UACE ORGANIC CHEMISTRY REVISION NOTES

Organic Reaction Types + Preparation of Alkanes

A structured revision guide covering the major organic reactions, how to recognize them, key examples, reagents and conditions, and the main UACE-level methods of preparing alkanes.

PART I — TYPES OF ORGANIC REACTIONS

Reaction	What happens?	Typical example
Substitution	One atom/group is replaced by another.	CH■ + Cl■ → CH■Cl + HCl
Addition	Atoms/groups add across a C=C or C≡C bond.	CH■=CH■ + H■ → CH■CH■
Elimination	Atoms/groups are removed, usually forming a multiple bond.	CH■CH■OH → CH■=CH■ + H■O
Oxidation	Usually gain of O or loss of H.	CH■CH■OH → CH■CHO
Reduction	Usually gain of H or loss of O.	CH■=CH■ + H■ → CH■CH■
Condensation	Two molecules join while a small molecule is removed.	Acid + alcohol → ester + H■O
Hydrolysis	A molecule is split using water.	Ester + H■O → acid + alcohol
Polymerisation	Many monomers join to form a polymer.	n(CH■=CH■) → [–CH■–CH■–]■

1. SUBSTITUTION REACTIONS

Substitution means replacement. One atom or group in an organic molecule is replaced by another.

• CH■ + Cl■ → CH■Cl + HCl

• Conditions: ultraviolet light (UV).

• Alkanes commonly undergo substitution with halogens.

• Exam clue: alkane + Cl■/Br■ + UV → substitution.

2. ADDITION REACTIONS

Addition means adding atoms/groups to an unsaturated molecule, usually across a C=C or C≡C bond.

• CH■=CH■ + H■ → CH■CH■ (Ni catalyst)

• CH■=CH■ + Br■ → CH■Br–CH■Br

• CH■=CH■ + H■O → CH■CH■OH (acid catalyst such as H■PO■)

• CH■=CH■ + HBr → CH■CH■Br

• Key idea: a double bond becomes a single bond as new atoms/groups are added.

3. ELIMINATION REACTIONS

Elimination is removal of atoms/groups from a molecule, often producing a C=C double bond.

• CH■CH■OH → CH■=CH■ + H■O

• A common method uses concentrated H■SO■ and heat.

• CH■CH■Br → CH■=CH■ + HBr

• Key idea: a single bond becomes a double bond because a small molecule is removed.

4. OXIDATION

In organic chemistry, oxidation commonly involves gaining oxygen or losing hydrogen.

• Primary alcohol → aldehyde → carboxylic acid.

• CH■CH■OH → CH■CHO → CH■COOH

• Secondary alcohol → ketone: CH■CHOHCH■ → CH■COCH■

• Tertiary alcohols resist oxidation under ordinary mild conditions.

• Acidified K■Cr■O■: orange → green.

• Acidified KMnO■: purple → colourless.

5. REDUCTION

Reduction commonly involves gaining hydrogen or losing oxygen.

• CH■=CH■ + H■ → CH■CH■

• CH■CHO + 2[H] → CH■CH■OH

• CH■COCH■ + 2[H] → CH■CHOHCH■

• Memory aid: OIL RIG — Oxidation Is Loss, Reduction Is Gain (of electrons).

6. CONDENSATION REACTIONS

Two molecules combine to form a larger molecule while a small molecule, commonly water, is removed.

• Carboxylic acid + alcohol ■ ester + water

• CH■COOH + CH■CH■OH ■ CH■COOCH■CH■ + H■O

• Conditions commonly include concentrated H■SO■ and heat.

• The reaction above is esterification.

7. HYDROLYSIS

Hydrolysis means breaking a molecule using water.

• CH■COOCH■CH■ + H■O ■ CH■COOH + CH■CH■OH

• An ester can therefore be hydrolysed to a carboxylic acid and an alcohol.

• Alkaline hydrolysis: ester + NaOH → carboxylate salt + alcohol.

• Alkaline ester hydrolysis is commonly called saponification in soap-making contexts.

8. POLYMERISATION

Polymerisation is the joining of many small molecules (monomers) to form a large molecule (polymer).

• Addition polymerisation: n(CH■=CH■) → [–CH■–CH■–]■

• Ethene → polyethene.

• Propene → polypropene.

• Condensation polymerisation involves functional groups reacting with loss of a small molecule such as water or HCl.

9. COMBUSTION

Combustion is reaction with oxygen, releasing energy.

• Complete combustion of a hydrocarbon gives CO■ and H■O.

• CH■ + 2O■ → CO■ + 2H■O

• C■H■OH + 3O■ → 2CO■ + 3H■O

• Incomplete combustion can produce CO and/or carbon when oxygen is insufficient.

10. CRACKING

Cracking breaks large hydrocarbon molecules into smaller, more useful molecules.

• C■■H■■ → C■H■■ + C■H■■

• Products can include an alkane and an alkene.

• Cracking may be thermal or catalytic; catalytic cracking commonly uses zeolite-type catalysts.

11. FERMENTATION

Fermentation converts glucose to ethanol and carbon dioxide using yeast under anaerobic conditions.

• C■H■■O■ → 2C■H■OH + 2CO■

• Important conditions: yeast, warm temperature, and limited/absence of oxygen.

