



1. Organic Chemistry

King

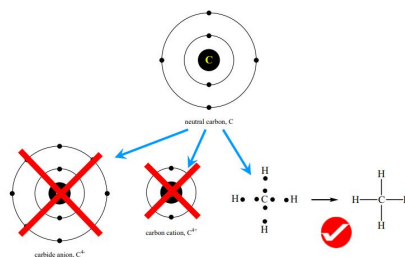
考点一：Name

- 1.1 illustrate, using **chemical formulas**, a wide variety of natural and synthetic compounds that contain **carbon**
- 1.2 explain the large number and diversity of **organic compounds** with reference to the unique nature of the **carbon atom**
- 1.3 write the **formula** and provide the **IUPAC name** for a variety of organic compounds

1. Organic compound.

Organic chemistry is concerned with the study of the structure and properties of compounds containing **carbon**.

- All **organic compounds** contain **carbon atoms**.
- **Inorganic compounds** contain **no carbons**. Most **inorganic compounds** are **ionic** compounds
- Carbon atoms are bonded to hydrogen atoms or other elements near carbon on the periodic table.
- Carbon atoms also bond to other carbon atoms and form long chains.

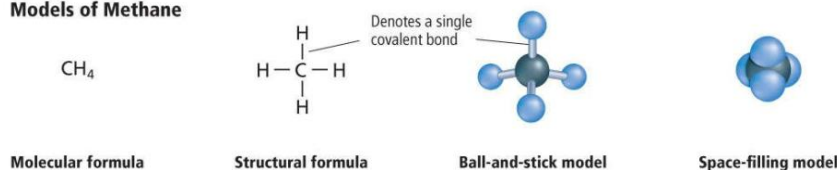


Carbon atoms can be linked by strong, stable **covalent bonds**

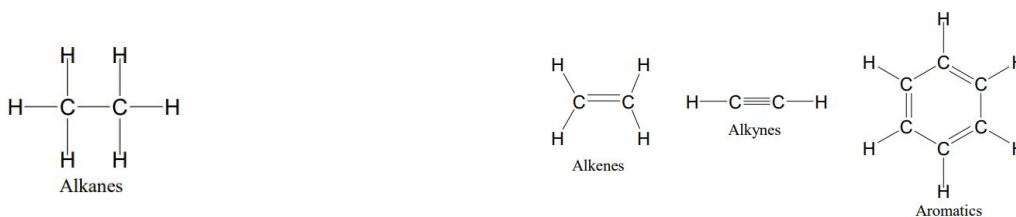
2. Hydrocarbons

The simplest organic compounds are **hydrocarbons**, which consist of only the elements **carbon** and **hydrogen**.

Models of Methane



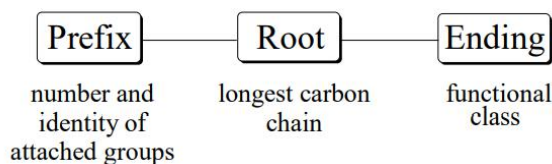
- Carbon atoms bond to each other by **single**, **double**, and **triple** bonds.
- **Saturated hydrocarbons** contain only **single bonds**.
- **Unsaturated hydrocarbons** contain at least one **double** or **triple bond**.



3. IUPAC System of Chemical Nomenclature

The system of nomenclature used to **name** organic compounds was developed by the **International Union of Pure and Applied Chemistry (IUPAC)**.

- A **root** identifies the **longest continuous chain** of **carbon atoms**.
- A **suffix** identifies the **main functional group** in the molecule.
- A set of **prefixes** identifies the **numbers** and **positions** of the substituents (groups which are attached to the longest chain).





3.1 IUPAC Nomenclature of Alkanes

- Step 1. Identify and name the **longest continuous chain of C atoms**

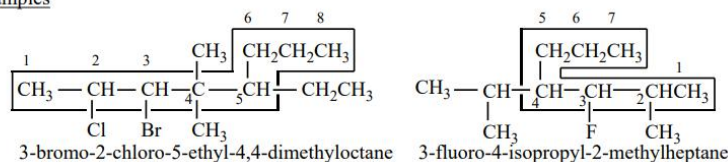
No. of C's	Prefix	No. of C's	Prefix
1	meth-	6	hex-
2	eth-	7	hept-
3	prop-	8	oct-
4	but-	9	non-
5	pent-	10	dec-

- Step 2. Number the atoms in the **longest chain**.
– Number consecutively from the end that will give the **lower number** to any C to which a group is attached.
- Step 3. Name the alkyl groups (**#C + -yl**) and other substituents connected to the **longest chain**.
- Step 4. If there is **more than one** of a particular substituent, combine them into a single word using the appropriate counting **prefix** (di-, tri-, tetra-, etc.).

