



FOUNTAIN OF KNOWLEDGE SCHOOL
2013 E.C (2020/21) ACADEMIC YEAR
FIRST SEMESTER
1ST QUARTER
CHEMISTRY GRADE 9 NOTE 1

INTRODUCTION

What is chemistry?

Chemistry is the science which studies the composition, structure, properties and reactions of matter, especially of atomic and molecular systems.

The key concept in chemistry is that all matter is composed of very small particles called atoms. We look at atomic theory, discuss atomic structure, and finally describe the electronic configuration of elements.

HISTORICAL DEVELOPMENT OF ATOMIC NATURE OF SUBSTANCES

The study of chemistry begun about 2000 years ago. Greek philosophers developed a theory of matter that was not based on the evidence that had been previously collected through experimentation.

A philosopher named Democritus was the first to state the theory that all matter was composed of tiny indivisible particles and his reasoning went something like this: If you cut a piece of, say, copper smaller and smaller, you must eventually reach a particle of copper so small that it can no longer be cut. Therefore, matter is ultimately composed of indivisible particles, with nothing between them but empty space. He suggested that all matter is composed of tiny, discrete, indivisible particles that he called atoms (Greek atomos, “uncuttable”).

His ideas, based entirely on philosophical speculation rather than experimental evidence, were rejected for 2000 years.

Democritus believed that atoms could not be created, destroyed, or further divided. However, after a certain period of time, Democritus ideas met criticism from other philosophers. Some of their challenges were “what holds the atoms together?” and “how do atoms move through space?”. Since Democritus was unable to answer the philosopher’s questions, his atomic theory was rejected eventually.

Another philosopher named Aristotle latter investigated this theory. It was Aristotle's belief that atomos did not exist and he instead believed that all matter was continuous. In other words, we can divide matter infinitely. It was nearly 200 years before anyone challenged Aristotle's theory of matter. While his theories show strong reasoning, there was little experimentation to suggest his theories were correct.

ATOMIC THEORY

The concept of the atom is relatively recent. Although the Greek philosophers in 500 B.C.E. reasoned that everything must contain minute particles they called atomos, the idea of atoms did not become a scientific theory until 1808. Then John Dalton (1766–1844) developed an atomic theory that proposed that atoms were responsible for the combinations of elements found in compounds.

DALTON'S ATOMIC THEORY

Dalton proposed the atomic theory based on the ideas of elements, compounds and the three laws of chemical combination: the law of conservation of mass, the law of definite proportion and the law of multiple proportions.

Dalton based his theory on the three laws of combinations:

1. The law of conservation of mass: It states that matter is neither created nor destroyed. This means a mass of reactants and a mass of products are equal in any chemical reaction. Therefore, any chemical reaction only involves the separation or union of atoms. Since a chemical reaction involves only the separation, union and rearrangement of atom, mass is conserved in a chemical reaction.
2. The law of definite proportions: This law states that a pure compound is always composed of the same elements combined in a definite ratio of mass. According to Dalton's theory, since atoms combine in small whole number ratios, a compound should contain the same elements combined in a definite ratio by mass of the elements.

Water, for example, is made up of the same proportions of hydrogen and oxygen at all times.

For example: sodium chloride, NaCl, is composed of the elements sodium and chlorine only. These elements are always in the proportion of 39.34% sodium to 60.66% chlorine. This verifies the law of definite proportions.

3. The law of multiple proportions: This law states that when two different compounds are formed of the same elements, the masses of one of elements in the two compounds compared to the given mass of the other element is in a small whole number ratio.

Since atoms combine in whole number ratios, the masses (number of atoms) of one element combining with a fixed mass (number of atoms) of the other elements must be in whole number ratio. A pair of compounds like (H_2O and H_2O_2), (CO and CO_2) illustrate this law.

For the law of multiple proportions, water and hydrogen peroxide can be considered. Assume that each of these compounds contain 1.0 g of hydrogen. In water (H_2O), 8 g of oxygen combines with 1 g of hydrogen. In H_2O_2 , 16 g of oxygen combine with 1 g of hydrogen. The ratio of the masses of oxygen in H_2O and H_2O_2 is exactly 1:2 respectively. This verifies the law of multiple proportions.

