



CHE1031 Module 1: Essential Knowledge Summary¹

1.1: Chemistry in context

Chemistry deals with the composition, structure, and properties of matter, and the ways by which various forms of matter may be interconverted. Thus, it occupies a central place in the study and practice of science and technology. Chemists use the **scientific method** to perform **experiments**, pose **hypotheses**, and formulate **laws** and develop **theories**, so that they can better understand the behavior of the natural world. To do so, they operate in the **macroscopic**, **microscopic**, and **symbolic** domains. Chemists measure, analyze, purify, and synthesize a wide variety of substances that are important to our lives.

1.2: Phases and classification of matter

Matter is anything that occupies space and has mass. The basic building block of matter is the **atom**, the smallest unit of an element that can enter into combinations with atoms of the same or other elements. In many substances, atoms are combined into **molecules**. On earth, matter commonly exists in three states: **solids**, of fixed shape and volume; **liquids**, of variable shape but fixed volume; and **gases**, of variable shape and volume. Under high-temperature conditions, matter also can exist as **plasma**. Most matter is a **mixture**: It is composed of two or more types of matter that can be present in varying amounts and can be separated by physical means. **Heterogeneous** mixtures vary in composition from point to point; **homogeneous** mixtures have the same composition from point to point. **Pure substances** consist of only one type of matter. A pure substance can be an **element**, which consists of only one type of atom and cannot be broken down by a chemical change, or a **compound**, which consists of two or more types of atoms.

1.3: Physical and chemical properties

All substances have distinct **physical and chemical properties**, and may undergo physical or chemical changes. **Physical properties**, such as hardness and boiling point, and physical changes, such as melting or freezing, do not involve a change in the composition of matter. **Chemical properties**, such as flammability and acidity, and chemical changes, such as rusting, involve production of matter that differs from that present beforehand. Measurable properties fall into one of two categories. **Extensive properties** depend on the amount of matter present, for example, the mass of gold. **Intensive properties** do not depend on the amount of matter present, for example, the density of gold. Heat is an example of an extensive property, and temperature is an example of an intensive property.

1.4: Measurements

Measurements provide quantitative information that is critical in studying and practicing chemistry. Each measurement has an **amount**, a **unit** for comparison, and an **uncertainty**. Measurements can be represented in either decimal or **scientific notation**. Scientists primarily use the SI (International System) or **metric systems**. We use base SI units such as meters, seconds, and kilograms, as well as derived units, such as liters (for volume) and g/cm³ (for

¹ Flowers et al., (2017) [Chemistry](#), OpenStax



density). In many cases, we find it convenient to use **unit prefixes** that yield fractional and multiple units, such as microseconds (10^{-6} seconds) and megahertz (10^6 hertz), respectively.

1.5: Measurement uncertainty, accuracy, and precision

Quantities can be **exact** or **measured**. Measured quantities have an associated uncertainty that is represented by the number of **significant figures** in the measurement. The **uncertainty** of a calculated value depends on the uncertainties in the values used in the calculation and is reflected in how the value is rounded. Measured values can be **accurate** (close to the true value) and/or **precise** (showing little variation when measured repeatedly).

1.6: Mathematical Treatment of Measurement Results

Measurements are made using a variety of units. It is often useful or necessary to convert a measured quantity from one unit into another. These **conversions** are accomplished using unit **conversion factors**, which are derived by simple applications of a mathematical approach called the factor-label method or **dimensional analysis**. This strategy is also employed to calculate sought quantities using measured quantities and appropriate mathematical relations.