mass of substance while intensive properties, such as density, are not dependent on the amount of substance. The density of a milliliter of water is the same as the density of a liter of water at the same temperature.
5. (a) Extensive Mass is a mass dependent property.

(b) Intensive The boiling point of a substance is the same for a mL as it is for a L of the compound so it is mass independent.

(c) Intensive The color of a substance does not change when you change the amount of substance.

(d) Extensive Surface area depends on the amount of substance. It also depends on the nature of the substance. A bar of metal has a smaller surface area than that of the same bar ground into fine particles.

(e) Intensive The physical state, gas, liquid, or solid, depends on temperature and pressure but not on the mass of the substance.

(f) Intensive The density of 1.0 g of water is the same as 100.0 g if both samples are at the same temperature. Thus, density is not dependent on the mass of substance.

(g) Extensive The volume occupied by a substance is dependent on the mass of substance.