No. of Groups	Prefix	No. of Groups	Prefix
1	—	6	hexa-
2	di-	7	hepta-
3	tri-	8	octa-
4	tetra-	9	nona-
5	penta-	10	deca-

- Step 5. Arrange the **alkyl groups** in front of the parent name in **alphabetical order**

Examples



3.2 Naming Molecules Containing Functional Groups

- Step 1. Find the **highest priority** functional group. Determine and name the **longest continuous carbon chain** that includes this group.

FROM HIGHEST TO LOWEST PRIORITY

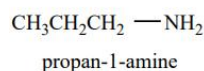
Family of Compound	Structure	Prefix	Suffix
Carboxylic Acid	$\text{R}-\overset{\text{O}}{\parallel}{\text{C}}-\text{OH}$	carboxy-	-oic acid (-carboxylic acid)
Aldehyde	$\text{R}-\overset{\text{O}}{\parallel}{\text{C}}-\text{H}$	oxo- (formyl)	-al (carbaldehyde)
Ketone	$\text{R}-\overset{\text{O}}{\parallel}{\text{C}}-\text{R}$	oxo-	-one
Alcohol	$\text{R}-\text{O}-\text{H}$	hydroxy-	-ol
Amine	$\text{R}-\text{N}$	amino-	-amine

- Step 2. Number the chain so that the **highest priority** functional group is assigned the lower number
- Step 3. Place the **prefixes**, with appropriate **position numbers**, in **alphabetical order** before the root name

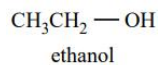
Substituent	Structure	Prefix	Suffix
Alkyl (see list below)	$\text{R}-$	alkyl-	-----
Alkoxy	$\text{R}-\text{O}-$	alkoxy-	-----
Halogen	$\text{F}-$	fluoro-	-----
	$\text{Cl}-$	chloro-	-----
	$\text{Br}-$	bromo-	-----
	$\text{I}-$	iodo-	-----



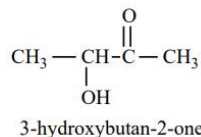
1) **Amines:** prefix: amino-; suffix: -amine



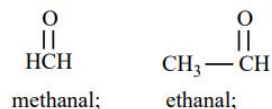
2) **Alcohols:** prefix: hydroxy-; suffix: -ol



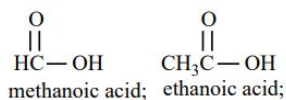
3) **Ketones:** prefix: oxo-; suffix: -one



4) **Aldehydes:** prefix: oxo-, or formyl- (O=CH-); suffix: -al (abbreviation: —CHO).



5) **Carboxylic Acids:** prefix: carboxy-; suffix: -oic acid (abbreviation: —COOH).



3.3 Naming Carboxylic Acid Derivatives

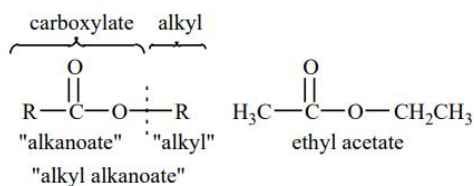
1) Salts of Carboxylic Acids

Salts are named with cation first, followed by the anion name of the carboxylic acid, where “ic acid” is replaced by “ate” :

acetic acid	becomes	acetate
butanoic acid	becomes	butanoate
cyclohexanecarboxylic acid	becomes	cyclohexanecarboxylate

2) Esters

Esters are named as “**organic salts**” that is, the **alkyl** name comes first, followed by the name of the **carboxylate** anion. (common abbreviation: —COOR)





