Lec. 1

General Chemistry

Chemistry is the study of matter, its chemical and physical properties, the chemical and physical changes it undergoes, and the energy changes that accompany those processes.

Matter is anything that has mass and occupies space. The changes that matter undergoes always involve either gain or loss of energy.

Energy is the ability to do work to accomplish some change. The study of chemistry involves matter, energy, and their interrelationship. Matter and energy are at the heart of chemistry.

Major Areas of Chemistry

Chemistry is a broad area of study covering everything from the basic parts of an atom to interactions between huge biological molecules. Because of this, chemistry encompasses the following specialties.

Biochemistry is the study of life at the molecular level and the processes associated with life, such as reproduction, growth, and respiration.

Organic chemistry is the study of matter that is composed principally of carbon and hydrogen. Organic chemists study methods of preparing such diverse substances as plastics, drugs, solvents, and a host of industrial chemicals.

Inorganic chemistry is the study of matter that consists of all of the elements other than carbon and hydrogen and their combinations. It is responsible for the development of unique substances such as semiconductors and high-temperature ceramics for industrial use.

Analytical chemistry involves the analysis of matter to determine its

composition and the quantity of each kind of matter that is present. Analytical chemists detect traces of toxic chemicals in water and air. They also develop methods to analyze human body fluids for drugs, poisons, and levels of medication.

Physical chemistry is a discipline that attempts to explain the way in which matter behaves. Physical chemists develop theoretical concepts and try to prove them experimentally. This helps us understand how chemical systems behaved.

Experimental Quantities

The quantities that are most often determined include mass, length, volume, time, temperature, and energy:

Mass

Mass describes the quantity of matter in an object. The terms *weight* and *mass*, in common usage, are often considered synonymous. They are not, in fact. Weight is the force of gravity on an object:

Weight = mass ×acceleration due to gravity

The common conversion units for mass are as follows:

1 gram (g) = 10^{-3} kilogram (kg) = $\frac{1}{454}$ pound (lb)

In chemistry, when we talk about incredibly small bits of matter such as individual atoms or molecules, units such as grams and even micrograms are much too large. Similarly, an atom of a substance such as hydrogen is very tiny. Its mass is only 1.661×10^{-24} gram.

Length

The standard metric unit of length, the distance between two points, is the meter. Large distances are measured in kilometers; smaller distances are measured in millimeters or centimeters. Very small distances such as the distances between atoms on a surface are measured in nanometers (nm):

1 nm = 10^{-7} cm = 10^{-9} m

Common conversions for length are as follows:

1 meter (m) = 10^{2} centimeters (cm) = 3.94 X 10^{1} inch (in)

Volume

The standard metric unit of volume, the space occupied by an object, is the liter. A liter is the volume occupied by 1000 grams of water at 4 degrees Celsius (°C). The volume, 1 liter, also corresponds to:

1 liter (L) = 10^{3} milliliters (ml) .The relationship between the liter and the milliliter is shown in Figure 2.

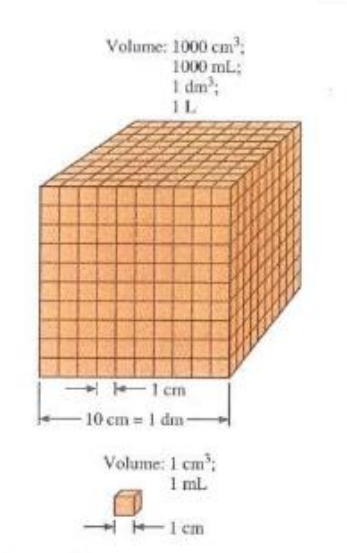
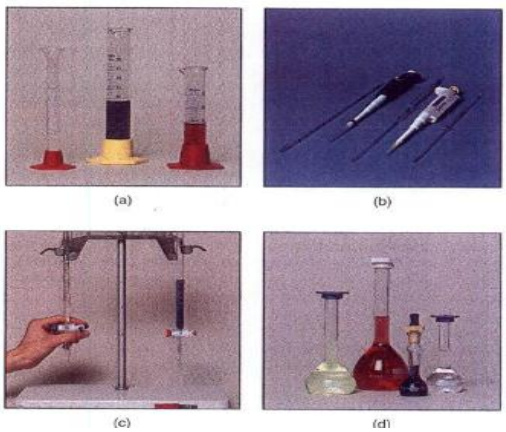


Figure 2 The relationship among various volum units

Typical laboratory glassware used for volume measurement is shown in Figure 3. The volumetric flask is designed to contain a specified volume, and the graduated cylinder, pipet, and burette dispense a desired volume of liquid.



Time

In fact, matter may be characterized by measuring the time required for a certain process to occur. The rate of a chemical reaction is a measure of change as a function of time.

Temperature

Temperature is the measure of the amount of heat in the object.

Many substances, such as mercury, expand as their temperature increases, and this expansion provides us with a way to measure temperature and temperature changes.

Three common temperature scales are Fahrenheit (°F), Celsius (°C), and Kelvin (K). Zero C = 273 K = 32 F freezing point of water.

100 C = 373 K = 212 F Boiling point of water.

It is often necessary to convert a temperature reading from one scale to another. To convert from Fahrenheit to Celsius, we use the following formula

$$C^{o} = \frac{^{\circ}F-32}{1.8}$$

Energy

Energy, the ability to do work, may be categorized as either kinetic energy, the energy of motion, or potential energy, the energy of position.

Kinetic energy may be considered as energy in process; potential energy is stored energy. All energy is either kinetic or potential.

- All chemical reactions involve either a "gain" or a "loss" of energy.

Energy absorbed or liberated in chemical reactions is usually in the form of heat energy. Heat energy may be represented in units of calories or joules, their relationship being

1 calorie (cal) = 4.18 joules (J)

One calorie is defined as the amount of heat energy required to increase the temperature of 1 gram of water 1°C.

Concentration

Concentration is a measure of the number of particles of a substance, or the mass of those particles, that are contained in a specified volume. Concentration is a widely used way of representing mixtures of different substances

We will describe many situations in which concentration is used to predict useful information about chemical reactions.

Density and Specific Gravity

Both mass and volume are a function of the amount of material present. Density, the ratio of mass to volume,

$$d = \frac{mass}{volume} = \frac{m}{V}$$

In density calculations the mass is usually represented in grams, and volume is given in either milliliters (ml) or cubic centimeters (cm^3 or cc):

1 ml = 1 cm^3 = 1 cc

The unit of density would therefore be g/ml, g/cm^3, or g/cc.

Density is called the specific gravity, the ratio of the density of the object in question to the density of pure water at 4 Cº.

$$\text{Specific gravity} = \frac{\text{Density of object (g/ml)}}{\text{Density of water (g/ml)}}$$