The laws of chemical combinations can only be true if we acknowledge the existence of the atoms. Atoms are considered as the smallest fundamental part of an element. From his research, Dalton was able to state his theory in what we call the postulates of Dalton's atomic theory.

Dalton's explanation summarized and expanded the nebulous concepts of early philosophers and scientists; more importantly, his ideas were based on reproducible experimental results of measurements by many scientists. These ideas form the core of Dalton's Atomic Theory, one of the highlights in the history of scientific thought. In condensed form, Dalton's ideas may be stated as follows:

1. An element is composed of extremely small, indivisible particles called atoms.
2. All atoms of a given element have identical properties that differ from those of other elements.
3. Atoms cannot be created, destroyed, or transformed into atoms of another element.
4. Compounds are formed when atoms of different elements combine with one another in small whole-number ratios.
5. The relative numbers and kinds of atoms are constant in a given compound.

Remember that the postulates of Dalton were based on experimental evidence whereas those of the ancient Greeks were simply a result of thinking and reasoning.

Dalton studied numerous chemical reactions, and was able to accurately determine the mass ratios of the elements involved in the reactions. Based on the experimental observations, Dalton's atomic theory easily explains the conservation of mass in chemical reactions as the result of the separation, combination, or rearrangements of atoms. Because the atoms are rearranged in the chemical reactions, their masses are conserved.

Dalton believed that atoms were solid, indivisible spheres, an idea we now reject. But he showed remarkable insight into the nature of matter and its interactions. Some of his ideas could not be verified (or refuted) experimentally at the time. They were based on the limited experimental observations of his day.

This is a classical view of atomic theory. Of these postulates, some have already been disproved and these are atoms are indivisible and indestructible – a dramatic example that disproves this theory is an atomic bomb, where atoms are split to release tremendous force and all atoms of a given element are identical in mass and any other properties – the existence of atoms of the same elements with different mass proves this theory was wrong.

Even with their shortcomings, Dalton's ideas provided a framework that could be modified and expanded by later scientists.

The following modifications were made on the atomic theories of Dalton. i.

Atoms are indivisible and indestructible.

ii. All atoms of a given element are identical in mass and in all other properties.

Even though some modifications were made on Dalton's work, his theory was a brilliant and logical explanation of many experimental discoveries and laws that were known at that time. These scientific assumptions were very closely related to what is presently known about the atom. Due to this, John Dalton is often referred to as the father of modern atomic theory.

MODERN ATOMIC THEORY

Towards the end of the 19th century, various experimental discoveries revealed the existence of subatomic particles, isotopes, and so on. In light of these findings, Dalton's Atomic Theory was modified.

The Modern Atomic Theory can be summarized as follows:

1. Atoms are the smallest particles of all elements that can take part in a chemical reaction.
2. An atom is divisible. It can be subdivided into electrons, protons, and neutrons. An atom is also indestructible i.e., atoms can neither be created nor destroyed during ordinary chemical reactions.

3. Atoms of the same element may not be identical in mass because of the existence of isotopes.
4. Atoms of the same elements have identical chemical properties.
5. Atoms of different elements have different chemical properties.
6. Atoms of two or more elements combine in simple whole-number ratios to form compounds.

A comparison of Dalton's theory and the modern atomic theory:

Dalton's Atomic Theory	Modern Atomic Theory
1. Elements are made up of small particles called atoms.	Elements are made up of small particles called atoms.
2. Atoms can neither be created nor destroyed.	Atoms cannot be created or destroyed during ordinary chemical reactions
3. Atoms are indivisible.	Atoms are divisible. They can be subdivided into electrons, protons and neutrons.
4. All atoms of the same element are identical and have the same mass and size.	All atoms of the same element have the same atomic number but may vary in mass number due to the presence of different isotopes.
5. Atoms of different elements have different mass and size.	Atoms of different elements are different.
6. Atoms combine in small whole numbers to form compounds.	Atoms combine in small whole numbers to form compounds.