

1.5.1 Alkene conditions, polymers and disposal

Name: _____ Class: _____ Date: _____ **Total: 22 marks**

KEY WORDS addition polymerisation • repeat unit
• biodegradable

Objective

Choose alkene reaction conditions, distinguish a formula from evidence for a double bond, and reconstruct addition-polymer monomers and repeat units.

1 Key knowledge and worked examples

■ Count rings as well as double bonds

An acyclic monoalkene has formula C_nH_{2n} . A cycloalkene with one ring and one $C=C$ has C_nH_{2n-2} . A saturated single-ring cycloalkane has C_nH_{2n} , so formula alone cannot prove a double bond.

Hydrogen/Ni adds H across $C=C$. Steam with an acid catalyst forms an alcohol. Cold dilute acidified potassium manganate(VII) gives a diol. Bromine decolourisation is a test for unsaturation under suitable conditions.

■ Preserve side groups in a repeat unit

Addition polymerisation opens the double bond into two single backbone bonds. For propene, the repeat unit is $[-CH_2-CH(CH_3)-]_n$: the methyl group remains attached to the same backbone carbon. Show continuation bonds through the brackets. No water or other small molecule is eliminated.

2 Practice

2.1 Give the molecular formula of cyclohexene and explain why it differs from hex-1-ene. [2]

2.2 State reagents/conditions and the organic product for hydrogenation, hydration and mild oxidation of ethene. [6]

2.3 Two pure liquids each have formula C_5H_{10} . One rapidly decolourises bromine water in the dark; the other does not. Give a possible compound for each and explain why the formula alone was insufficient. [3]

3 Exam-style questions

3.1 Name the alkene monomer corresponding to the repeat unit $[-CH_2-CH(CH_2CH_3)-]_n$, giving its structural formula. Explain why the pendant ethyl group is not inserted into the main polymer backbone. [3]

3.2 A student says that any alkene with different groups attached to its $C=C$ shows E/Z isomerism. Use 2-methylpropene and pent-2-ene to evaluate the statement, stating the condition separately for each double-bond carbon. [4]

3.3 Compare recycling, incineration with gas treatment, and developing biodegradable polymers as ways to limit disposal problems. Explain one limitation of each and why the label biodegradable does not mean immediate breakdown in every environment. [4]

Solutions

Original authored guidance; equivalent structural formulae are accepted.

2.1 C_6H_{10} . One ring removes two hydrogens relative to acyclic hexene C_6H_{12} , while both already contain a double bond.

2.2 Hydrogen with nickel catalyst gives ethane. Steam with an acid catalyst gives ethanol. Cold dilute acidified potassium manganate(VII) gives ethane-1,2-diol. Strong hot oxidation is not the specified diol-producing method.

2.3 Pent-1-ene can be the decolourising liquid, cyclopentane the other. Both have C_5H_{10} , but one has $\text{C}=\text{C}$ and the other a saturated ring; the formula does not reveal connectivity. The test supports unsaturation rather than uniquely proving pent-1-ene.

3.1 But-1-ene, $\text{CH}_2=\text{CHCH}_2\text{CH}_3$. The two original double-bond carbons become adjacent backbone carbons; the attached ethyl group remains a side group.

3.2 Each double-bond carbon must have two different groups. In 2-methylpropene, $\text{CH}_2=\text{C}(\text{CH}_3)_2$, one carbon has two H and the other two methyl groups, so it cannot show E/Z isomerism. In pent-2-ene, $\text{CH}_3\text{CH}=\text{CHCH}_2\text{CH}_3$, each has H plus a different carbon group, so E and Z forms are possible. Restricted rotation about $\text{C}=\text{C}$ allows these forms to remain distinct; different groups somewhere in the molecule is insufficient.

3.3 Recycling can conserve feedstock but needs collection/sorting and suitable clean material. Incineration can recover energy, but relevant toxic gases must be removed and carbon emissions remain. Biodegradable alternatives may reduce persistence, but breakdown needs suitable conditions, organisms, time and often industrial composting. They do not automatically degrade rapidly in a cold sea or landfill, and must not be treated as permission to litter. Accept other linked scientific tradeoffs.