

ATOM & MOLECULE

Definition

An atom is a particle of matter that uniquely defines a chemical element. An atom consists of a central nucleus that is usually surrounded by one or more electrons. Each electron is negatively charged.

The nucleus is positively charged, and contains one or more relatively heavy particles known as protons and neutrons.

Atoms are the smallest particle of an element that can exist, and can be regarded as the building blocks of everything. Atoms can combine to form molecules. Molecules are the smallest particle of either an element or a compound that can exist independently.

Subatomic Particles

The atom is made up of sub-atomic particles: *the proton, the neutron and the electron*. The protons and neutrons are concentrated together in a tiny, enormously dense structure in the centre of the atom, called the nucleus. The electrons orbit this nucleus at a very high speed. The various elements differ from each other in the number of protons and electrons they have. For example, gold has 79 protons in its nucleus, whilst carbon has 6. The subatomic particles carry an electrical charge: the proton is positively charged, the electron is negatively charged, whilst the neutron is neutral. Atoms are electrically neutral because they contain equal numbers of protons and electrons.

The chemical properties of elements depend on the structure of their atoms. It is the arrangements of the electrons around the nucleus that give elements their particular chemical properties. Electrons are arranged in 'shells' and it is the state of the outermost shell which is crucial. A stable atom has a complete outer shell - only the elements known as the noble gases (such as helium) have this structure, and so they are stable as single atoms. Other elements have incomplete outer shells, so they bond with other atoms to form stable molecules.

Isotopes

Isotopes are atoms of an element with the same number of protons and electrons but with a different number of neutrons and therefore differing atomic masses. Isotopes are either stable or radioactive.

Allotropes : An allotrope is a variant of a substance consisting of only one type of atom. It is a new molecular configuration, with new physical properties. Substances that have allotropes include carbon, oxygen, sulfur, and phosphorous.

Mole Concept

Mole is a SI unit and used in chemical calculations and can be defined as one mole of substance is equal to 6.023×10^{23} entities (atoms, molecules or ions) or molecular mass/ atomic mass/ formula mass in grams or 22.4 L of a gas at a standard temperature and pressure.

Molecule

A molecule is the smallest particle in a chemical element or compound that has the chemical properties of that element or compound.

Molecules are made up of atoms that are held together by chemical bonds.

Molecular size

The size or hydrodynamic radius R_H can be determined in two ways. The first method is by Dynamic Light Scattering (DLS), which is generally used as a batch technique to measure the average size in the whole sample, but can be used as a detector for Size Exclusion Chromatography.

Molecular formula

Chemical formulas such as HClO_4 can be divided into empirical formula, molecular formula, and structural formula.

Chemical symbols of elements in the chemical formula represent the elements present, and subscript numbers represent mole proportions of the preceding elements.

chemical formula, such as H_2O for water. This formula implies that the water molecules consist of 2 hydrogen, and 1 oxygen atoms.

The formula H_2O is also the molecular formula of water.

Molecular geometry

Molecular geometry or molecular structure is the three-dimensional arrangement of atoms within a molecule. It is important to be able to predict and understand the molecular structure of a molecule because many of the properties of a substance are determined by its geometry.

Molecular spectroscopy

Spectroscopy is the use of the absorption, emission, or scattering of electromagnetic radiation by atoms or molecules to qualitatively or quantitatively study the atoms or molecules, or to study physical processes. The interaction of radiation with matter can cause redirection of the radiation and transitions between the energy levels of the atoms or molecules.

Element: An element is a substance that is made entirely from one type of atom. For example, the element hydrogen is made from atoms containing a single proton and a single electron.

Atomic number : The number of protons in the nucleus of an atom determines an element's atomic number.

Atomic number: It is the number of protons in one atom of a particular element. An undisturbed atom is electrically neutral, so the number of electrons in it is the same as its atomic number.

Atomic mass: The mass of an atom or a molecule is often called its atomic mass. Mass is a basic physical property of matter and strictly speaking there is no difference between mass and atomic mass.

Nomenclature : A system of names used in a particular discipline, as in medicine and surgery, anatomy and biochemistry, etc. A standard system of nomenclature presupposes the existence of an organized classification of the entities within that field.

Fission

During a nucleus fissions, an atom splits into several smaller fragments. These fragments, or fission products, are about equal to half the original mass.

Two or three neutrons are also emitted.

Radioactive decay

Many nuclei are radioactive. This means they are unstable, and will eventually decay by emitting a particle, transforming the nucleus into another nucleus, or into a lower energy state.

There are three main types of radiation

- Alpha radiation
- Beta radiation
- Gamma radiation

Nucleosynthesis

A star's energy comes from the combining of light elements into heavier elements in a process known as fusion, or "nuclear burning".

It is generally believed that most of the elements in the universe heavier than helium are created, or synthesized, in stars when lighter nuclei fuse to make heavier nuclei. The process is called nucleosynthesis.