

Victoria Junior College
2024 JC1 H2 Organic Chemistry Tutorial: Alkenes

Summary of Reactions

Complete the following table.

1 Preparation of Alkenes

Starting compound	Reaction type	Reagents & Conditions	Products formed
$\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$	Elimination	Excess conc. H_2SO_4 , heat OR Al_2O_3 , heat	
$\text{CH}_3\text{CH}(\text{Br})\text{CH}_2\text{CH}_3$			

2 Reactions of Alkenes

Starting compound	Reaction type	Reagents & Conditions	Carbon-containing product(s)
$\text{CH}_3\text{CH}_2\text{CH}=\text{CH}_2$		$\text{HBr}(\text{g})$	
			$\text{CH}_3\text{CH}_2\text{CH}(\text{Br})\text{CH}_2\text{Br}$
		$\text{Br}_2(\text{aq})$	
			$\text{CH}_3\text{CH}_2\text{CH}(\text{OH})\text{CH}_3$
			$\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3$
	Oxidation	cold KMnO_4 in $\text{NaOH}(\text{aq})$	
		KMnO_4 in $\text{H}_2\text{SO}_4(\text{aq})$, heat	

Note: If no heat is written for a reaction, it means that the reaction can take place at room temperature.

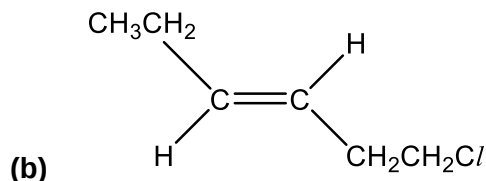
Introduction

1 Write down the skeletal formula for each of the following.

- (a) 4-bromopent-1-ene
(b) *cis*-2,2-dimethylhex-3-ene

2 Give the IUPAC name for each of the following.

- (a) $(\text{CH}_3)_2\text{C}=\text{CHCH}_3$



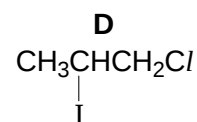
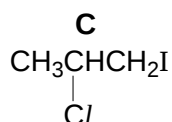
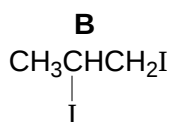
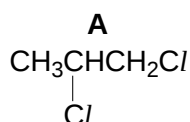
Reaction mechanism

- 3 (a) Name the type of reaction and describe the mechanism for the reaction between but-1-ene and hydrogen bromide to form 2-bromobutane. Show all charges and relevant lone pairs and show the movement of electron pairs using curly arrows.
- (b) State the type of hybridisation in the alkene carbon atom of but-1-ene and the reactive carbon atom in the intermediate formed in the mechanism.
- (c) By referring to the shape of the reactive carbon atom in the intermediate formed in the mechanism, explain why compound formed from the reaction between but-1-ene and hydrogen bromide has no effect on plane-polarised light.
- (d)(i) Write an equation, giving the structural formula of the major organic product, for the reaction between but-1-ene and aqueous bromine under room temperature.
- (ii) [EXTENSION] Describe the mechanism written in (d)(i). Show all charges and relevant lone pairs and show the movement of electron pairs using curly arrows.

Electrophilic addition of alkenes

- 4 Hydrogen iodide undergoes an addition reaction with propene forming 2-iodopropane. When propene is bubbled through iodine monochloride, ICl , dissolved in a suitable solvent, a similar reaction occurs.

Which product will be present in the greatest yield?



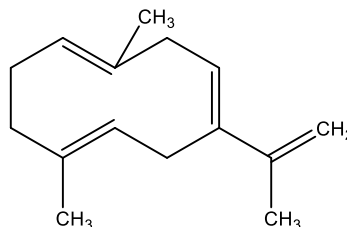
[N13/II/21]

Oxidative cleavage of alkenes

- 5 The following compound is used as an alarm pheromone by some aphids.

Which product is obtained from the reaction of this pheromone with excess hot concentrated acidic KMnO_4 ?

- A** $\text{CH}_3\text{COCH}_2\text{CHO}$
B $\text{CH}_3\text{COCH}_2\text{CH}_2\text{CO}_2\text{H}$
C HCHO
D $\text{HO}_2\text{CCH}_2\text{COC}(\text{CH}_3)=\text{CH}_2$



- 6 An alkene, **X**, has the molecular formula C_5H_{10} . On oxidation with hot acidified potassium manganate(VII) solution, **X** gives rise to $CH_3(CH_2)_2CO_2H$ as the only organic compound. Deduce the structure of **X**, and using [O] notation, write the equation for the above reaction.
- 7 An alkane **B** is a component of petrol. When treated with bromine under free radical conditions it produces a mixture of brominated compounds, including **C**, $C_6H_{12}Br_2$. Dehydrobromination of **C** produces **D**, C_6H_{10} . When **D** is oxidised by hot concentrated $KMnO_4$, three compounds, CO_2 , CH_3CO_2H and CH_3COCO_2H , are formed in equimolar amounts.

