# 1.1: Prelude to Chemistry

The explosive decomposition of nitrogen triiodide shown in the video is an exciting (and forceful) example of chemistry in action. For many of us, this explosion is the work of *chemists* who work magic at the lab bench. In reality, chemistry is much broader. The transformations of matter can be as fast and explosive as the video shows, or involve the slow decay of living organisms into fossil fuels. The compounds around us in everyday life have many properties that would have been conceived as *magic* only a few centuries ago. Could you imagine describing to previous generations neon signs or electricity from batteries? Could you imagine what they would say seeing the decomposition of nitrogen triiodide?

*Nitrogen Triiodide is a contact explosive. Here I have some on five filter papers stacked on a ring stand and the original filter paper is just off to the left of the screen (if you watch when it detonates you can see a secondary purple cloud from the left).*

The science of chemistry is concerned with the composition, properties, and structure of matter and with the ways in which substances can change from one form to another. Since anything that has mass and occupies space can be classified as matter, this means that chemistry is involved with almost everything in the universe. But this definition is too broad to be useful. Chemistry isn't the only science that deals with the composition and transformations of matter. Some matter is composed of cells, which transform by meiosis and other processes that biologists study. Matter is also composed of subatomic particles called leptons, which transform by processes like annihilation studied by physicists. Chemists are unique because they understand or explain everything, from our bodies to our universe, in terms of the properties of just over 100 kinds of atoms found in all matter and the amazing variety of molecules and other atomic-scale structures that are created by forming and breaking bonds between atoms. In the video explosion, bonds break in nitrogen triiodide ($NI_3$) molecules and the atoms recombine to form nitrogen ($N_2$) and iodine ($I_2$). ***So chemistry is defined by its approach, not its subject matter***. Chemistry explains or understands any subject in terms of the properties of atoms and molecules. Chemistry, in other words, is not just something that happens in laboratories. It is a unique perspective, or way of understanding, all that is around us, and even inside us. Chemistry is going on in places as diverse as the smallest bacterium, a field of ripening wheat, a modem manufacturing plant, the biospheres of planets such as Earth, the vast reaches of interstellar space, and even your eyes and brain as you read these words.

ChemPRIME recognizes that the chemical perspective can add to our understanding of anything that catches our interest. Our goal will be to add another dimension--understanding in terms of the properties of atoms and molecules and how they interact--to many subjects, thereby making it clear how the study of chemistry is of importance to a wide variety of people. Biologists, for example, have examined smaller and smaller organisms, cells, and cell components, until, in the study of viruses and genes, they joined forces with chemists who were interested in larger and larger molecules. The result was a new inter-disciplinary field called molecular biology, and a reinforcement of the idea that living organisms are complicated, highly organized chemical systems. Chemists interact in similar ways with scientists in areas such as chemical physics, geochemistry, pharmacology, toxicology, ecology, meteorology, oceanography, and many others. Current practice in these fields is such that a person lacking basic chemical knowledge is at a severe disadvantage, because the perspective of the molecular level has become so important.

Chemistry also underlies a great deal of modern technology. The manufacture of such basic commodities as steel, aluminum, glass, plastics, paper, textiles, and gasoline all involve chemists and chemistry. Without the abundant cheap supply of these and other substances that chemistry has helped to produce, our lives would be much less comfortable. However, as we are now beginning to discover, callous and indiscriminate use of technology can produce disadvantages as well as benefits. Automobiles, power plants, and industrial processes spew into the air harmful substances that are not always easy or cheap to eliminate. Rivers and lakes are also more easily contaminated than we once thought - substances once believed harmless now have proven to be the opposite.

Issues involving the effects of technology on the environment affect everyone - not just scientists. Decisions about them are political, at least in part, and require some chemical knowledge on the part of voters as well as their elected representatives. At the very least, a citizen needs to be able to distinguish valid and invalid arguments put forward by scientific “experts” regarding such issues. (In some cases such “expertise” may be mainly a willingness to speak out rather than a command of the scientific and political issues.) It is to be hoped also that more persons will follow the example of Russell Peterson, formerly a researcher in a large chemical company, who served as Governor of Delaware and Chairman of the President’s Council on Environmental Quality. Only by a combination of scientists willing to leave their laboratories and citizens willing to master some of the basics of science can intelligent political decisions be made in a democratic society. Indeed, such a combination may be a necessity if democracy is not to degenerate into an oligarchy ruled by those who control the experts.

Given the universality of chemistry, its central role among the sciences, and its importance in modern life, how is it possible to learn much about it in a short time? If everything has a chemical aspect, because atoms and molecules can aid in understanding everything, is the field of chemistry so broad and all-encompassing that one cannot master enough to make its study worth-while? We think the answer to this second question is a resounding no! This entire book has been designed to help you learn a good deal of chemistry in a short time. If it is successful, the first question will have been answered as well.

An important and valuable technique of science and scientists is that of subdividing large, seemingly unsolvable problems into smaller, simpler parts. If the latter are chosen carefully, each can be mastered. Individual small advances can then be combined to yield an important, more complicated result. Thus chemists have not acted on the assumption that because all the world may be understood in terms of chemicals and chemistry, they should try to study it all at once. Rather, many chemists do much of their work under controlled, laboratory conditions, advancing in small steps toward more general, useful, and exciting results.

Since people’s process of studying and understanding chemistry is far from complete, we can narrow our area of interest considerably by redefining chemistry as those things that chemists can explain on the molecular level, or are attempting to explain in terms of atoms and molecules and their properties. This more restricted view constitutes the main theme of this book. We hope that when you have finished with it, you will have a solid background in the facts, laws, and theories of chemistry, as well as those modes of behavior and thinking that chemists have found useful in solving the problems they have faced.