12. NEUTRALISATION

Organic acids can undergo ordinary acid–base neutralisation.

• CH■COOH + NaOH → CH■COONa + H■O

• Ethanoic acid + sodium hydroxide → sodium ethanoate + water.

FAST RECOGNITION RULES

What you notice	Reaction
C=C becomes C–C and something is added	Addition
C–C becomes C=C and something is removed	Elimination
One atom/group is swapped for another	Substitution
More O / fewer H	Oxidation
More H / fewer O	Reduction
Two molecules join + small molecule leaves	Condensation
Water is used to split a molecule	Hydrolysis
Many monomers join	Polymerisation

PART II — PREPARATION OF ALKANES

Alkanes are saturated hydrocarbons with general formula C■H■■■■. The main UACE preparation methods are summarized below.

1. HYDROGENATION OF ALKENES

• General: Alkene + H■ → Alkane.

• Example: CH■=CH■ + H■ —Ni→ CH■CH■.

• Typical conditions: hydrogen gas, nickel catalyst, heat.

• Hydrogen adds across the C=C bond. This is also called catalytic hydrogenation.

2. REDUCTION OF HALOALKANES

• General: R–X + 2[H] → R–H + HX.

• Example: CH■CH■Br + 2[H] → CH■CH■ + HBr.

• Thus a haloalkane can be converted into the corresponding alkane by reduction.

3. WURTZ REACTION

• General: 2R–X + 2Na → R–R + 2NaX.

• Conditions: sodium metal in dry ether.

• Example: 2CH■Cl + 2Na → CH■CH■ + 2NaCl.

• Example: 2CH■CH■Cl + 2Na → CH■CH■CH■CH■ + 2NaCl.

• Best suited to preparing symmetrical alkanes. Using two different haloalkanes can give mixtures.

4. DECARBOXYLATION WITH SODA LIME

• General: RCOONa + NaOH —CaO, heat→ RH + Na■CO■.

• Soda lime is a mixture based mainly on NaOH and CaO.

• Example: CH■COONa + NaOH —soda lime, heat→ CH■ + Na■CO■.

• Key rule: the alkane has one fewer carbon atom than the original carboxylate salt.

5. KOLBE ELECTROLYSIS

• Carboxylate ions are electrolysed and the alkyl radicals combine.

• Example: CH■COO■ → CH■• + CO■; then CH■• + CH■• → CH■CH■.

• Therefore sodium/potassium ethanoate can give ethane by Kolbe electrolysis.

• Important: Kolbe electrolysis joins two identical alkyl groups, whereas soda-lime decarboxylation gives the alkane with one fewer carbon.

6. REDUCTION OF ALDEHYDES AND KETONES

• Aldehydes and ketones can be reduced strongly to hydrocarbons.

• Aldehyde: RCHO → RCH■.

• Ketone: RCOR′ → RCH■R′.

• Named methods include Clemmensen reduction (Zn(Hg)/HCl) and Wolff–Kishner reduction (NH■NH■/KOH, heat).

7. CRACKING OF LARGER HYDROCARBONS

• Large hydrocarbons can be cracked into smaller hydrocarbons.

• Example: C■■H■■ → C■H■■ + C■H■■.

• Because one product can be an alkane, cracking can provide smaller alkanes as well as alkenes.

• Cracking may be thermal or catalytic.

THE THREE IMPORTANT COMPARISONS

Method	Starting material	What happens
Soda-lime decarboxylation	Sodium carboxylate	Gives alkane with one fewer carbon
Wurtz reaction	Haloalkane	Two alkyl groups join using Na
Kolbe electrolysis	Carboxylate salt	Two alkyl radicals join

EXAM-STYLE RECOGNITION

• Prepare ethane from ethene: use hydrogenation, CH■=CH■ + H■ —Ni→ CH■CH■.

• Prepare methane from sodium ethanoate: use soda-lime decarboxylation, CH■COONa + NaOH → CH■ + Na■CO■.

• Prepare butane from chloroethane: use Wurtz reaction, 2CH■CH■Cl + 2Na → CH■CH■CH■CH■ + 2NaCl.

• Prepare ethane from sodium ethanoate by electrolysis: use Kolbe electrolysis; methyl radicals combine to form ethane.

MASTER MEMORY MAP

ALKANE — substitution → **HALOALKANE** — elimination → **ALKENE** — addition → **ALKANE**

ALKENE — addition of H■O → **ALCOHOL** — oxidation → **ALDEHYDE** — oxidation → **CARBOXYLIC ACID**

SECONDARY ALCOHOL — oxidation → **KETONE**

CARBOXYLIC ACID + ALCOHOL ■ ESTER + WATER

FINAL UACE REVISION CHECKLIST

■ Know the definition and recognition clue for substitution, addition, elimination, oxidation, reduction, condensation, hydrolysis and polymerisation.

■ Know the oxidation pathway: primary alcohol → aldehyde → carboxylic acid.

■ Know: secondary alcohol → ketone.

■ Know the reagents/conditions for alkene addition and alcohol oxidation/dehydration.

■ Know hydrogenation, Wurtz reaction, soda-lime decarboxylation and Kolbe electrolysis for alkane preparation.

■ Practice predicting products rather than only memorising names.

■ Always check the number of carbon atoms when preparing an alkane.