

Organic Chemistry Reaction Notes (Final)

Benzene Reactions

Electrophilic Substitution Reactions:

1. **Benzene + Chlorine** $\xrightarrow{\text{AlCl}_3, \text{ rtp}}$ Chlorobenzene + HCl (*Electrophilic substitution*)
2. **Benzene + Bromine** $\xrightarrow{\text{AlBr}_3, \text{ rtp}}$ Bromobenzene + HBr (*Electrophilic substitution*)
3. **Benzene + Nitric acid (conc.)** $\xrightarrow{\text{Conc. H}_2\text{SO}_4, 55^\circ \text{C}}$ Nitrobenzene + H₂O (*Electrophilic substitution*)

Other Benzene Reactions:

4. **Benzene + Halogenoalkane** $\xrightarrow{\text{Aluminium halide / Iron(III) halide}}$ Alkyl benzene + Hydrogen halide (*Electrophilic substitution - Note: handwritten notes incorrectly label this as Nucleophilic*)
5. **Benzene + Acyl chloride** $\xrightarrow{\text{Aluminium chloride catalyst}}$ Phenyl ketone + HCl (*Electrophilic substitution*)
6. **Methyl Benzene** $\xrightarrow{\text{Alkaline KMnO}_4 + \text{Heat under reflux}}$ Benzoic acid + H₂O (*Oxidation*)
 - **Reaction pathway:** Methyl benzene $\xrightarrow{\text{OH}^-}$ Benzoate ion (COO⁻) + H₂O $\xrightarrow{\text{dil. H}_2\text{SO}_4}$ Benzoic acid (COOH)
7. **Benzene + H₂** $\xrightarrow{\text{Ni/Pt catalyst, heat}}$ Cyclohexane (*Reduction / Addition*)
8. **Benzene + Nitric acid** $\xrightarrow{\text{Conc. HNO}_3, \text{ Conc. H}_2\text{SO}_4}$ Nitrobenzene + H₂O (*Electrophilic substitution*)

Phenol Reactions

8. **Phenol + Metal** \longrightarrow Metal phenoxide + H₂ (*Redox*)
9. **Phenol + Metal hydroxide** \longrightarrow Metal phenoxide + H₂O (*Acid-base / Neutralisation*)
10. **Phenol + Benzenediazonium chloride** \longrightarrow Azo compound (*Electrophilic substitution / Coupling*)
11. **Phenol + Nitric acid** \longrightarrow 2-nitrophenol + 4-nitrophenol + H₂O (*Electrophilic substitution*)
12. **Phenol + Bromine** \longrightarrow 2,4,6-tribromophenol + HBr (*Electrophilic substitution*)

Amine & Diazonium Reactions

11. **Amino benzene + HNO₂** \longrightarrow Benzene diazonium ion + Water (*Diazotisation*)

12. **Nitrobenzene** $\xrightarrow{\text{LiAlH}_4, \text{conc. HCl, heat}}$ Phenyl amine + H_2O (*Reduction*)
13. **Phenylamine + aq. Br_2** \longrightarrow 2,4,6-tribromophenylamine + 3HBr (*Electrophilic substitution*)
14. **Phenyl amine + Sodium nitrite + HCl** $\xrightarrow{0^\circ\text{C} < T < 10^\circ\text{C}}$ Benzene diazonium chloride (*Diazotisation*)

Coupling Reactions & Azo Dyes (from diagrams):

- **Benzenediazonium Chloride:** $[\text{C}_6\text{H}_5\text{-N} \equiv \text{N}]^+\text{Cl}^-$
- **Coupling Reaction:** $[\text{C}_6\text{H}_5\text{-N} \equiv \text{N}]^+ + \text{H}_2\text{O} \longrightarrow \text{C}_6\text{H}_5\text{OH} + \text{N}_2 + \text{H}^+$ (*Coupling*)
- **Azo Dye Formation:** $[\text{C}_6\text{H}_5\text{-N} \equiv \text{N}]^+ + [\text{C}_6\text{H}_5\text{-O}]^-\text{Na}^+ \longrightarrow \text{C}_6\text{H}_5\text{-N}=\text{N}-\text{C}_6\text{H}_4\text{O}^-\text{Na}^+$ (*Coupling*)

