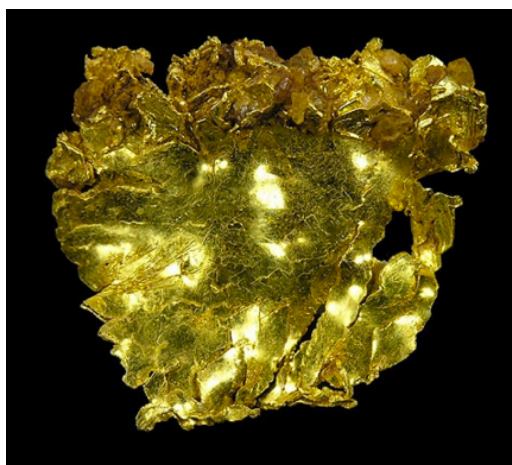


Investigating Physical Properties

Deciding whether a material is a mixture or a pure substance is a typical challenge in the classification of matter. A pure substance is made up of the same material throughout and has the same properties throughout. A diamond is a pure substance; it consists only of carbon. A mixture is made up of different sorts of things. Fruit salad, cake mix, the atmosphere, the ocean, and the sands of the beach are mixtures.

Ores and minerals
extracted from the
earth in mines such as



Pure substances such as gold are
extracted from these ores.

Pure Substance or Mixture?

We can sometimes distinguish a mixture from a pure substance by examining it closely. But the reliability of a visual test depends upon how carefully we look! The beach from a distance looks like single substance—sand. But, as we come nearer, we can see other materials—soft drink bottles, candy wrappers, pieces of driftwood.

If we strain out the garbage from a bucket of sand and then examine a sample with a magnifying glass, we find that even the "pure" sand has grains that are different in color.

In order to classify a portion of matter as either a mixture or a pure substance, chemists must ask themselves two questions: Do all the samples of the material have certain properties that are unchanging? Or can the material be separated into two or more different substances by a simple means?

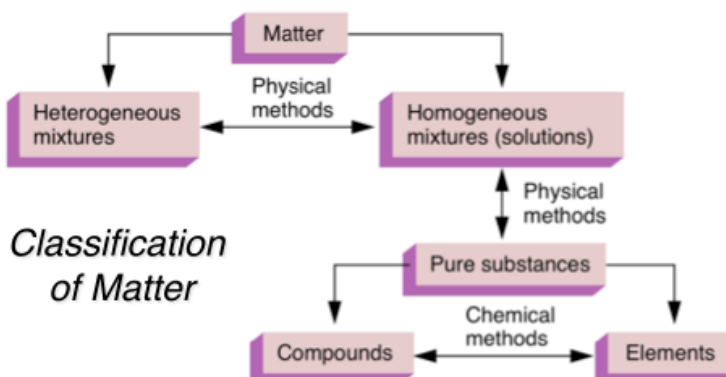


Pismo Beach Sand,
California

There are two kinds of pure substances: elements and compounds. An *element* (carbon, for example) is a type of matter that cannot be decomposed or broken down into simpler materials by an ordinary chemical method. A *compound* (water, for example) is a substance consisting of two or more elements in combination. A compound can be decomposed, or broken down into its individual elements.



A *mixture* is a combination of two or more pure substances that retain their separate identities and properties in the mixture. For example, beach sand or a salad dressing consisting of oil and vinegar are mixtures. You have a mixture when you pour milk over your breakfast cereal. You can easily separate the cereal from the milk. (In fact, the milk and cereal can each be separated into simpler materials; they must be mixtures also.)



A convenient way to express the actual composition of a mixture is to report the mass percent (%) of each component. To consider a general case, assume that you have a mixture that includes a certain material, unknown material A. The mass percent of A in the mixture can be found by completing this calculation:

$$\text{Mass percent (\%) A} = \frac{\text{Mass of A}}{\text{Total Mass of mixture}} \times 100$$

For example, consider a solid white mixture, which is made up of 25.0 g of salt (sodium chloride) and 37.0 g of sugar (sucrose). What is the mass percent of salt and the mass percent of sugar in this mixture?

Since the total mass of this mixture equals 62.0 g (25.0 g + 37.0 g), the mass percentages are easily calculated:

$$\text{Mass percent (\%) salt} = \frac{25.0 \text{ g Salt}}{62.0 \text{ g Mixture}} \times 100 = 40.3\%$$

The sum of all mass percentages for all components in a mixture must equal 100% (40.3% + 59.7% = 100.0%)—the whole equals the sum of its parts!

If the calculations just shown are completed with an electronic calculator, the mass percent of salt is displayed as 40.32258065, and the mass percent of sugar appears to be 59.67741935. Unfortunately, calculators are capable of generating more digits than are justified by the measured data. We *round off* our calculated answers to express only the *significant digits* or *significant figures*; in the sample calculations the results are correctly expressed to three significant figures because the measured masses are known to three significant figures.

Problems:

1. A mixture of sand and sawdust contains 124 g of sand and 305 g of sawdust. Find the mass percent of each component in this mixture.
2. A 5.00-kg package of grass seed is composed of three types of grass seed—Kentucky bluegrass, red fescue, and colonial bent grass. Find the mass percent of all three types of grass seed in the mixture, if the package contains 2.80 kg of red fescue and 1.20 kg of colonial bent grass. (Hint: What mass of Kentucky bluegrass must be present?)
3. Grain alcohol is normally 95 percent alcohol by mass. How many grams of alcohol are there in 2 kg of grain alcohol?