

Warm-up question:

Consider the Following 4 statements:

- A. The sun rises in the East.
- B. All objects are attracted to Earth.
- C. In a closed system there is no gain or loss of mass due to chemical reactions.
- D. "Principles of Chemistry" class starts at 11 am.

Questions:

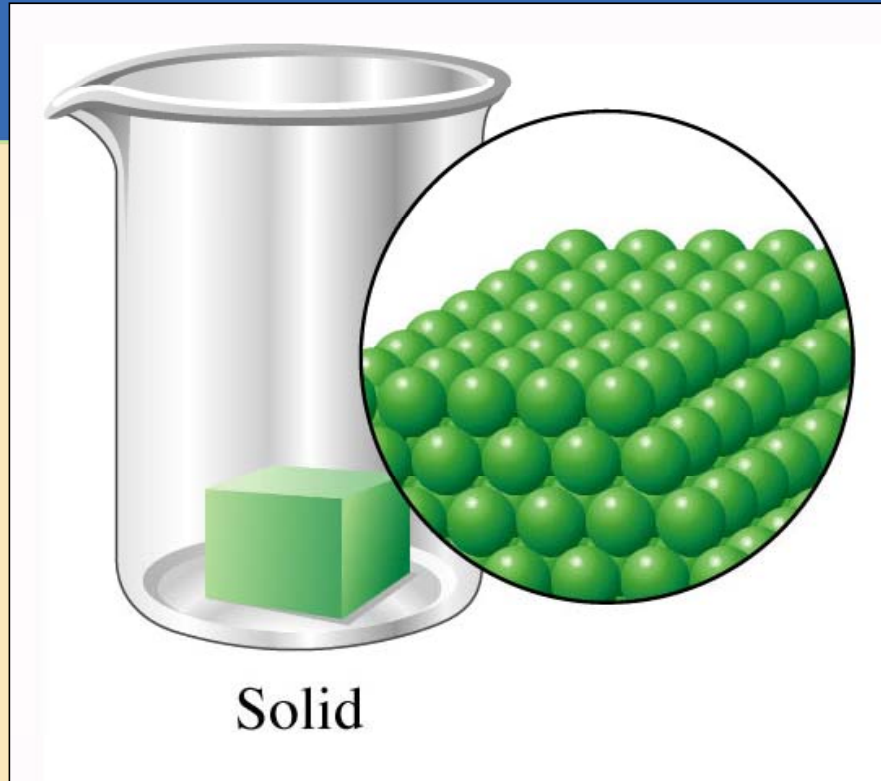
1. Which one(s) is/ are observations? all
2. Scientific Laws? B, C
3. Observations of natural phenomenon? All but D

Matter: Physical State and Chemical Constitution

- There are two principal ways of classifying matter:
 - By its physical state as a solid, liquid, or gas.
 - (Ice, vapor, water – all different PHYSICAL states of the same compound, H₂O)
 - By its chemical constitution as an element, compound, or mixture.
 - (H₂ is element, H₂O is a compound,
 - H₂O with NaCl dissolved in it - is a homogeneous mixture, called solution.)

Figure 1.11a: Molecular representation of a solid.:

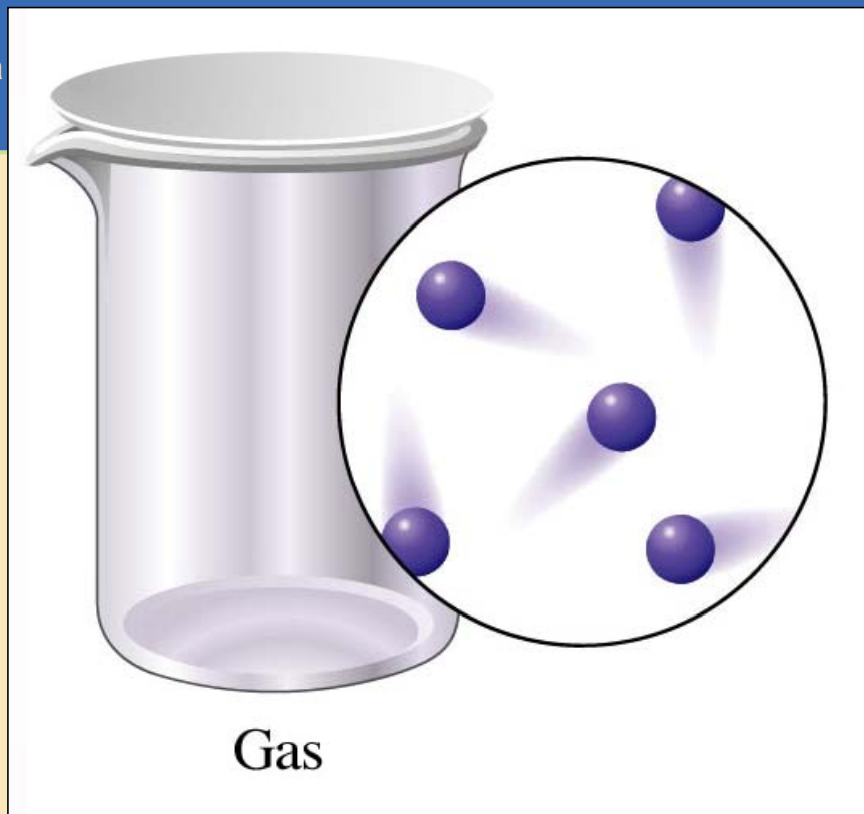
Solid: the form of matter characterized by rigidity; a solid is relatively incompressible and has a fixed shape and volume



