

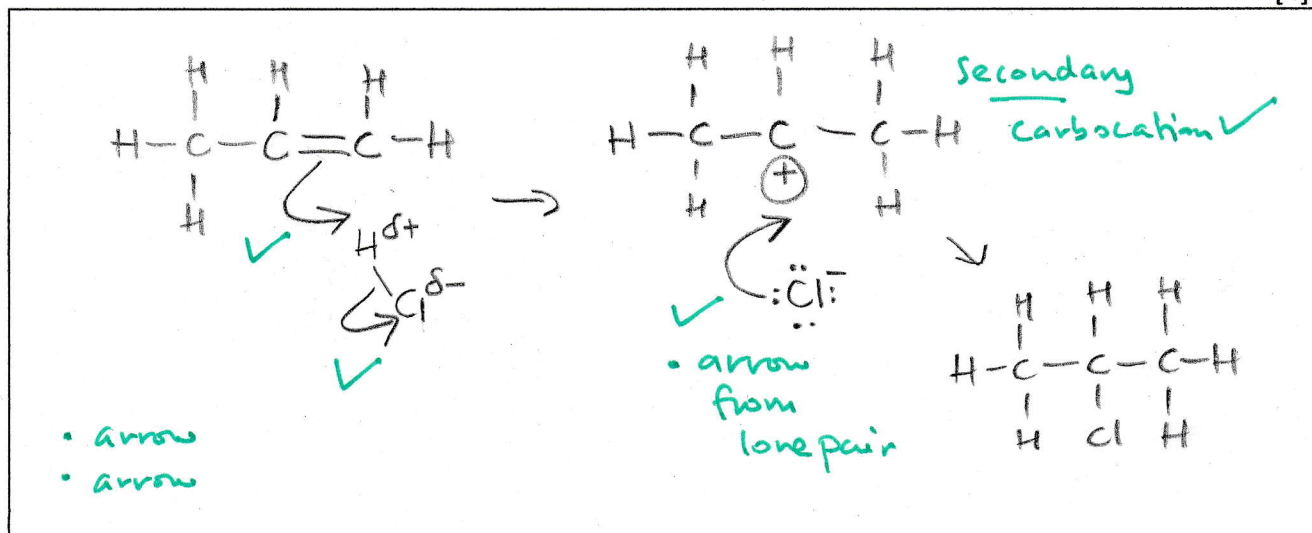
ORGANIC CHEMISTRY AHL (HL only)

Please ensure that you have also completed the Core (SL & HL) questions

1. (a) Propene (CH_3CHCH_2) reacts readily with hydrogen chloride in an electrophilic addition reaction. The major organic product is 2-chloropropane.

(i) Sketch the mechanism for the reaction of propene with hydrogen chloride using curly arrows.

[4]



(ii) Explain why the major organic product is 2-chloropropane.

[2]

The secondary carbocation is most stable / more stable than primary. ✓
Due to the positive inductive effect / electron donating ability of neighbouring alkyl groups ✓

(iii) State the reagent needed to convert 2-chloropropane into propan-2-ol.

[1]

$\text{NaOH}(\text{aq})$ ✓ (allow water) ✓

(iv) Propan-2-ol can also be made from propanone (CH_3COCH_3). State the type of reaction, and the reagents needed for the conversion.

