Module 1: Foundations
Physical and Chemical Properties

Fundamentals of Chemistry Open Course

Learning Objectives | Module 1

1. Extract useful quantitative information from problems; generate a list of known and unknown quantities from the text of a problem.
2. Solve equations for a single unknown variable using standard algebraic operations.
3. Draw and interpret graphs relating physical variables with relevance to chemistry.
4. Recognize the essential components of a measurement.
5. Apply dimensional analysis with knowns and unknowns to solve equations involving measured quantities.
6. Calculate measures of accuracy and precision to assess the quality of a set of measurements.
7. Express quantities calculated from measurements at the appropriate level of precision by applying the rules for significant digits.
8. Recognize and distinguish between physical and chemical properties.
9. Classify different types of matter as pure substances or mixtures; compare and contrast homogeneous and heterogeneous mixtures.
10. Describe and apply the scientific method.

Properties of Matter

- **Properties** are characteristics by which we can identify or describe a substance.
  - Examples: color, odor, state of matter, temperature of a phase transition, chemical reactivity, etc.

- **Physical properties** involve processes or characteristics that do not affect the chemical identity of the substance.
  - Examples: color, odor, density, melting point, state of matter, viscosity, etc.

- **Chemical properties** involve processes or characteristics associated with a chemical change.
  - Examples: flammability, acidity, toxicity, corrosiveness, etc.

- **Extensive properties** have values that depend on the quantity of the sample
  - Examples: mass, volume, number of moles, etc.

- **Intensive properties** have the same value regardless of the quantity of the sample
  - Examples: boiling point, density, [anything] per gram, [anything] per mole, etc.

- **Physical changes** alter the state or appearance of matter but do not affect its chemical composition.

Melting wax (a) and condensing water (b) are physical changes.

(a)

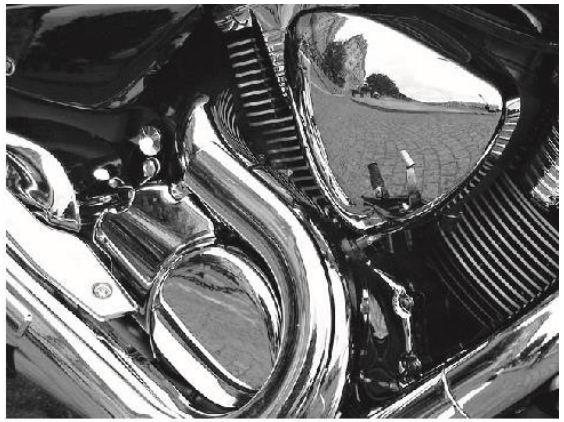
(b)

Figure 1.18
(OpenStax Chemistry 2e)

- **Chemical changes (chemical reactions)** alter the chemical structure of a substance by breaking and/or forming chemical bonds.

Reaction of iron with oxygen (a) is a chemical change; chromium does not react with oxygen (b).

(a)



(b)

Figure 1.19
(OpenStax Chemistry 2e)

- Physical and chemical changes may *both* occur during a process.
  - When we fry an egg, a solid-to-liquid phase transition is observed (physical change) along with browning (chemical change).

- The distinction between physical and chemical change is sometimes murky.
  - Is dissolution and dissociation of an ionic salt in water a physical or chemical change?

$$\mathbf{NaCl(s) \rightarrow Na^{+}(aq) + Cl^{-}(aq)}$$

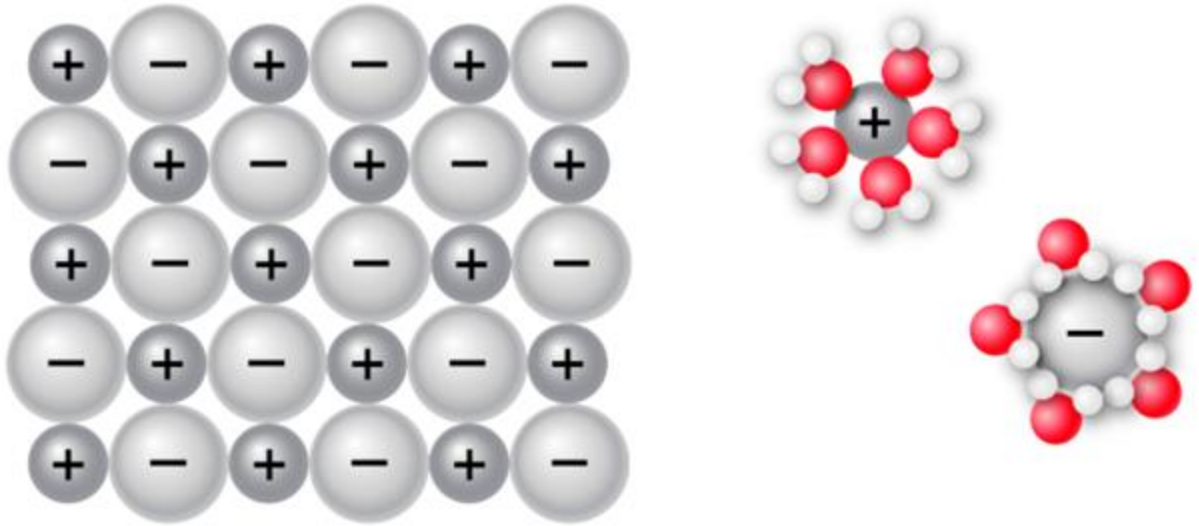


Figure. Sodium (+) and chloride (–) ions are surrounded by water molecules when sodium chloride is dissolved in water. The surrounded ions are said to be **hydrated**.