Solids, Liquids, and Gases

- Solid: the form of matter characterized by rigidity; a solid is relatively incompressible and has a fixed shape and volume.
- Liquid: the form of matter that is a relatively incompressible fluid; liquid has a fixed volume but no fixed shape.
- Gas: the form of matter that is an easily compressible fluid; a given quantity of gas will fit into a container of almost any size in shape. (NB! Only gas has variably pressure!)

Figure 1.11c:
Molecular
representatin of a
gas.



Elements, Compounds, and Mixtures

- To understand how matter is classified by its chemical constitution we must first look at physical and chemical changes.
 - A physical change is a change in the form of matter but not in its chemical identity.
 - Physical changes are usually reversible.
 - No new compounds are formed during a physical change.
 - Melting ice is an example of a physical change.

Elements, Compounds, and Mixtures (*cont'd*)

- A chemical change, or chemical reaction, is a change in which one or more kinds of matter are transformed into a new kind of matter or several new kinds of matter.
 - Chemical changes are usually irreversible.
 - New compounds are formed during a chemical change.
 - The rusting of iron is an example of a chemical change.

Elements, Compounds, and Mixtures (*cont'd*)

- A physical property is a characteristic that can be observed for material without changing its chemical identity.
- Examples are physical state (solid, liquid, or gas), melting point, and color.
- A chemical property is a characteristic of a material involving its chemical change.
 - A chemical property of iron is its ability to react with oxygen to produce rust.

Elements, Compounds, and Mixtures (cont'd)

- Millions of substances have been characterized by chemists. Of these, a very small number are known as elements, from which all other substances are made.
 - An element is a substance that cannot be decomposed by any chemical reaction into simpler substances.
 - The smallest unit of an element is the atom.

Figure 1.14:
Elements:
sulfur,
arsenic,
iodine,
magnesium,
bismuth,
mercury.
*Photo
courtesy of
American
Color.*



Elements, Compounds, and Mixtures (*cont'd*)

- Most substances are compounds.
 - A compound is a substance composed of two or more elements chemically combined.
 - The smallest unit of a compound is the molecule.
 - The law of definite proportions states that a pure compound, whatever its source, always contains definite or constant proportions of the elements by mass.

Elements, Compounds, and Mixtures (*cont'd*)

- Most of the materials we see around us are mixtures.
 - A mixture is a material that can be separated by physical means into two or more substances
 - Unlike a pure compound, a mixture has variable composition.
 - Mixtures are classified as heterogeneous if they consist of physically distinct parts or homogeneous when the properties are uniform throughout.

A magnet separates the iron filling from the mixture with sand: this physical process is based on difference in physical properties – magnetism of iron is much higher than that of sand.



Measurement and Significant Figures

- Measurement is the comparison of a physical quantity to be measured with a unit of measurement -- that is, with a fixed standard of measurement.
 - The term precision refers to the closeness of the set of values obtained from identical measurements of a quantity.
 - Accuracy is a related term; it refers to the closeness of a single measurements to its true value.

EXERCISE Distinguishing among Elements, Compounds, and Mixtures

“White gold,” used in jewelry, contains two elements, gold and palladium. Two different samples of white gold differ in the relative amounts of gold and palladium that they contain. Both are uniform in composition throughout. Without knowing any more about the materials, use TABLE in HANDOUT (next page) to characterize and classify white gold.

Solution Because the material is uniform throughout, it is homogeneous. Because its composition differs for the two samples, it cannot be a compound. Instead, it must be a homogeneous mixture. Gold and palladium can be said to form a solid solution with one another.

