1.4 Introductory organic chemistry and alkanes

Name: _____ Class: _____ Date: _____ **Total: 17 marks**

KEY WORDS homologous series • structural isomers • initiation • propagation • termination • cracking

Objective

Practise Topic 4: nomenclature and isomers, homologous series, crude oil and cracking, combustion equations, and the free-radical substitution mechanism.

1 Key knowledge and worked examples

■ Name by the rules

Longest chain containing the functional group → lowest locants → prefixes alphabetically. 2-methylbutane, not 3-methylbutane. Count structural isomers systematically by carbon skeleton, then by position.

■ Radical substitution – the three stages

- **Initiation** : $Cl_2 \rightarrow 2Cl\cdot$ (UV light homolyses the bond).
- **Propagation** : $Cl\cdot + CH_4 \rightarrow HCl + CH_3\cdot$; $CH_3\cdot + Cl_2 \rightarrow CH_3Cl + Cl\cdot$. The radical is regenerated – a chain reaction.
- **Termination** : any two radicals combine ($CH_3\cdot + Cl\cdot \rightarrow CH_3Cl$; $CH_3\cdot + CH_3\cdot \rightarrow C_2H_6$).

Worked check. Why does the product mixture include C_2H_6? Because a termination step joins two methyl radicals – the mechanism itself predicts the trace by-product.

■ Cracking and combustion

Cracking converts long alkanes to shorter alkanes PLUS alkenes (the C=C is the signature in any "which mixture" question). Complete combustion: C_xH_y + (x + y/4) O_2 → x CO_2 + (y/2) H_2O. Incomplete combustion gives CO or C – the toxicity questions.

2 Practice

2.1 Give the IUPAC name for the alkane $(CH_3)_2CHCH_2CH_2CH_3$. [1]

2.2 State the energy source that starts radical substitution of methane by chlorine, and explain its role. [2]

2.3 Write the equation for the complete combustion of dodecane, $C_{12}H_{26}$. [2]

3 Exam-style questions

3.1 A single molecule of $C_{12}H_{26}$ is cracked. The products are two molecules of ethene, one molecule of propene and one molecule of an alkane. Deduce the molecular formula and give a possible structure of the alkane. [3]

3.2 Give the equations for the initiation step and the TWO propagation steps in the reaction between chlorine and ethane, and explain why a trace of butane appears in the products. [5]

3.3 How many structural isomers have the formula C_6H_{14}? Draw skeletal formulas for any three of them. [4]