Chapter 1: Chemical Reactions and Equations

Definitions

- **Chemical reaction**: Process in which new substances with new properties are formed by rearrangement of atoms.
- **Combination reaction**: Two or more substances combine to form a single substance.
- **Decomposition reaction**: A single compound splits into two or more simpler substances (thermal, electrolytic, photolytic).
- **Displacement reaction**: One element displaces another from its compound.
- **Double displacement reaction**: Exchange of ions between two compounds (also called precipitation or neutralization).
- **Oxidation**: Addition of oxygen or removal of hydrogen.
- **Reduction**: Removal of oxygen or addition of hydrogen.
- **Redox reaction**: Oxidation + reduction occur together.
- **Exothermic**: Heat released (+ heat on product side).
- **Endothermic**: Heat absorbed (+ heat on reactant side).
- **Precipitate**: Insoluble solid formed.
- **Rancidity**: Oxidation of fats/oils causing bad smell/taste.
- **Corrosion**: Oxidation of metals (e.g., rusting).

Key Reactions & Observations (with color changes highlighted)

Reaction	Equation	Type	Observations/Color Change
Magnesium burns in air	$2Mg(s) + O_2(g) \rightarrow 2MgO(s)$	Combination	White powder forms
Zinc + dil. H_2SO_4	$Zn(s) + H_2SO_4(aq) \rightarrow ZnSO_4(aq) + H_2(g)$	Displacement	Heat evolved; H_2 gas (pop sound)
Lead nitrate heated	$2Pb(NO_3)_2(s) \rightarrow 2PbO(s) + 4NO_2(g) + O_2(g)$	Thermal decomposition	Yellow residue; brown fumes
Ferrous sulphate heated	$2FeSO_4(s) \rightarrow Fe_2O_3(s) + SO_2(g) + SO_3(g)$	Thermal decomposition	Green → brown; burning sulphur smell
Potassium iodide + lead nitrate	$Pb(NO_3)_2(aq) + 2KI(aq) \rightarrow PbI_2(s) + 2KNO_3(aq)$	Double displacement	Yellow precipitate (colourless → yellow)
Ferrous sulphate + NaOH	$FeSO_4(aq) + 2NaOH(aq) \rightarrow Fe(OH)_2(s) + Na_2SO_4(aq)$	Double displacement	Green precipitate

Barium chloride + H_2SO_4/Na_2SO_4	$BaCl_2(aq) + H_2SO_4(aq) \rightarrow BaSO_4(s) + 2HCl(aq)$	Double displacement	White precipitate
Copper + oxygen + water (rusting-like)	$2Cu(s) + O_2(g) + H_2O(l) \rightarrow Cu(OH)_2(s)$ or basic carbonate	Oxidation	Reddish-brown Cu → green
Iron + copper sulphate	$Fe(s) + CuSO_4(aq) \rightarrow FeSO_4(aq) + Cu(s)$	Displacement	Blue → pale green; reddish-brown Cu deposit
Hydrogen + copper oxide	$H_2(g) + CuO(s) \rightarrow Cu(s) + H_2O(l)$	Redox (reduction of CuO)	Black → reddish-brown
Quicklime + water	$CaO(s) + H_2O(l) \rightarrow Ca(OH)_2(aq) + heat$	Combination (exothermic)	Vigorous heat evolution
Photosynthesis	$6CO_2(g) + 6H_2O(l) \rightarrow C_6H_{12}O_6(aq) + 6O_2(g)$	Endothermic (light)	—
Silver chloride in sunlight	$2AgCl(s) \rightarrow 2Ag(s) + Cl_2(g)$	Photodecomposition	White → grey

Common indicators of reaction: Evolution of gas, formation of precipitate, **change in colour**, change in temperature, change in state.

Chapter 2: Acids, Bases and Salts

Definitions

- **Acid**: Substance that produces H^+ ions in water, turns blue litmus red, sour taste.
- **Base/Alkali**: Produces OH^- ions, turns red litmus blue, bitter taste.
- **Salt**: Formed by acid + base (neutralisation).
- **Neutralisation**: Acid + base → salt + water + heat.
- **pH**: <7 acidic, 7 neutral, >7 basic.
- **Indicators**: Dyes that show colour change in acid/base.