考点二：Homologous series

1.4 explain how **carbon bonds** to form alkanes

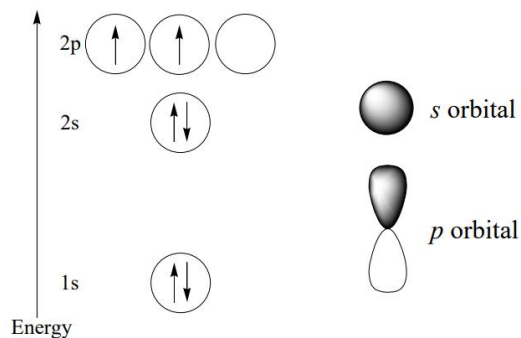
1.5 identify the following functional groups: **alkene, alkyne, aryl, phenyl, alkyl halide (halogenoalkane), alcohol, ether, aldehyde, ketone, carboxylic acid, ester, acid halide, acid anhydride, amine, amide and nitrile**

1.7 classify various organic compounds by determining to which families they belong, based on their names or structures

1. Alkane

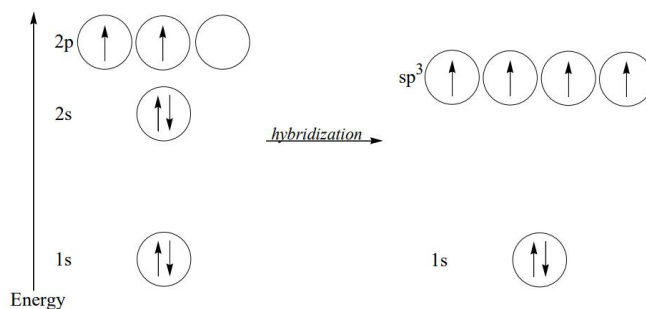
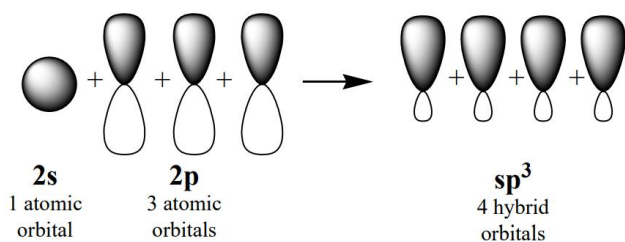
Alkanes are hydrocarbons that have only **single bonds** between atoms

1.1 Atomic Orbitals on Carbon

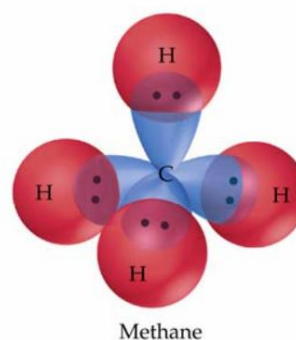
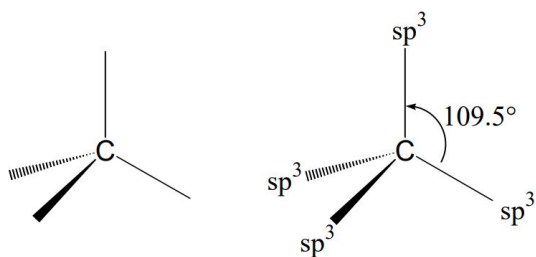


1.2 Hybrid Orbitals

When carbon atoms bond to **4 other atoms**, the **2s orbital** and all **three 2p orbitals** in the valence shell combine to produce **four sp^3 hybrid orbitals**:

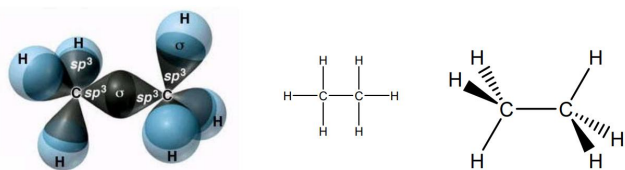


1.3 The Shape of an sp^3 Carbon



1.4 Bonding in Ethane

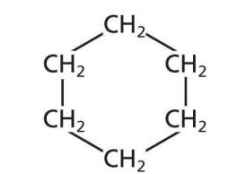
- Bonds arise from the overlap of orbitals on adjacent atoms.
- **End-on-end** overlap of sp^3 orbitals produces a **σ -bond** (sigma bond).
- All single bonds are **σ -bonds**.
- **Free rotation** is possible around **σ -bonds**



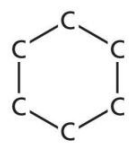


2. Cycloalkanes

- An organic compound that contains a **hydrocarbon ring** is called a **cyclic hydrocarbon**.
- Cyclic hydrocarbons with **only single bonds** are called **cycloalkanes**.