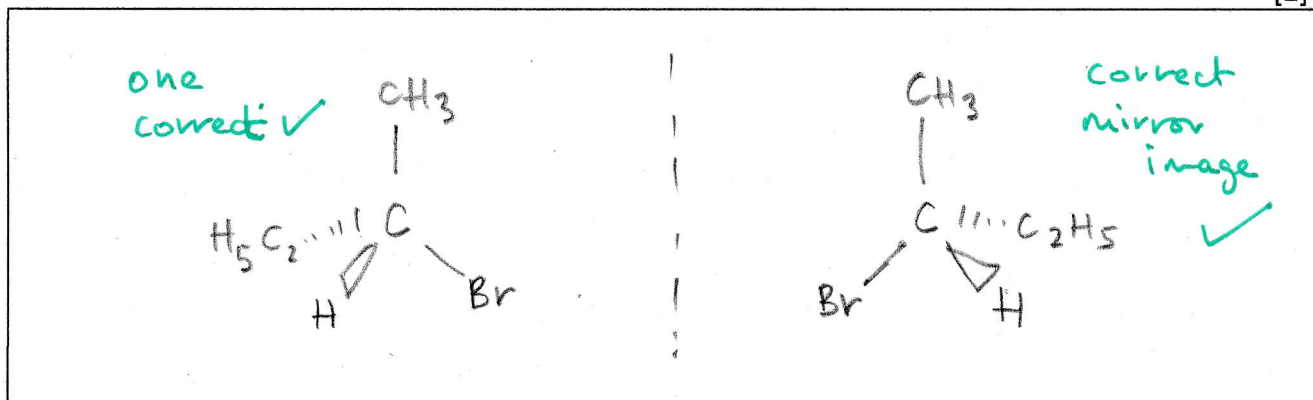
[3]

Type of reaction: reduction ✓
Reagents: $\text{NaBH}_4(\text{aq})$ (in alkaline solution) ✓ (allow LiAlH_4 in dry ether) ✓
then dilute acid / $\text{H}^+(\text{aq})$ ✓

2. (a) 2-bromobutane exhibits optical isomerism.

(i) Draw the two stereoisomers for 2-bromobutane using wedge-dash type representations.

[2]



(ii) Outline how two enantiomers can be distinguished using a polarimeter.

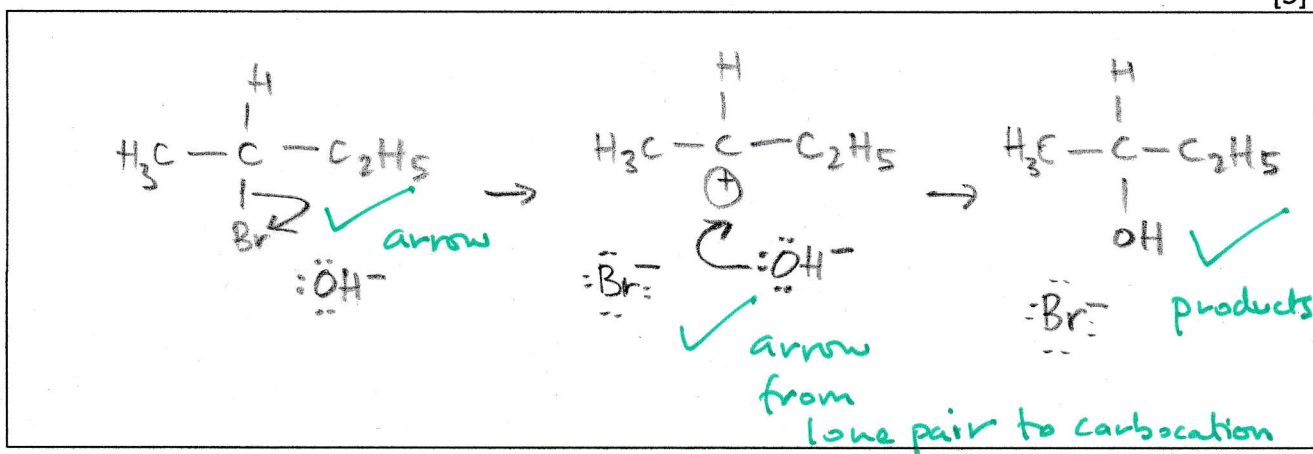
[2]

Pass plane polarised light through the samples ✓
Each enantiomer will rotate the plane of light in opposite directions. ✓

(b) 2-bromobutane undergoes an S_N1 mechanism with a hydroxide ion in a polar protic solvent.

(i) Sketch the mechanism for the S_N1 reaction of 2-bromobutane with a hydroxide ion using curly arrows.

[3]



(ii) Name a suitable polar protic solvent.

[1]

Ethanol ✓ or water or amine
(allow any solvent with H-bonds)

(iii) State the meaning of each of the three terms in S_N1 .

[2]

Substitution nucleophilic

(1 species in the rate determining step / RDS molecularity of 1.