Indicator Colour Changes (very important for exams)

Indicator	Colour in Acid	Colour in Base/Alkali
Litmus	Red	Blue
Methyl orange	Red	Yellow
Phenolphthalein	Colourless	Pink
Red cabbage extract	Red/pink	Green
Turmeric	Yellow	Red-brown

Universal indicator	Red–orange (strong–weak acid)	Green–blue–purple (neutral–strong base)

Key Reactions

- **Acid + Metal** (active metals): Zn/Mg/Fe/Al + dil. $HCl/H_2SO_4 \rightarrow$ salt + $H_2(g)$ (pop sound)
  Example: $Zn(s) + 2HCl(aq) \rightarrow ZnCl_2(aq) + H_2(g)$
- **Acid + Metal carbonate/hydrogencarbonate**: $Na_2CO_3/NaHCO_3 + HCl \rightarrow$ salt + $CO_2(g)$ + H_2O (brisk effervescence; CO_2 turns lime water milky)
  $NaHCO_3(s) + HCl(aq) \rightarrow NaCl(aq) + CO_2(g) + H_2O(l)$
- **Acid + Metal oxide (basic)**: $CuO(s) + 2HCl(aq) \rightarrow CuCl_2(aq) + H_2O(l)$ (black → blue-green solution)
- **Neutralisation**: $HCl(aq) + NaOH(aq) \rightarrow NaCl(aq) + H_2O(l)$ + heat
- **Chlor-alkali process** (electrolysis of brine): $2NaCl(aq) + 2H_2O(l) \rightarrow 2NaOH(aq) + Cl_2(g) + H_2(g)$
- **Baking soda + acid** (in baking powder): $NaHCO_3$ + tartaric/citric acid → $CO_2(g)$ (dough rises)
- **Plaster of Paris setting**: $CaSO_4 \cdot \frac{1}{2}H_2O + 1\frac{1}{2}H_2O \rightarrow CaSO_4 \cdot 2H_2O$ (sets hard)
- **Copper sulphate hydration**: White anhydrous $CuSO_4 + 5H_2O \rightarrow$ blue $CuSO_4 \cdot 5H_2O$ (colour change white → blue on heating reverses)

Chapter 3: Metals and Non-metals

Definitions

- **Metals**: Lustrous, malleable, ductile, good conductors, electropositive.
- **Non-metals**: Non-lustrous, brittle, bad conductors, electronegative.
- **Reactivity series**: K > Na > Ca > Mg > Al > Zn > Fe > Sn > Pb > H > Cu > Hg > Ag > Au (more reactive displaces less reactive).
- **Corrosion**: Slow oxidation of metals by air/moisture (rusting of iron).
- **Alloy**: Homogeneous mixture of metals (e.g., brass, stainless steel) to prevent corrosion.

Key Reactions & Color Changes

- **Metal + Oxygen** (basic oxides):
  $4Na + O_2 \rightarrow 2Na_2O$ (white)
  $2Mg + O_2 \rightarrow 2MgO$ (white)
  $2Cu + O_2 \rightarrow 2CuO$ (black coating)
- **Metal + Water/Steam**:
  $2Na + 2H_2O \rightarrow 2NaOH + H_2$ (H_2 catches fire)
  $3Fe + 4H_2O(g) \rightarrow Fe_3O_4 + 4H_2$ (steam)
- **Metal + Dil. Acid**: Mg/Fe/Zn + dil. $HCl/H_2SO_4 \rightarrow$ salt + $H_2(g)$ (pop sound)

- **Displacement reactions (color changes)**:
  Zn + $CuSO_4$(aq): Zn(s) + $CuSO_4$(aq) → $ZnSO_4$(aq) + Cu(s)
  Observation: Blue solution → colourless; reddish-brown Cu deposit on Zn.
  Fe + $CuSO_4$: Blue → pale green; reddish-brown Cu.
  Cu + 2$AgNO_3$: Solution → blue; greyish-white Ag deposit on Cu.
- **Rusting of iron**: $4Fe + 3O_2 + 2xH_2O \rightarrow 2Fe_2O_3 \cdot xH_2O$ (rust)
  Observation: Grey iron → **red-brown flaky rust**.
- **Aluminium corrosion**: Forms protective Al_2O_3 layer (no further corrosion).
- **Copper corrosion**: Green basic copper carbonate.
- **Silver tarnishing**: $2Ag + H_2S \rightarrow Ag_2S$ (black) + H_2.

