1.S: Measurements and Atomic Structure (Summary)

- Matter is defined as any substance that has mass. Matter is composed of atoms. that are constructed primarily from neutrons, protons and electrons. Neutrons have no charge, protons, carry a positive charge, and electrons, have a negative charge.
- The mass of atoms and subatomic particles is measured using atomic mass units (abbreviated amu); protons and neutrons have a mass of one amu, and the mass of an electron is negligible.
- The neutron and the proton are in the center of the atom in the nucleus. Virtually all of the mass of the atom resides in the nucleus. Electrons are placed in a diffuse cloud surrounding the nucleus.
- The electron cloud carries a net negative charge and in a neutral atom there are always as many electrons in this cloud as there are protons in the nucleus.
- The identity of an atom is defined by the number of protons in its nucleus; each unique type of atom is called an element. Elements with the same number of protons, but differing numbers of neutrons in their nucleus are called isotopes. The atomic mass of an element is the weighted average of the masses each of these isotopes.
- Each element is referred to using its chemical symbol, which is an abbreviation of its name (many symbols are based on Latin or Greek names).
- The atomic symbol for an element consists of the chemical symbol with the atomic number for the element as a subscript, preceding the chemical symbol, and directly above this, a superscript showing the mass number for the particular isotope of the element.
- The average atomic mass for an element can be calculated as the sum of the fraction of each isotope within the natural abundance, multiplied by the mass number of that isotope; or, average atomic mass = $f_1M_1 + f_2M_2 + f_3M_3 \ldots$
- The number of protons in the nucleus of an element is called the atomic number of that element. Elements are typically arranged in order of increasing atomic numbers in the periodic table. In the periodic table, horizontal rows are called periods and vertical columns are called groups.
- Typically in the sciences, very large or very small numbers are shown using scientific notation (exponential notation) where a number n is shown as the product of that number and 10, raised to some exponent x; that is, $(n \times 10^x)$.
- In the SI (or metric) system, the unit for distance is the meter (m), kilogram (kg) is used for mass and second (s) for time. The volume of a substance is a derived unit based on the meter, and a cubic meter (m^3) is defined as the volume of a cube that is exactly 1 meter on all edges. Typically, in the laboratory, mass is expressed in grams (g) ($^1/_{1000}$ of a kilogram) and the cubic centimeter (cc) is to describe volume. A cubic centimeter is a cube that is $^1/_{100}$ meter on each edge. For liquids and gasses, volume is usually described using the liter, where a liter (L) is defined as 1000 cubic centimeters.
- SI base units are typically represented using the abbreviation for the unit itself, preceded by a metric prefix, where the metric prefix represents the power of 10 that the base unit is multiplied by.
- When converting between metric units, a simple algorithm involves taking a given measurement and multiplying it by a known proportion or ratio to give a result having the metric unit, or dimension, that you were trying to find.
- In a measurement in science, the last digit that is reported is estimated, and this digit is called the least significant digit; this, along with the total number of exact digits plus the estimated digit is called the number of significant figures in the measurement. When identifying the number of significant figures in a measurement, all leading zeros are excluded. Zeros that are surrounded by non-zero digits are included, and, for numbers with a decimal point, trailing zeros are also included. If a number does not have a decimal point, trailing zeros are not included. A number written in scientific notation includes all significant digits in n; $(n \times 10^x)$.
- According to the quantum model of the atom, electrons reside in seven different quantum levels, denoted by the principal quantum number n, where n has a value of one to seven, corresponding to the seven rows in the periodic table. The first row (n = 1) can accommodate two electrons; the second row (n = 2) can accommodate eight electrons; the third row (n = 3), eighteen, up to a maximum of $2n^2$ for the known elements.
- Quantum theory also tells us that the electrons in a given energy level reside within sublevels (or subshells). The sublevels for any given level are identified by the letters, s, p, d and f and the quantum number for the level, written as $1s^2\ 2s^2\ 2p^5$, etc. Each of the sublevels is also associated with an orbital, where an orbital is simply a region of space where the electron is likely to be found.
- When adding electrons to sublevels, Hund's rules state that every orbital in a subshell is singly occupied with one electron before any one orbital is doubly occupied, and all electrons in singly occupied orbitals have the same spin (shown using "up and down" arrows). Electrons are added in order of increasing energy of the sublevel, not necessarily in numeric order.