(iv) The 2-bromobutane used in the reaction in 2(b) above consisted of a single enantiomer. State the enantiomeric nature of the product of the reaction. Explain your answer.

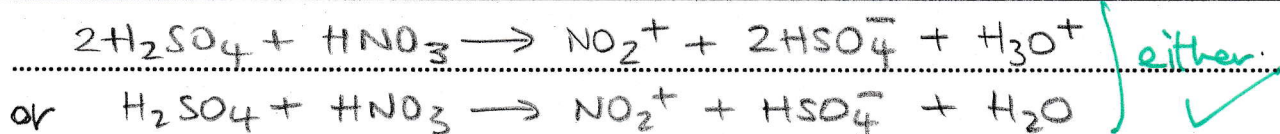
[2]

- Product will be 50:50 / equal mixture / racemic mixture
- because the carbocation is planar and nucleophile / OH^- ion can attack from either side

3. (a) Benzene will undergo nitration when exposed to a nitrating mixture. If the temperature is kept below $50^\circ C$ mono-nitration will occur.

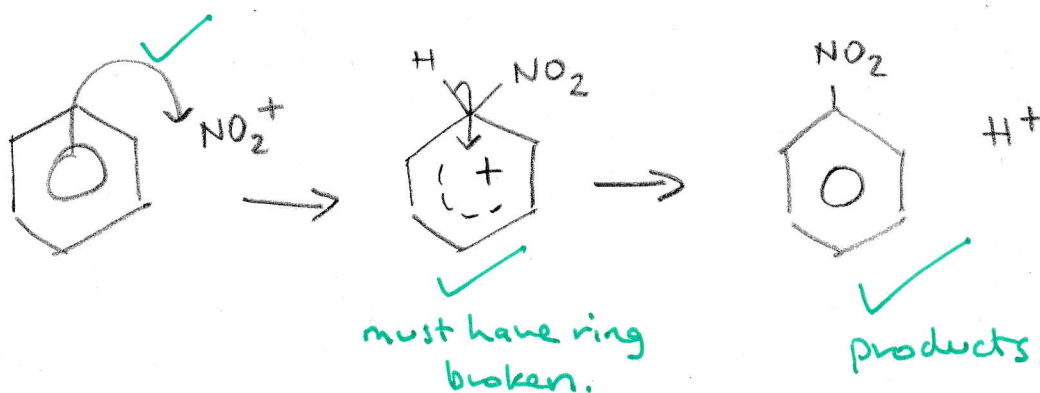
(i) Write the equation to produce the active nitrating agent from concentrated sulfuric and nitric acids.

[1]



(ii) Sketch the mechanism for the nitration of benzene, using curly arrows.

[3]



(iii) State the role of the sulfuric acid.

[1]

A catalyst (it is recycled $H^+ + HSO_4^- \rightleftharpoons H_2SO_4$)

(iv) What does a double-headed curly arrow represent?

[1]

movement of a pair of electrons. ✓

(v) Nitrobenzene, $C_6H_5NO_2$, can be converted to phenylamine via a two-stage reaction.

In the **first stage**, nitrobenzene is reduced with tin in an acidic solution to form an intermediate ion and tin(II) ions. In the **second stage**, the intermediate ion is converted to phenylamine in the presence of hydroxide ions.

Formulate the equation for each stage of the reaction

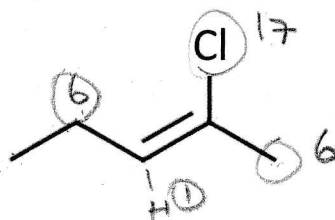
This is a very challenging question!

oxidation state +3 (+6e⁻)

[2]



4. E/Z isomerism is exhibited by the molecule, M:



(a) Determine which isomer is shown above. Explain your answer.

[1]

This is the Z isomer as the two highest priority groups (C₂H₅ and Cl) are on the same side.

OWTTE.

Z and explanation ✓

(b) Use your answer in 4(a) to determine the full IUPAC name for molecule, M.

[1]

(Z)-2-chloropent-2-ene ✓

Total Marks 32 (48 minutes)