Thermite reaction (exothermic): $Fe_2O_3 + 2Al \rightarrow 2Fe + Al_2O_3$ + heat (molten iron).

Chapter 4: Carbon and its Compounds

Definitions

- **Covalent compounds**: Electron sharing (e.g., all carbon compounds).
- **Hydrocarbons**: Only C & H (saturated alkanes CnH2n+2; unsaturated alkenes CnH2n, alkynes CnH2n–2).
- **Functional group**: Determines properties (–OH alcohol, –COOH carboxylic acid, etc.).
- **Combustion**: Burning → CO_2 + H_2O + heat/light.
- **Oxidation**: Addition of O or removal of H (e.g., alcohol → acid).
- **Addition reaction**: Unsaturated compounds + H_2/Br_2/H_2O.
- **Substitution reaction**: Saturated compounds (alkanes + Cl_2 in sunlight).
- **Esterification**: Acid + alcohol → ester + water (sweet smell).
- **Saponification**: Ester + NaOH → soap + alcohol.

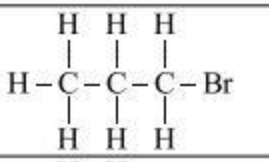
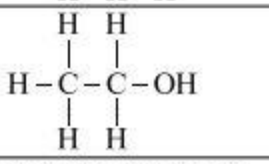
Key Reactions & Color Changes

- **Combustion**: $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$ (clean flame); $C_2H_2 + 5/2O_2 \rightarrow 2CO_2 + H_2O$ (sooty flame).
- **Oxidation of ethanol** (with alkaline $KMnO_4$ or acidified $K_2Cr_2O_7$):
  $C_2H_5OH \rightarrow CH_3COOH$
  Observation: **Purple $KMnO_4$ decolourises**; orange $K_2Cr_2O_7$ → green.
- **Dehydration of ethanol** (conc. H_2SO_4, 170°C): $C_2H_5OH \rightarrow C_2H_4 + H_2O$.
- **Hydrogenation (addition)**: $C_2H_4 + H_2 \rightarrow C_2H_6$ (Ni catalyst).
- **Bromine water test (addition, color change)**:
  Ethene/Ethyne + Br_2 water → decolourises (unsaturated).
  Alkanes: No change (saturated).

- **Ethanol + Na**: $2C_2H_5OH + 2Na \rightarrow 2C_2H_5ONa + H_2(g)$ (pop sound).
- **Ethanoic acid + $NaHCO_3$/Na_2CO_3**: $CH_3COOH + NaHCO_3 \rightarrow CH_3COONa + H_2O + CO_2(g)$ (brisk effervescence; lime water milky).
- **Esterification**: $CH_3COOH + C_2H_5OH \rightarrow CH_3COOC_2H_5$ (ethyl acetate, sweet smell) + H_2O (conc. H_2SO_4).
- **Soap making (saponification)**: Fat/oil + NaOH → soap (sodium stearate) + glycerol.

Litmus test: Carboxylic acids turn blue litmus red; alcohols do not.

Table: IUPAC names of different functional group

S. No.	Functional group	Prefix / Suffix	Functional group	Example	IUPAC Name
1.	Halogen	Chloro, bromo, Iodo	–Cl, – Br, – I		Bromopropane
2.	Alcohol	–ol	–OH		Ethanol
3.	Aldehyde	–al	–CHO	$CH_3CH_2CH_2CHO$	Butanal
4.	Ketone	–one	–CO	CH_3COCH_3	Propanone
5.	Carboxylic acid	–oic acid	–COOH	CH_3CH_2COOH	Propanoic acid
6.	Amine	Amino	$-NH_2$	$CH_3CH_2NH_2$	Amino ethane
7.	Ester	oate –	–COOR	CH_3COOCH_3	Methyl ethanoate
8.	Double bond	ene	$>C=C<$	$CH_3-CH=CH_2$	Propene
9.	Triple bond	yne	$-C\equiv C-$	$CH_3-CH_2-C\equiv CH$	Butyne