



Keys to the Study of Chemistry

- **Chemistry** is the study of matter, its properties, changes, and the energy associated with these changes
- **Matter** is everything that has mass and occupies space
 - **Pure substances**
 - **Mixtures**

1.1 Fundamental Definitions

- **Changes of matter**
 - **Physical** – changes in the physical form of matter, but not in its chemical identity (e.g., boiling, melting, mixing, diluting, ...)
 - **Chemical** – changes in the chemical identity of matter (e.g., chemical reactions such as rusting of Fe, burning of gasoline, digestion of food, ...)

- **Properties of matter**
 - **Physical** – characteristics of matter that can be observed without changing its chemical identity (e.g., mass, density, color, physical state, ...)
 - **Chemical** – characteristics of matter related to its chemical change (e.g., hydrogen is a flammable gas that burns in the presence of O₂ to produce H₂O)
- A substance is identified by its own set of physical and chemical properties

- **Physical states of matter**

- **Solid** – a rigid form of matter with definite volume and shape
- **Liquid** – a fluid form of matter with definite volume but not shape
- **Gas** – a fluid form of matter with no definite volume or shape (no surface)
- In general, changes in the physical state are reversible and can be achieved by changing temperature and pressure

- **Macroscopic and microscopic properties and events**

- **Macroscopic** – observable properties and events of large visible objects
- **Microscopic** – result from changes at a much smaller (atomic) level not visible by the naked eye
- Macroscopic properties and events occur as a result of microscopic properties and events

Examples:

- Define the following as physical or chemical properties or changes:
 - A stove becomes red-hot
 - The leaves of a tree turn yellow
 - Lead is a dense metal
 - Acetone is quite volatile (easily vaporized)
 - Iron rusts when exposed to air
 - Gasoline is flammable

- **Energy** – the ability to do work

- **Potential energy** – due to position or interaction
- **Kinetic energy** – due to motion
- **Total energy** – sum of potential and kinetic energy
- **Law of conservation of energy** – the total energy of an isolated object (or a system of objects) is constant
 - Energy is neither created nor destroyed – it is only converted from one form to another

Conservation of Energy

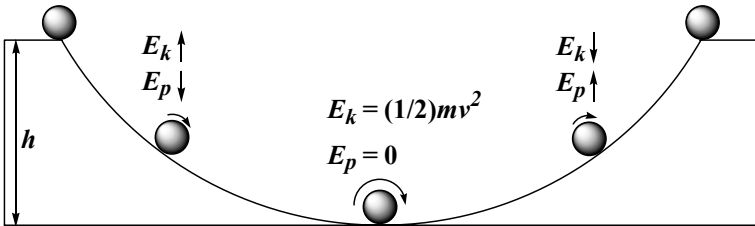
$$E_{tot} = E_k + E_p = \text{constant}$$

$$E_k = 0$$

$$E_p = mgh$$

$$E_k = 0$$

$$E_p = mgh$$



Note: The friction is neglected.

A A gravitational system. The potential energy gained when a weight is lifted is converted to kinetic energy as the weight falls.

B A system of two balls attached by a spring. The potential energy gained when the spring is stretched is converted to the kinetic energy of the moving balls when it is released.

C A system of oppositely charged particles. The potential energy gained when the charges are separated is converted to kinetic energy as the attraction pulls them together.

D A system of fuel and exhaust. A fuel is higher in chemical potential energy than the exhaust. As the fuel burns, some of its potential energy is converted to the kinetic energy of the moving car.