Chapter One – Sections 1.0 through 1.6

What is chemistry? The study of matter.

What is matter? Anything that has mass and volume.

What are the states of matter? Sold, liquid and gas.

Basic premise: all matter consists of submicroscopic particles called atoms.

What is an atom? The smallest and simplest form of a chemical element.

What is a chemical element? A fundamental substance that can not be broken down chemically into a simpler substance.

How many elements are there? About 110 known, 92 are naturally-occurring. The elements are universal. The multiverse includes the same elements found on earth. The most abundant element in the multiverse is hydrogen. The most abundant element on earth is also hydrogen. The most abundant in terms of mass is oxygen. An oxygen atom is 8x heavier than a hydrogen atom.

Where does one find a table of the elements? The Periodic Table. The elements are arranged according to families of elements that have similar chemical properties. Each element has a symbol, an atomic number and an atomic mass.

Types of elements: metals, nonmetals and metalloids. States of matter: solids, liquids and gases.

We will toggle between two worlds: the first is the macro world, things we can see and touch or, in the case of air, things we can transform by physical means into things we can see and touch. The other is the submicroscopic world of atoms waves, things that are invisible to the naked eye. The macro world consists of large collections of atoms. The study of macro world has allowed the chemist to infer the existence of the unseen particles of the submicroscopic world.

What are the properties of matter? It depends. Chemists early on figured out that it doesn't make sense to study the properties of anything but pure substances.

What is a pure substance? It is a substance that consists of one and only one type of chemical. A pure substance as opposed to a mixture. Pure substances have uniform chemical and physical properties. Mixtures have variable chemical and physical properties, depending on the composition of the mixture.

Examples: Iron is a pure substance. Water is a pure substance that consists of two atoms of hydrogen and one atom of oxygen. Aluminum is a pure substance. Common table salt, sodium chloride, is a pure substance. And even most things we think of as pure substances are not quite pure because of trace impurities. Drinking water, for example. But most common things are mixtures: Air, beer, wood, plastics, dirt, dishes, silverware, ocean water, the list goes on and on.

In principle, mixtures may be separated into their components or constituents by physical means. For example, drinking water can be converted to pure water by distillation or reverse osmosis. Many mixtures are not separable in this way. Wood, for example, is an example of a heterogeneous mixture. Salt water, on the other hand, is an example of a homogeneous mixture, separable into its pure components by boiling off and collection the water and leaving the salt behind.

How is matter classified? See Figure 1.3 in the text. Matter = mixtures or pure substances. Mixtures are homogeneous or heterogeneous. Pure substances exist as chemical compounds or as elements or as both. Chemical compounds exist as molecular compounds or as ionic compounds.

What is meant by ‘chemical change’? What is the difference between chemical change and physical change? Examples: chemical change: carbon dioxide and water react under the conditions of photosynthesis to make glucose, a sugar. Physical change: Water evaporates; lead melts; cookies crumble.

Iron rusts. Milk goes sour. An egg is fried. A candle burns. Lemonade is made: lemon juice, sugar, water. Beer is made by fermentation. Vodka is made by distillation. Drinking water is sterilized by chlorination. A pear ripens. A muscle tenses. Dust settles. Niagara Falls generates electricity. Food is digested. A golf ball rolls down an incline. TNT explodes. The sun shines. A tree takes in water through its roots. An earthquake occurs. A glass falls on the floor and breaks.

Preview of the submicroscopic world: molecules, atoms, ions. More fundamental particles: proton, electron, neutron, photon.

The two critical characteristics of the fundamental particles are CHARGE and MASS.

Particle	**Charge**	**Mass (amu)**
Proton	+1	1
Neutron	0	1
Electron	-1	0.0005 (very small)
Photon	0	0 (rest mass)

(There is also a particle with charge +1 and mass ‘very small’ called a *positron*. We will meet it in Chapter 11).

Atoms consist of a nucleus (protons and neutrons) surrounded by electrons. Chemistry mostly involves interactions of the electrons. The exception is nuclear chemistry (chapter 11). The behavior of the electron is governed by very strict rules. These rules fall within the realm of quantum chemistry and we say that the energies of electrons are quantized. More about that later.

The electron behaves more like a wave than a particle. In fact we may think of matter in general as having a dual wave-particle character. And the photon, a particle of electromagnetic energy, is a wave traveling at the speed of light. Wave, particle, particle, wave, what’s the difference? Google it!

So you, the student, may or may not be just a collection of waves. But one thing is for sure: as counterintuitive as it may seem, you are mostly empty space.