Condensed structural formula



Skeletal structure



Line structure

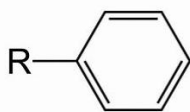
3. Functional group

Class	Functional Group	Example of expanded structural formula	Example of condensed structural formula	IUPAC / Common name
Alkane	None	$\begin{array}{c} \text{H} & \text{H} \\ & \\ \text{H}-\text{C} & -\text{C}-\text{H} \\ & \\ \text{H} & \text{H} \end{array}$	CH_3CH_3	ethane
Alkene		$\begin{array}{c} \text{H} & & \text{H} \\ & \backslash & / \\ & \text{C}=\text{C} \\ & / & \backslash \\ \text{H} & & \text{H} \end{array}$	$\text{H}_2\text{C}=\text{CH}_2$	ethene (ethylene)
Alkyne		$\text{H}-\text{C}\equiv\text{C}-\text{H}$	$\text{HC}\equiv\text{CH}$	ethyne (acetylene)
Aromatic				benzene
Alcohol		$\begin{array}{c} \text{H} & \text{H} \\ & \\ \text{H}-\text{C} & -\text{C}-\text{O}-\text{H} \\ & \\ \text{H} & \text{H} \end{array}$	$\text{CH}_3\text{CH}_2\text{OH}$	ethyl alcohol
Ether		$\begin{array}{c} \text{H} & & \text{H} \\ & & \\ \text{H}-\text{C} & -\text{O}- & \text{C}-\text{H} \\ & & \\ \text{H} & & \text{H} \end{array}$	CH_3OCH_3	methoxymethane (dimethyl ether)
Aldehyde		$\begin{array}{c} \text{H} & \text{O} \\ & \\ \text{H}-\text{C} & -\text{C}-\text{H} \\ \\ \text{H} \end{array}$	$\begin{array}{c} \text{O} \\ \\ \text{CH}_3\text{CH} \end{array}$	ethanal (acetaldehyde)
Ketone		$\begin{array}{c} \text{H} & \text{O} & \text{H} \\ & & \\ \text{H}-\text{C} & -\text{C}- & \text{C}-\text{H} \\ & & \\ \text{H} & & \text{H} \end{array}$	$\begin{array}{c} \text{O} \\ \\ \text{CH}_3\text{CCH}_3 \end{array}$	2-propanone (acetone)
Carboxylic acid		$\begin{array}{c} \text{H} & \text{O} \\ & \\ \text{H}-\text{C} & -\text{C}-\text{O}-\text{H} \\ \\ \text{H} \end{array}$	$\begin{array}{c} \text{O} \\ \\ \text{CH}_3\text{COH} \end{array}$	ethanoic acid (acetic acid)
Ester		$\begin{array}{c} \text{H} & \text{O} & \text{H} \\ & & \\ \text{H}-\text{C} & -\text{C}-\text{O}- & \text{C}-\text{H} \\ & & \\ \text{H} & & \text{H} \end{array}$	$\begin{array}{c} \text{O} \\ \\ \text{CH}_3\text{COCH}_3 \end{array}$	methyl ethanoate (methyl acetate)
Amine		$\begin{array}{c} \text{H} & \text{H} \\ & \\ \text{H}-\text{C} & -\text{N}-\text{H} \\ \\ \text{H} \end{array}$	CH_3NH_2	methylamine
Amide		$\begin{array}{c} \text{H} & \text{O} \\ & \\ \text{H}-\text{C} & -\text{C}-\text{N}-\text{H} \\ & \\ \text{H} & \text{H} \end{array}$	$\begin{array}{c} \text{O} \\ \\ \text{CH}_3\text{CNH}_2 \end{array}$	ethanamide (acetamide)