***Strategy:**

Draw a flowchart. Easier to understand all the reactions.

Compare the difference among all molecular formulae in deducing the structures.

- (a) Suggest reagents and conditions for the conversion of **C** to **D**.
- (b) Suggest a structure for compound **D**, and hence deduce the structure of compound **B**.
- (c) There are four possible isomers of $C_6H_{12}Br_2$ that could give **D** on dehydrobromination. Draw the structures of **two** of them.
- (d) Suggest, with a reason, the number of stereoisomers of compound **D**.

[N06/III/6(b)]

Supplementary Questions

- 1 Reaction of ethene with bromine in the presence of aqueous sodium chloride gives a mixture of products.

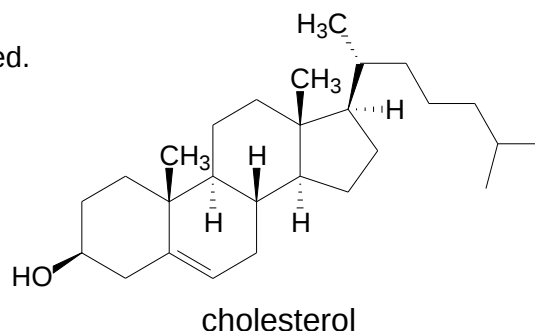
Which pair of products will be included in this mixture?

- | | | |
|----------|---|---|
| A | $\text{CH}_2\text{OH}-\text{CH}_2\text{Br}$ | $\text{CH}_2\text{Cl}-\text{CH}_2\text{OH}$ |
| B | $\text{CH}_2\text{Br}-\text{CH}_2\text{Br}$ | $\text{CH}_2\text{OH}-\text{CH}_2\text{Cl}$ |
| C | $\text{CH}_2\text{Br}-\text{CH}_2\text{Br}$ | $\text{CH}_2\text{Cl}-\text{CH}_2\text{Cl}$ |
| D | $\text{CH}_2\text{Br}-\text{CH}_2\text{Br}$ | $\text{CH}_2\text{Cl}-\text{CH}_2\text{Br}$ |

- 2 The diagram shows the structure of the naturally-occurring molecule cholesterol.

Cholesterol reacts with cold, dilute acidified KMnO_4 . Four students made claims about this reaction.

- W The cyclohexene ring becomes saturated.
 X The cyclohexene ring is broken open.
 Y The number of chiral centres increases by 1.
 Z The number of chiral centres increases by 2.



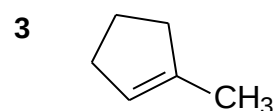
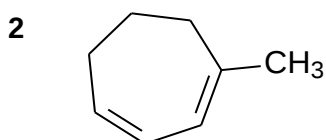
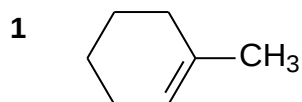
Which students' claims are correct?

- A** W and Y **B** W and Z **C** X and Y **D** X and Z
 [N12/II/22]

- 3 Predict the carbon-containing product(s) obtained by subjecting each of the following alkenes under the following conditions.

	cold, alkaline KMnO_4	hot alkaline KMnO_4	Conc. H_2SO_4 followed by H_2O
$\text{CH}_3\text{CH}_2\text{CH}=\text{CH}_2$			
$(\text{CH}_3)_2\text{C}=\text{CHCH}_3$			

- 4 A hydrocarbon, on heating with an excess of hot concentrated acidic $\text{KMnO}_4(\text{aq})$, produces $\text{HO}_2\text{CCH}_2\text{CH}_2\text{CH}_2\text{COCH}_3$. What could the hydrocarbon be?



- 5 How many different alkenes, including *cis-trans* isomers, could be produced when $\text{CH}_3\text{CHBrCH}_2\text{CH}_3$ is reacted with hot ethanolic NaOH ? How could one of these isomers be distinguished from the rest through a chemical test? In each case identify the products of any reaction.
- 6 A hydrocarbon of molecular formula C_4H_{10} undergoes chlorination to form a mixture of monosubstituted products of molecular formula $\text{C}_4\text{H}_9\text{Cl}$.

Compounds **A** and **B** of molecular formula $\text{C}_4\text{H}_9\text{Cl}$ undergo elimination to form compounds **C** and **D** respectively. Only compound **C** exists as a pair of *cis-trans* isomers **E** and **F**. Compound **D** reacts with hot acidified $\text{KMnO}_4(\text{aq})$ to yield propanoic acid, $\text{CH}_3\text{CH}_2\text{CO}_2\text{H}$, and carbon dioxide as the only carbon-containing products.

- (a) State the reagents and conditions for the formation of compounds **C** and **D**.
- (b) Identify the compounds **A**, **B**, **D**, **E** and **F**.
- 7 Suggest a structural formula for each of the compounds **A** – **D** in the following schemes.