PRACTICE EXERCISE

Aspirin is composed of 60.0% carbon, 4.5% hydrogen, and 35.5% oxygen by mass, regardless of its source. Use TABLE in HANDOUT (next page) to characterize and classify aspirin.

Answer: It is a compound because it has constant composition and can be separated into several elements.

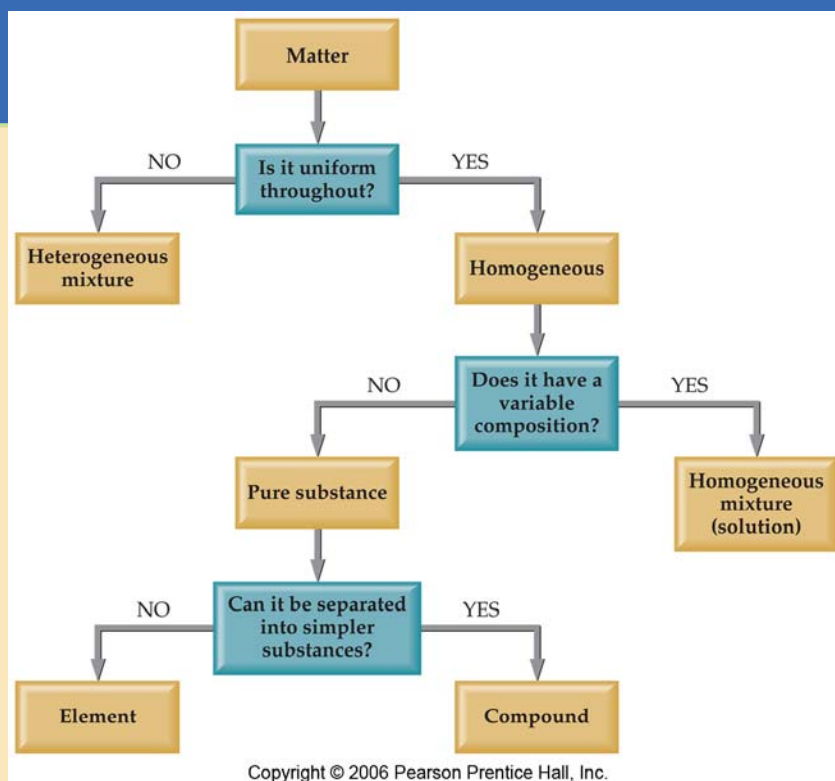
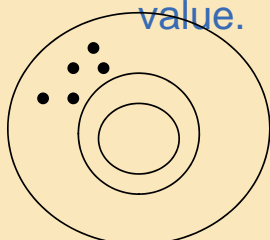


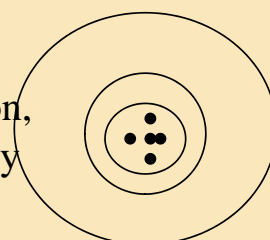
Figure 1.9
Classification of matter. At the chemical level all matter is classified ultimately as either elements or compounds.

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Good precision,
 bad accuracy



Good precision,
 good accuracy

Measurement and Significant Figures (*cont'd*)

- To indicate the precision of a measured number (or result of calculations on measured numbers), we often use the concept of significant figures.
 - Significant figures are those digits in a measured number (or result of the calculation with a measured number) that include all certain digits plus a final one having some uncertainty.

Measurement and Significant Figures (*cont'd*)

- To count the number of significant figures in a measurement, observe the following rules:
 1. All nonzero digits are significant.
 2. Zeros between significant figures are significant.
 3. Zeros preceding the first nonzero digit are not significant.
 4. Zeros to the right of the decimal after a nonzero digit are significant.
 5. Zeros at the end of a nondecimal number may or may not be significant. (Use scientific notation.)

Questions:

1. How many sig. figs are in the expression:

“2.040 g of solid MgO was obtained in combustion”?

Answer: ALL numbers are significant – including “0” in the end – that is 5 sig. figs. Last “0” tells you the precision with which the sample was weighed, i.e. it gives useful information. (Rule 4)

However even if the result was reported as “000002.040 g” – FIRST five zeroes BEFORE the non-zeros would not count – they contain no useful information.

2. A balance has a precision of ± 0.001 g. A sample that has a mass of about 25 g is placed on this balance. How should the weight be reported for this measurement? How many sig. figs can be possibly reported this way?

Answer: the result should look like XX.XXX as in the measurement 24.905 g

How many sig. figs are reported this way? Five. Zero between 9 and 5 counts. (See rule 2)