Describing Matter

Why do all samples of a substance have the same intensive properties?

Understanding matter begins with observation, and what you observe when you look at a particular sample of matter is its properties. Is a solid shiny or dull? Does a liquid flow quickly or slowly? Is a gas odorless, or does it have a smell? Properties used to describe matter can be classified as extensive or intensive properties.

Extensive Properties Recall that matter is anything that has mass and takes up space. The **mass** of an object is a measure of the amount of matter the object contains. The mass of the basketball in Figure 2.1 is greater than the mass of the golf ball. There is also a difference in the volume of the balls. The **volume** of an object is a measure of the space occupied by the object. The volume of the basketball is greater than the volume of the golf ball. Mass and volume are both examples of extensive properties. An **extensive property** is a property that depends on the amount of matter in a sample.

Intensive Properties Basketballs may appear to be all the same. But, there are properties to consider when selecting a basketball besides mass and volume. The outer covering may be made of leather, rubber, or a synthetic composite. Each of these materials has different properties which make the basketballs suitable for different playing situations. For example, leather balls are suitable for indoor play but not outdoor play. Leather balls absorb water and dirt more than rubber balls. Absorbancy is an example of an intensive property. An **intensive property** is a property that depends on the type of matter in a sample, not the amount of matter.

Figure 2.1 Extensive Properties Golf balls and basketballs have different masses and different volumes.

Identifying a Substance Each object in Figure 2.2 has a different chemical makeup, or composition. The soda can is mainly aluminum. The watering can is mainly copper. Matter that has a uniform and definite composition is called a **substance.** Aluminum and copper are examples of substances, which are also referred to as *pure substances.* **Every sample of a given substance has identical intensive properties because every sample has the same composition.**

Aluminum and copper have some properties in common, but there are differences besides their distinctive colors. Aluminum is highly reflective and is often used in silver paints. Pure copper can scratch the surface of pure aluminum because copper is harder than aluminum. Copper is better than aluminum as a conductor of heat or electric current. Copper and aluminum are both malleable, which means they can be hammered into sheets without breaking. Hardness, color, conductivity, and malleability are examples of physical properties. A **physical property** is a quality or condition of a substance that can be observed or measured without changing the substance's composition.

Table 2.1 lists physical properties for some substances. The states of the substances are given at room temperature. (Although scientists use room temperature to refer to a range of temperatures, in this book it will be used to refer to a specific temperature, 20°C.) Physical properties can help chemists identify substances. For example, a colorless substance that was found to boil at 100°C and melt at 0°C would likely be water. A colorless substance that boiled at 78°C and melted at −117°C would definitely not be water. Based on Table 2.1, it would likely be ethanol.

Figure 2.2 Aluminum and Copper
This soda can is made almost entirely of a thin sheet of aluminum. The watering can is made of copper, which has been hammered to give its textured appearance.
Analyze Data ***Which of the properties listed in Table 2.1 could not be used to distinguish copper from aluminum?***

CHEMISTRY & YOU

Q: *Glass is often used to make windows, while copper is often used in electrical wires. What properties of glass make it a desirable material to use for windows?*

Table 2.1

Physical Properties of Some Substances

Substance	State	Color	Melting point (°C)	Boiling point (°C)
Neon	Gas	Colorless	−249	−246
Oxygen	Gas	Colorless	−218	−183
Chlorine	Gas	Greenish-yellow	−101	−34
Ethanol	Liquid	Colorless	−117	78
Mercury	Liquid	Silvery-white	−39	357
Bromine	Liquid	Reddish-brown	−7	59
Water	Liquid	Colorless	0	100
Sulfur	Solid	Yellow	115	445
Aluminum	Solid	Silver	660	2519
Sodium chloride	Solid	White	801	1413
Gold	Solid	Yellow	1064	2856
Copper	Solid	Reddish-yellow	1084	2562

Source: Pearson Chemistry, pages 34-35.