Non Metal and Metals [And Their Compounds]

Chapter 23: Non-metals and Their Compounds

Non-metals are elements that generally tend to gain or share electrons, forming compounds with distinct properties compared to metals.

23.1 General Characteristics of Non-metals

- **Location in Periodic Table:** Found on the right side of the periodic table.
- **Physical State:** Can exist as solids (e.g., carbon, sulfur), liquids (e.g., bromine), or gases (e.g., oxygen, nitrogen) at room temperature.
- **Appearance:** Lack luster; they are dull in appearance.
- **Conductivity:** Generally poor conductors of heat and electricity, with the exception of graphite (an allotrope of carbon).
- **Malleability and Ductility:** Brittle in the solid state; they cannot be hammered into sheets (malleable) or drawn into wires (ductile).
- **Density:** Generally have lower densities compared to metals.
- **Melting and Boiling Points:** Typically have lower melting and boiling points compared to metals (though some, like carbon, have very high melting points).
- **Electron Behavior:** Tend to gain electrons to form negative ions (anions) or share electrons to form covalent bonds.
- **Electronegativity and Ionization Energy:** Have high electronegativities and high ionization energies.
- **Oxides:** Form acidic or neutral oxides when they react with oxygen.

23.2 Important Non-metals and Their Compounds

1. **Hydrogen (H)**
    - **Properties:** Lightest element, exists as diatomic gas (H_2). Highly flammable.
    - **Compounds:** Forms water (H_2O), acids (e.g., HCl, H_2SO_4), hydrocarbons (e.g., CH_4, C_2H_4), and hydrides (compounds with metals, e.g., NaH).
    - **Uses:** Fuel, production of ammonia, hydrogenation of oils.
2. **Oxygen (O)**
    - **Properties:** Reactive non-metal, exists as diatomic gas (O_2). Supports combustion and respiration.
    - **Compounds:** Forms oxides with most elements (e.g., CO_2, Fe_2O_3, H_2O).
    - **Uses:** Respiration, combustion, steelmaking, medical applications.

3. **Nitrogen (N)**
    - **Properties:** Inert diatomic gas (N_2) at room temperature due to a strong triple bond.
    - **Compounds:** Ammonia (NH_3), nitric acid (HNO_3), nitrates (e.g., KNO_3), nitrogen oxides (NO_x).
    - **Uses:** Production of fertilizers, inert atmosphere, cryogenic freezing.
4. **Carbon (C)**
    - **Properties:** Unique ability to catenate (form long chains and rings) and form multiple bonds, leading to a vast number of organic compounds. It exists in allotropic forms like diamond, graphite, and amorphous carbon.
    - **Compounds:** Carbon dioxide (CO_2), carbon monoxide (CO), carbonates (e.g., $CaCO_3$), and all organic compounds (e.g., hydrocarbons, alcohols, acids).
    - **Uses:** Fuels, structural materials, manufacturing of plastics, graphite for lubricants and pencils.
5. **Sulfur (S)**
    - **Properties:** Yellow solid, exists in various allotropic forms.
    - **Compounds:** Sulfur dioxide (SO_2), sulfur trioxide (SO_3), hydrogen sulfide (H_2S), sulfuric acid (H_2SO_4).
    - **Uses:** Production of sulfuric acid, vulcanization of rubber, fungicides.
6. **Halogens (Group 17) (F, Cl, Br, I)**
    - **Properties:** Highly reactive non-metals, exist as diatomic molecules. They have 7 valence electrons and readily gain one electron to form -1 ions. Reactivity decreases down the group.
    - **Compounds:** Halides (e.g., NaCl, HCl), interhalogen compounds.
    - **Uses:** Chlorine for water purification, PVC production. Fluorine for fluoride toothpaste. Iodine as antiseptic.
7. **Noble Gases (Group 18) (He, Ne, Ar, Kr, Xe, Rn)**
    - **Properties:** Inert (unreactive) gases due to a full outer electron shell. Exist as monatomic gases.
    - **Compounds:** Under special conditions, some (like Xenon) can form compounds, but generally unreactive.
    - **Uses:** Argon in light bulbs and welding. Neon in advertising signs. Helium in balloons and cryogenics.

Chapter 24: Metals and Their Compounds

Metals are a large group of elements characterized by their tendency to lose electrons and form positive ions. They exhibit distinctive physical and chemical properties.

24.1 General Characteristics of Metals

- **Location in Periodic Table:** Found on the left and center of the periodic table.
- **Physical State:** Typically solids at room temperature, with the exception of mercury (liquid).
- **Appearance:** Possess a characteristic metallic luster (shiny).
- **Conductivity:** Excellent conductors of heat and electricity. This is due to the presence of delocalized electrons (sea of electrons).