Carboxylic Acid Reactions

14. **Carboxylic acid + PCl_5** \longrightarrow Acyl chloride + $\text{POCl}_3 + \text{HCl}$ (*Nucleophilic substitution / Halogenation*)
15. **Carboxylic acid + SOCl_2** \longrightarrow Acyl chloride + $\text{SO}_2 + \text{HCl}$ (*Nucleophilic substitution / Halogenation*)
16. **Carboxylic acid + PCl_3** $\xrightarrow{\text{Heat under reflux}}$ 3 Acyl chloride + Phosphorous acid (H_3PO_3) (*Nucleophilic substitution / Halogenation*)
17. **Methanoic acid** $\xrightarrow{\text{Tollens' reagent / Fehling's reagent}}$ $\text{CO}_2 + \text{H}_2\text{O}$ (*Oxidation*)
18. **Ethanedioic acid** $\xrightarrow{\text{Warm KMnO}_4}$ $\text{CO}_2 + \text{H}_2\text{O}$ (*Oxidation*)

Acyl Chloride Reactions

19. **Acyl chloride + H_2O** \longrightarrow Carboxylic acid + HCl (*Addition-elimination / Hydrolysis*)
20. **Acyl chloride + Alcohol** \longrightarrow Ester + HCl (*Addition-elimination / Condensation*)
21. **Acyl chloride + Phenol** \longrightarrow Ester + HCl (*Addition-elimination / Condensation*)
22. **Acyl chloride + NH_3** \longrightarrow Amide + HCl (*Addition-elimination / Condensation*)
23. **Acyl chloride + Amine** \longrightarrow Substituted amide + HCl (*Addition-elimination / Condensation*)
24. **Alcohol + Acyl chloride** \longrightarrow Ester + HCl (*Addition-elimination*) (*duplicate of 20*)
25. **Phenol + Acyl chloride** \longrightarrow Ester + HCl (*Addition-elimination*) (*duplicate of 21*)

Halogenoalkane, Nitrile, Amide & Amino Acid Reactions

26. **Halogenoalkane + Hot conc. ammonia** $\xrightarrow{\text{E1/E2 mechanism}}$ Alkyl amine (primary) + Hydrogen halide
(Nucleophilic substitution)
27. **Nitrile** $\xrightarrow{\text{LiAlH}_4 \text{ (in dry ether) OR H}_2 \text{ with Ni/Pt}}$ Alkyl amine (Reduction)
28. **Amide** $\xrightarrow{\text{LiAlH}_4 \text{ (dry ether)}}$ Amine + H_2O (Reduction)
29. **Amide + Acid** \longrightarrow Carboxylic acid + Ammonium salt (Hydrolysis)
30. **Amide + Alkali** \longrightarrow Carboxylic salt + Ammonia (Hydrolysis)
31. **Amide** $\xrightarrow{\text{LiAlH}_4}$ Amine (Reduction)
32. **Amino acid + Amino acid** \longrightarrow Dipeptide + Water (Condensation)
33. **Dipeptide + Amino acid** \longrightarrow Tripeptide + H_2O (Condensation)

Synthesis Flowchart

A step-by-step conversion pathway:

- Alkane** $\xrightarrow{\text{UV, Cl}_2}$ **Halogenoalkane** (Free radical substitution)
- Halogenoalkane** $\xrightarrow{\text{NaOH (aq)}}$ **Alcohol** (Nucleophilic substitution)
- Alcohol** $\xrightarrow{\text{K}_2\text{Cr}_2\text{O}_7, \text{distill}}$ **Aldehyde** (Oxidation)
- Aldehyde** $\xrightarrow{\text{Reflux}}$ **Carboxylic acid** (Oxidation)
- Carboxylic acid** $\xrightarrow{\text{SOCl}_2}$ **Acyl chloride** (Nucleophilic substitution / Halogenation)

From Acyl chloride, the pathway branches:

- **Alcohol** \longrightarrow Ester (Addition-elimination)
- NH_3 \longrightarrow Amide (Addition-elimination)