

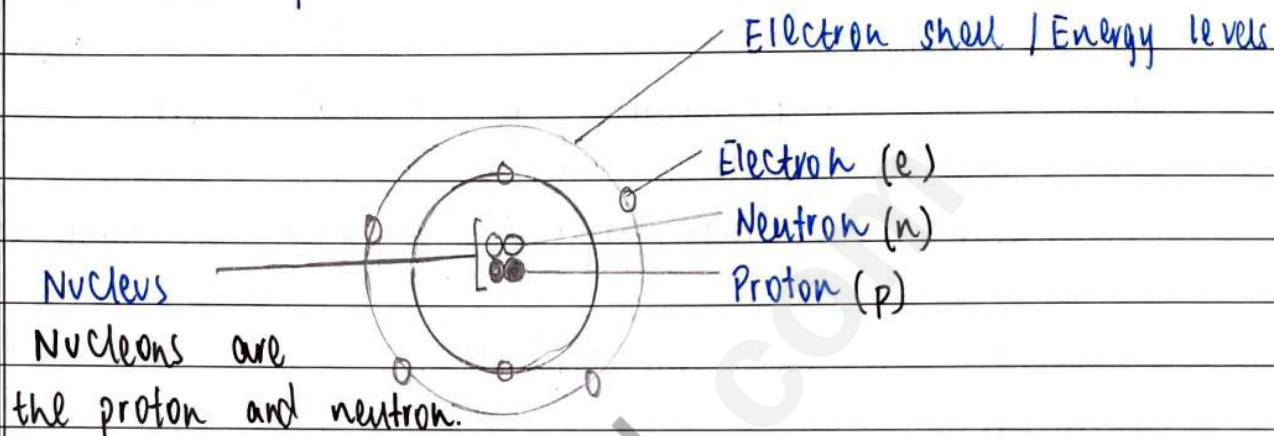


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# ATOMS, ELEMENTS AND COMPOUNDS

## Atomic structure

- The subatomic particles in atoms are protons, neutrons and electrons.



Relative mass

Relative charge

Electron

0

-1

Neutron

1

no charge

Proton

1

+1

- Hence, neutrons + protons = mass number / nucleon number.

## Importance of proton

- Number of protons is the atomic number.
- In the Periodic Table, elements are arranged in order of their proton number.

## Isotopes

- Isotopes are atoms with the same number of protons but different numbers of neutrons.
- An atom is shown like this:

23 → Nucleon number / mass number

Na → Element symbol

11 → Proton number

- Isotopes can be radioactive or non-radioactive.
- If it is radioactive, its nucleus is unstable so it breaks over a period of time. As it decays, the nucleus gives out particles of ray. These are radioisotopes.

#### Uses of isotopes

- Medical uses of radioisotopes are to treat cancer.
- An isotope of cobalt is used.
- Industrial uses of radioisotopes are to check oil leaks or gas pipelines.

### Elements, compounds and Mixtures

#### Elements

- A substance containing only one type of atom.

#### Mixtures

- Two or more substances mixed together, not chemically bonded.

#### Molecular compounds

- Each atom in a molecular compound is chemically bonded together.

#### Ionic compounds

- different atoms form a bond due to attraction between opposite charges.

### Physical and Chemical changes

#### Physical changes

- reversible
- melting of ice
- recyclable

#### Chemical changes

- irreversible
- digestion
- cannot restore reactants

## Electronic Structure

### Electron shells

- Arrangement of electrons in the shell is the electron configuration.

### Arranging

- Horizontal rows are periods.
- Vertical columns are groups.
- Atoms in the same group have the same number of electrons in the outer shell. This is called the valency electrons.

The number of valency electrons in an atom determines the chemical properties of the element.

## Metals and Non-metals

### Physical property

Electricity conductor

Heat conductor

Malleable

Lustrous

Sonorous

metal

✓

✓

✓

✓

✓

non-metal

except graphite

except graphite

### Chemical Properties

- When reacting, metals form positive ions.
- When reacting, non-metals form negative ions ; except hydrogen.