Aryl group

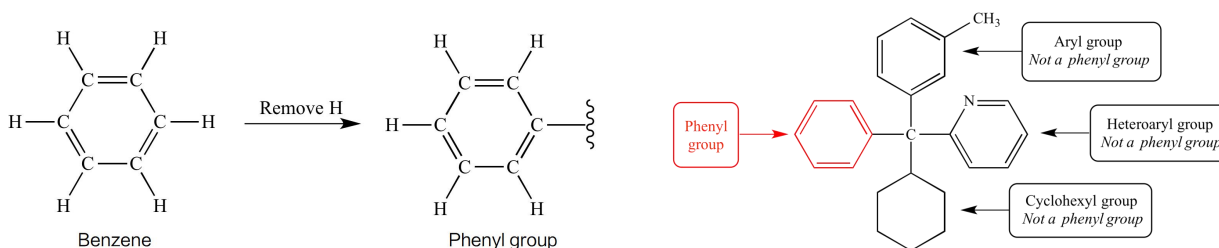
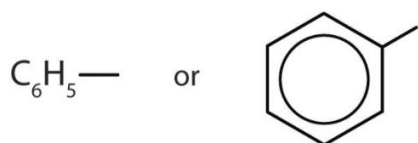
An **aryl group** is a functional group derived from a simple **aromatic ring** compound where one **hydrogen atom** is removed from the ring.



phenyl group

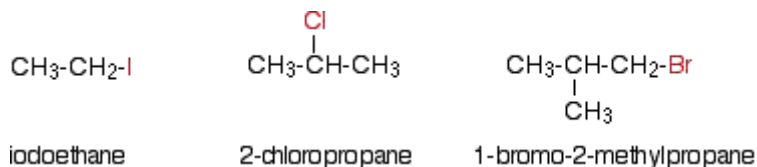
In organic chemistry, the **phenyl group**, or **phenyl ring**, is a cyclic group of atoms with the formula C_6H_5 .

Phenyl group is a member of the **aryl group**. It contains organic molecules derived from benzene.



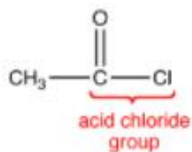
Alkyl halides

Alkyl halides are also known as **haloalkanes**. Alkyl halides are compounds in which one or more **hydrogen atoms** in an alkane have been replaced by halogen atoms (**fluorine, chlorine, bromine or iodine**).



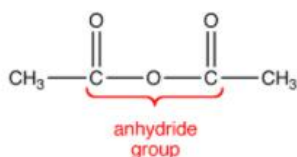
Acid halide

An **acid halide** is the compound obtained when one or more **hydroxy groups** in an **oxoacid** are replaced with **halogen** atoms.



Acid anhydride

An **acid anhydride** or, simply, **anhydride** is the product of formal **condensation** of two **oxoacid molecules** with the release of a **water** molecule.