- **Malleability and Ductility:** Malleable (can be hammered into sheets) and ductile (can be drawn into wires).
- **Density:** Generally have high densities.
- **Melting and Boiling Points:** Typically have high melting and boiling points.
- **Electron Behavior:** Tend to lose electrons to form positive ions (cations).
- **Ionization Energy and Electronegativity:** Have low ionization energies and low electronegativities.
- **Oxides:** Form basic oxides when they react with oxygen.

24.2 Important Metals and Their Compounds

1. **Alkali Metals (Group 1) (Li, Na, K)**
    - **Properties:** Highly reactive metals, soft, silvery, with low melting points. Have 1 valence electron, readily lose it to form +1 ions. React vigorously with water to produce hydrogen gas and hydroxides.
    - **Sodium (Na) Compounds:** Sodium chloride (NaCl, common salt), sodium hydroxide (NaOH, caustic soda), sodium carbonate (Na2CO3, washing soda).
    - **Uses:** Sodium for streetlights, compounds in food preservation, soap making, glass manufacturing.
2. **Alkaline Earth Metals (Group 2) (Mg, Ca)**
    - **Properties:** Reactive metals (less reactive than alkali metals), harder, higher melting points. Have 2 valence electrons, readily lose them to form +2 ions.
    - **Calcium (Ca) Compounds:** Calcium carbonate (CaCO3, limestone), calcium oxide (CaO, quicklime), calcium hydroxide (Ca(OH)2, slaked lime).
    - **Uses:** Calcium for bones and teeth, compounds in cement, building materials, agriculture.
    - **Magnesium (Mg) Compounds:** Magnesium oxide (MgO), magnesium hydroxide (Mg(OH)2, milk of magnesia).
    - **Uses:** Lightweight alloys, antacids, flares.
3. **Aluminium (Al)**
    - **Properties:** Light, strong, ductile, good conductor of heat and electricity, corrosion-resistant due to a protective oxide layer.
    - **Compounds:** Aluminium oxide (Al2O3), aluminium chloride (AlCl3).
    - **Uses:** Aircraft and automobile parts, beverage cans, electrical wiring.
4. **Iron (Fe)**
    - **Properties:** A transition metal, relatively strong, magnetic, rusts in the presence of oxygen and water. Exhibits variable oxidation states (+2, +3).
    - **Compounds:** Iron oxides (e.g., Fe2O3, rust), iron sulfides (FeS2), iron sulfates (FeSO4).
    - **Uses:** Major component of steel, construction, manufacturing.
5. **Copper (Cu)**
    - **Properties:** Reddish-brown, highly ductile and malleable, excellent conductor of electricity and heat.
    - **Compounds:** Copper(II) oxide (CuO), copper(II) sulfate (CuSO4).
    - **Uses:** Electrical wiring, plumbing, coinage, alloys (brass, bronze).
6. **Lead (Pb)**
    - **Properties:** Soft, dense, bluish-gray metal.
    - **Compounds:** Lead(II) oxide (PbO), lead(II) nitrate (Pb(NO3)2).

    - **Uses:** Car batteries, radiation shielding (though many uses are declining due to toxicity).
7. **Zinc (Zn)**
    - **Properties:** Bluish-white, reactive metal, resists corrosion by forming a protective oxide layer.
    - **Compounds:** Zinc oxide (ZnO), zinc sulfate ($ZnSO_4$).
    - **Uses:** Galvanizing steel to prevent rust, batteries, alloys (brass).
8. **Transition Metals (Groups 3-12)**
    - **Properties:** Generally hard, have high melting points, high densities. Exhibit variable oxidation states and form colored compounds. Many act as catalysts.
    - **Examples:** Chromium, Manganese, Nickel, Titanium.
    - **Uses:** Widely used in alloys (stainless steel), pigments, catalysts.

Glossary of Terms

- **Non-metal:** Element tending to gain/share electrons, dull, brittle, poor conductor.
- **Metal:** Element tending to lose electrons, lustrous, malleable, ductile, good conductor.
- **Allotrope:** Different structural forms of the same element (e.g., diamond and graphite for carbon).
- **Catenation:** Ability of an atom to form long chains with itself (characteristic of carbon).
- **Alkali Metals:** Group 1 elements, highly reactive.
- **Alkaline Earth Metals:** Group 2 elements, reactive.
- **Halogens:** Group 17 elements, highly reactive non-metals.
- **Noble Gases:** Group 18 elements, unreactive.
- **Transition Metals:** Elements in groups 3-12, often colored compounds, variable oxidation states, catalysts.
- **Corrosion:** Deterioration of metals due to chemical reactions with their environment.
- **Galvanizing:** Coating iron with zinc to prevent rusting.