Comprehensive Chemistry Concepts Notes

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1. Atomic Structure

1.1 Fundamental Particles

- **Proton (p^+):** Charge +1, Mass ≈ 1 amu
- **Neutron (n^0):** Charge 0, Mass ≈ 1 amu
- **Electron (e^-):** Charge –1, Mass ≈ 1/1836 amu

Atomic number (Z): Number of protons **Mass number (A):** Protons + Neutrons

Isotopes: Same Z, different A (e.g., C-12, C-14)

1.2 Bohr Model (Derivation Highlights)

- Electrons move in fixed orbits.
- Angular momentum quantized: $\mathbf{mvr = n\hbar}$
- Energy of electron: $\mathbf{E_n = -13.6\ eV / n^2}$
- Radius: $\mathbf{r_n = n^2 a_0}$

Concept Diagram:

```
nucleus ---> e- orbit (n=1)
          ---> e- orbit (n=2)
```

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2. Periodic Table Concepts

2.1 Periodic Trends

- **Atomic radius:** ↓ across period, ↑ down group
- **Electronegativity:** ↑ across period, ↓ down group
- **Ionization energy:** ↑ across period
- **Metallic character:** ↓ across period, ↑ down group

Table – Key Periodic Trends

Property	Trend Across Period	Trend Down Group
Atomic Radius	Decreases	Increases
Ionization Energy	Increases	Decreases
Electronegativity	Increases	Decreases

Property	Trend Across Period	Trend Down Group
Reactivity (Metals)	Decreases	Increases
Reactivity (Nonmetals)	Increases	Decreases

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3. Chemical Bonding

3.1 Ionic Bond

- Transfer of electrons
- Metal + Nonmetal
- Strong electrostatic attraction

Example: $Na^+ + Cl^- \rightarrow NaCl$

3.2 Covalent Bond

- Sharing of electrons
- Nonmetal + Nonmetal

Types: Single, Double, Triple

3.3 Lewis Structures

Steps: 1. Count valence electrons 2. Place central atom 3. Distribute electrons for octet 4. Form double/triple bonds if needed

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4. Stoichiometry

4.1 Mole Concept

- **1 mole = 6.022×10^{23} particles**
- **Molar mass (g/mol)**
- **Moles = mass / molar mass**

4.2 Balanced Equations

Follow conservation of mass.

4.3 Stoichiometric Steps

1. Convert given to moles
2. Use mole ratio
3. Convert to required quantity

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5. States of Matter

5.1 Gas Laws

Boyle's Law: $P_1V_1 = P_2V_2$ **Charles' Law:** $V \propto T$ **Combined Gas Law:** $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$ **Ideal Gas Law:** $PV = nRT$

Diagram – Gas Laws

```
P vs V ---> downward curve (Boyle)
V vs T ---> straight line (Charles)
```

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6. Solutions & Concentrations

6.1 Types of Solutions

- Saturated
- Unsaturated
- Supersaturated

6.2 Concentration Units

Unit	Formula
Molarity (M)	moles solute / L solution
Molality (m)	moles solute / kg solvent
% w/v	grams solute / 100 mL

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7. Acids, Bases, & pH

7.1 Definitions

- **Arrhenius:** Acids → H^+, Bases → OH^-
- **Brønsted-Lowry:** Acid = proton donor

7.2 pH Scale

$pH = -\log[H^+]$

pH Range	Nature
0–6	Acidic
7	Neutral
8–14	Basic

Neutralization Reaction

Acid + Base → Salt + Water

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8. Thermochemistry

8.1 Enthalpy (ΔH)

- Heat absorbed or released
- Exothermic: $\Delta H < 0$
- Endothermic: $\Delta H > 0$

8.2 Hess's Law

Total enthalpy change = sum of intermediate steps.

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9. Electrochemistry

9.1 Redox Reactions

Oxidation → loss of electrons Reduction → gain of electrons

9.2 Electrochemical Cells

- **Anode:** oxidation
- **Cathode:** reduction

Cell Potential: $E°cell = E°cathode – E°anode$

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10. Organic Chemistry Basics

10.1 Hydrocarbons

- Alkanes: C_nH_{2n+2} (single bonds)
- Alkenes: C_nH_{2n} (double bond)
- Alkynes: C_nH_{2n-2} (triple bond)

10.2 Functional Groups

Group	Example
Alcohol (–OH)	ethanol
Aldehyde (–CHO)	methanal
Carboxylic acid (–COOH)	ethanoic acid
Amine ($–NH_2$)	methylamine

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11. Conceptual Diagrams (Text-based)

Ionic vs Covalent Bonding:

```
Metal ---> (loses e−) ---> Nonmetal
Nonmetal <--- (shares e−) ---> Nonmetal
```

Electrochemical Cell:

```
Anode (-) ---> electrons flow ---> Cathode (+)
  Oxidation                    Reduction
```

If you'd like, I can add: - Numerical practice problems - Chapter-wise breakdown (Matric/FSc) - Reaction mechanisms - Diagram sketches in proper graphics - A PDF or DOCX export