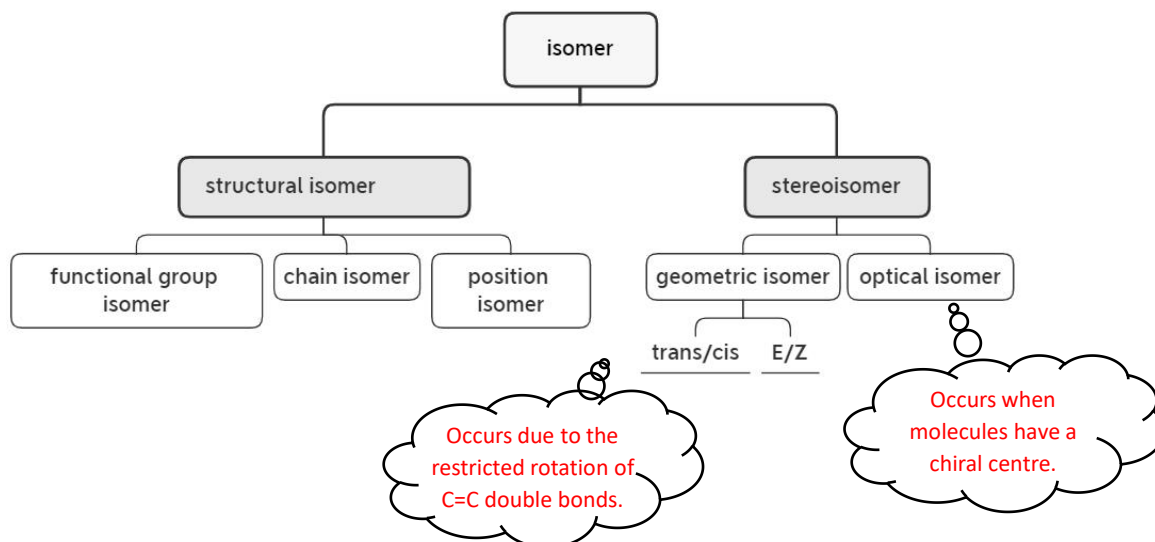
考点三：Isomer

1.6 define **isomers** and illustrate the structural formulas for a variety of organic isomers: specifically (a) the different types of **constitutional isomers** (chain isomers, position isomers and functional group isomers); (b) **optical isomers** (chirality); and (c) **geometric** (cis-trans) isomers.

1. **Isomers** are two or more compounds that have the **same molecular formula** but **different molecular structures**.

--**Structural/constitutional isomers** have the same **chemical formula** but their atoms are bonded in **different arrangements**

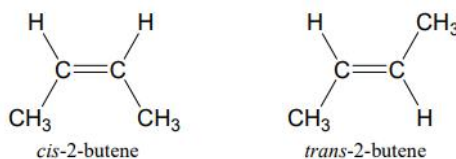
--**Stereoisomers** have the **same structural formula** but differ because their atoms or groups are **arranged differently** in three dimensions.



1) Geometric isomer

– the prefix **cis-** is used when the arms of the longest chain are on the **same side** of the double bond

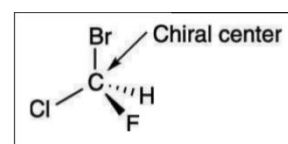
– the prefix **trans-** is used when they are on **opposite sides** of the double bond.



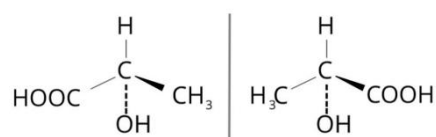
2) Optical isomer

1, Chiral Centres

A chiral centre is a carbon atom with **four different groups** attached on it.

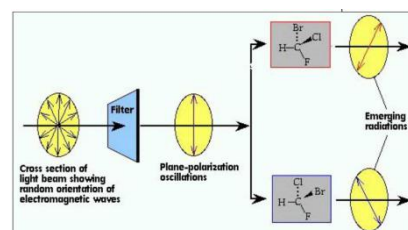


2, Optical Isomers (enantiomers)



--can't be **superimposed**

--cant rotate **plane polarised light**





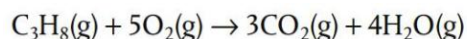
考点四：Chemical equations

1.8 write and balance **chemical equations** to predict the reactions of **selected organic compounds**

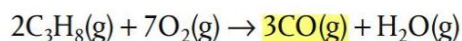
1.9 identify the following types of organic reaction: **reduction, oxidation, substitution, elimination and addition**, and predict the **products** of these reactions

1. Chemical equations

complete combustion:

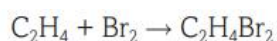


incomplete combustion:

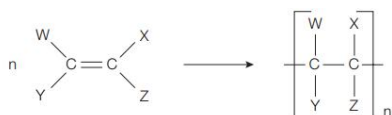


2. Types of organic reaction

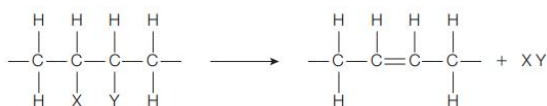
Addition — **joining** two or more molecules **together** to form a **larger molecule**.



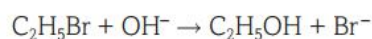
Polymerisation — joining together **lots of simple molecules** to form a **giant molecule**.



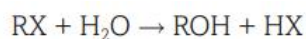
Elimination — when a small group of atoms **breaks away** from a larger molecule.



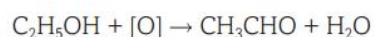
Substitution — when one species is **replaced** by another.



Hydrolysis — **splitting** a molecule into two new molecules by adding **H⁺** and **OH⁻** derived from **water**.



Oxidation — any reaction in which a species **loses electrons** (加 O 或失 H).



Reduction — any reaction in which a species **gains electrons** (加 H 或失 O).

