Carbon & Its Compounds - Cheat Sheet

Characteristics of Carbon

- **Valency:** 4 (forms 4 covalent bonds)
- **Bond type:** Covalent (shares electrons)
- **Catenation:** Ability to form long chains/rings with other carbon atoms
- **Tetravalency:** Combines with H, O, N, Cl, etc.

Hydrocarbons

Type	Bond	General Formula	Example
Alkanes	Single	C_nH_{2n+2}	CH_4 (Methane)
Alkenes	Double	C_nH_{2n}	C_2H_4 (Ethene)
Alkynes	Triple	C_nH_{2n-2}	C_2H_2 (Ethyne)

Homologous Series

- Series of compounds with same functional group & similar properties.
- Difference: $-CH_2-$ (14 u) in molecular mass.
- Example: CH_4, C_2H_6, C_3H_8 ...

Chemical Properties & Key Reactions

1. **Combustion**:

   $$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O + Heat$$

2. **Addition** Reaction (for unsaturated hydrocarbons - also for hydrogenation of oils)

   $C_2H_4 + H_2 \xrightarrow[\text{Ni Cat+ Heat}]{} C_2H_6$

   Veg Oil + $H_2 \xrightarrow[\text{Ni Cat+ Heat}]{}$ Veg Ghee (saturated)

3. **Substitution** Reaction (for alkanes)

   $CH_4 + Cl_2 \xrightarrow[\text{Sunlight}]{} Ch_3Cl + HCl$

   (Chloromethane, Dichloromethane, Tricholoromethane (Chloroform), Tetrachloromethane)

4. **Oxidation** (for ethanol)

   $CH_3CH_2OH + 2[O] \xrightarrow[\text{+ Heat}]{\text{Alkaline } KMnO_4 \text{ or Acidified } K_2Cr_2O_7} CH_3COOH + H_2O$

   Aq. Solution of Alkaline Potassium Permanganate or Acidified Potassium Dichromate are oxidizing agents that provide nascent Oxygen, [O]

5. **Dehydration** (for ethanol)

   $CH_3\text{-}CH_2OH \xrightarrow[\text{Conc. } H_2SO_4]{} CH_2 = CH_2 + H_2O$

6. **Ethanol with Na**

   $2\ CH_3\text{-}CH_2OH + 2Na \rightarrow 2\ CH_3\text{-}CH_2O^-Na^+ + H_2$

7. **Esterification**:

   Alcohol + Acid → Ester + Water

   ($CH_3COOH + C_2H_5OH \rightarrow CH_3COOC_2H_5 + H_2O$)

8. **Saponification**:

   Fat or oil + Base (e.g. NaOH) → Alcohol + Soap

   $$C_3H_5(OOCC_{17}H_{35})_3 + 3NaOH \rightarrow C_3H_5(OH)_3 + 3C_{17}H_{35}COONa$$

Allotropes of Carbon

Allotrope	Structure	Example/Use
Diamond	3D tetrahedral	Cutting tools
Graphite	Layers of hexagonal carbon	Lubricant, conductor
Fullerene (C_{60})	Spherical	Nanotechnology

Functional Groups

Functional Group	Formula	Example
Alcohol	-OH	Ethanol (C_2H_5OH)
Aldehyde	-CHO	Ethanal (CH_3CHO)
Ketone	-CO-	Propanone (CH_3COCH_3)
Carboxylic Acid	-COOH	Ethanoic acid (CH_3COOH)
Ester	-COO-	Ethyl acetate ($CH_3COOC_2H_5$)

Important Compounds

Compound	Formula	Use
Ethanol	C_2H_5OH	Alcoholic drinks, fuel
Ethanoic Acid	CH_3COOH	Vinegar, preservative
Soap	Sodium/potassium salt of fatty acid (R-COONa)	Cleansing
Detergent	Sulphonate/sulphate salt (R-SO_3Na or R-OSO_3Na	Cleansing in hard water

Soap vs Detergent

Property	Soap	Detergent
Composition	Sodium or potassium **salt of a fatty acid**	Sodium or ammonium **salt of a sulphonate or sulphate**
General Formula	R-COONa (where R = long alkyl chain, e.g. $C_{17}H_{35}$-)	R-SO_3Na or R-OSO_3Na
Example	**Sodium stearate ($C_{17}H_{35}COONa$)** - main ingredient in many soaps	**Sodium lauryl sulphate ($C_{12}H_{25}OSO_3Na$)** or **Sodium alkyl benzene sulphonate (R-C_6H_4-SO_3Na)**
Works in hard water?	❌ Forms scum (with Ca^{2+} / Mg^{2+})	✅ Works well, even in hard water
Type of cleansing agent	Natural / biodegradable	Synthetic / usually non-biodegradable