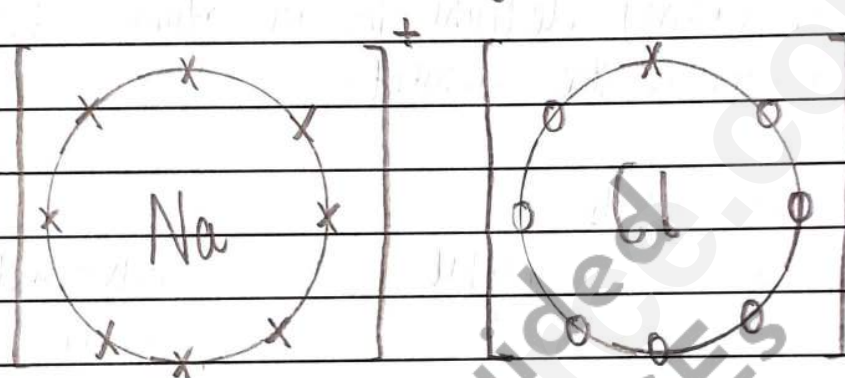
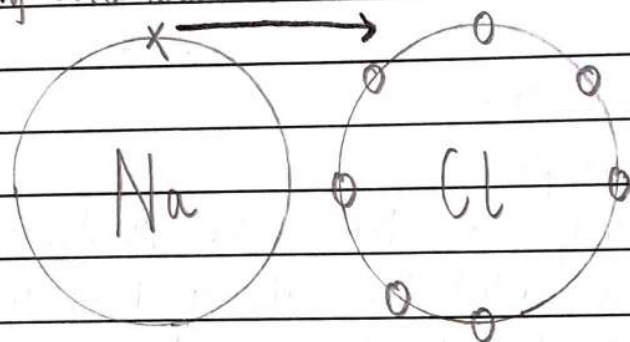
## Solvent, Solute, Solution and Concentration

- Solvent: A substance that dissolves another substance.
- Solute: A substance that dissolves in a solvent.
- Solution: A mixture of a solute in a solvent.
- Concentration: Amount of one substance dissolved in another.

## Ions and Ionic Bonding

- The attraction between oppositely charged ions is called ionic bonding.

\* Only outer shell is drawn



$[2,8]^+$

$[2,8,8]^-$

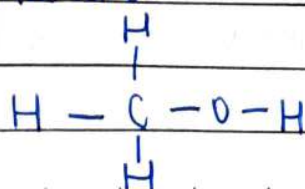
$[Na^+Cl^-] NaCl$

- This diagram is known as the dot-and-cross diagram.
- The full outer shell of 8 electrons is called a stable octet of electrons.

## Molecules and Covalent Bonds

- A covalent bond is formed when non-metallic atoms share a pair of electrons.
- A single covalent bond is shown by a line between atoms.

- Methanol

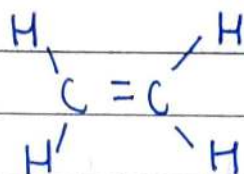


- Oxygen  
 $\text{O} = \text{O}$

- Nitrogen  
 $\text{N} \equiv \text{N}$

- Carbon dioxide  
 $O = C = O$

- Ethene



- Valency of an atom can be defined as the number of electrons lost or gained to form a complete electron shell in a ionic or covalent compound.
- Valency is the combining power.

Ionic or covalent?

- Ions are regularly arranged in a crystal, in a three-dimensional network. This is known as a lattice structure.
- Covalent bonds within molecules is strong, but forces between separate molecules is weak. This weak force is intermolecular force. It is easy to separate molecules, meaning that less energy is required.

Differences

- Ionic compounds have high melting and boiling points. Covalent compounds have low melting and boiling points.
- Ionic compounds are soluble in water. Covalent compounds are insoluble in water.
- Ionic compounds conduct electricity when molten or in water. Covalent compounds do not conduct electricity as they have no ions.

## Macromolecules

- A polymer (substance made of a huge number of small molecules that have combined) or a giant covalent structure.
- Macromolecules have a three-dimensional network of strong covalent bonds throughout the crystal.
- A lot of energy is required to break these bonds.
- Macromolecules have high melting and boiling points.

## Diamond and Graphite - two forms of carbon

- These are known as allotropes.

### Diamond

- One carbon atom is bonded with four other carbon atoms.
- Diamond is hard, and is used in cutting and drilling metals and glass.

### Graphite

- One carbon atom is bonded with three other carbon atoms.
- They are arranged in hexagons.
- Graphite conducts electricity as it has delocalised electrons that can drift along layers when voltage is supplied.
- Graphite is used as a lubricant and is also used to make carbon electrodes.

### Silicon oxide

- Silicon oxide has a similar structure to diamond.
- One silicon atom is bonded to four oxygen atoms.
- Silicon oxide does not conduct electricity.

## Metallic Bonding

- Positive ions are held together by mobile electrons that move between the positive ions.
- When voltage is applied, delocalised electrons carry energy through the metallic structure quickly.

- The electrons will not move as readily through the lattice if the atoms are vibrating faster. This is why electrical conductivity of a metal decreases with increasing temperature.
- It takes a lot of energy to break the forces of attraction between ions and delocalised electrons.