

## ORGANIC CHEMISTRY Core (SL & HL)

1. (a) Ethanol ( $C_2H_5OH$ ) is an alcohol and is a commonly used solvent.

(i) Ethanol can be oxidised to ethanal ( $CH_3CHO$ ). State the reaction conditions needed to isolate ethanal and name the oxidising agent and catalyst commonly used to oxidise ethanol to ethanal.

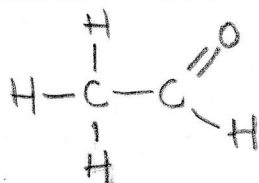
[2]

Potassium dichromate with an acid catalyst /  $Cr_2O_7^{2-}$  and  $H^+$  ✓  
(and heat) ✓

Ethanal must be distilled out as it is formed. ✓

(ii) Draw the displayed (full structural) formula for ethanal.

[1]



(iii) Write a fully balanced equation for the oxidation of ethanol to ethanal. Use [O] to represent oxygen from the oxidising agent.

[1]



(b) Ethanol, when reacted with carboxylic acids (and an  $H_2SO_4$  catalyst) is also be used to make esters that are commonly used as flavourings.

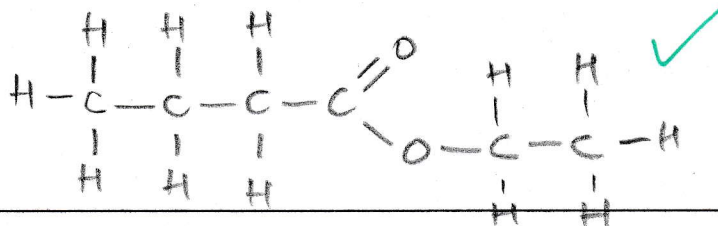
(i) Name and draw the full structural formula for the ester formed from butanoic acid and ethanol.

[2]

Name:

Ethyl butanoate ✓

Structure:



allow any unambiguous structure

(ii) Name an isomer of the ester in 1(b)(i) above that is also an ester.

[1]

Propyl propanoate ✓ any ester with 6 carbons.

2. (a) Alkanes are a homologous series of hydrocarbons with the same general formula.

(i) Describe two features of a homologous series, other than having the same general formula.

[2]

same functional group / similar chemical properties /  
formulae differ in series by  $\text{CH}_2$  / they show a gradation  
of physical properties  
any 2 ✓✓

(ii) State the general formula for the alkanes.

[1]

$\text{C}_n\text{H}_{2n+2}$  ✓ any letter for n

(b) Alkanes are often used as fuels, and combust completely in the presence of sufficient oxygen.

(i) Write an equation to show the complete combustion of butane.

[2]

$\text{C}_4\text{H}_{10} + 6\frac{1}{2}\text{O}_2 \rightarrow 4\text{CO}_2 + 5\text{H}_2\text{O}$  formulae ✓  
balanced ✓  
any multiples.

(ii) Explain why the **incomplete** combustion of butane can be dangerous.

[1]

It produces carbon monoxide which is toxic / binds  
to haemoglobin on red blood cells / prevents carriage of  
oxygen.

(c) Ethane ( $\text{C}_2\text{H}_6$ ) will react with chlorine in the presence of sunlight to produce chloroethane.

(i) State the type of reaction and the mechanism by which this reaction occurs.

[2]

Free radical substitution

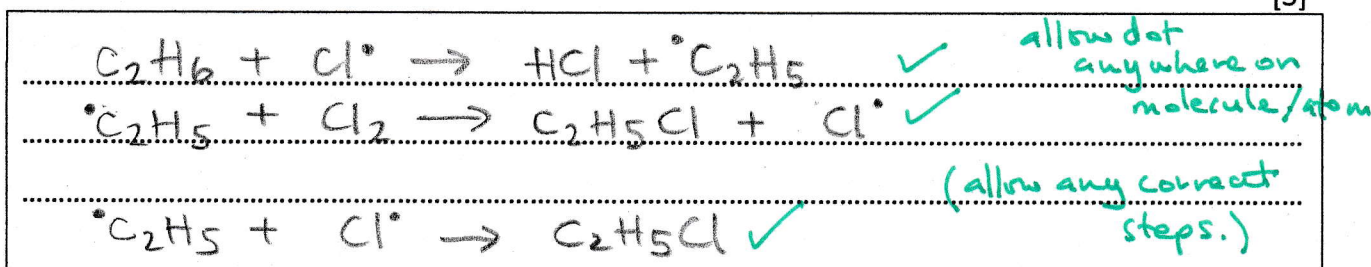
(ii) Write an equation to show the initiation step of the reaction mechanism.

[1]

$\text{Cl}_2 \rightarrow 2\text{Cl}\cdot$  ✓  
allow free radicals without dot  
if consistent throughout question.

(iii) Formulate **two** possible propagation steps and one possible termination step in the formation of chloroethane.

[3]



3. Benzene ( $C_6H_6$ ) can be represented by a Kekulé structure (A) and a delocalised structure (B):



A



B

(a) State one piece of physical evidence and one piece of chemical evidence that suggests that benzene has a delocalised structure (B) rather than the Kekulé structure (A).

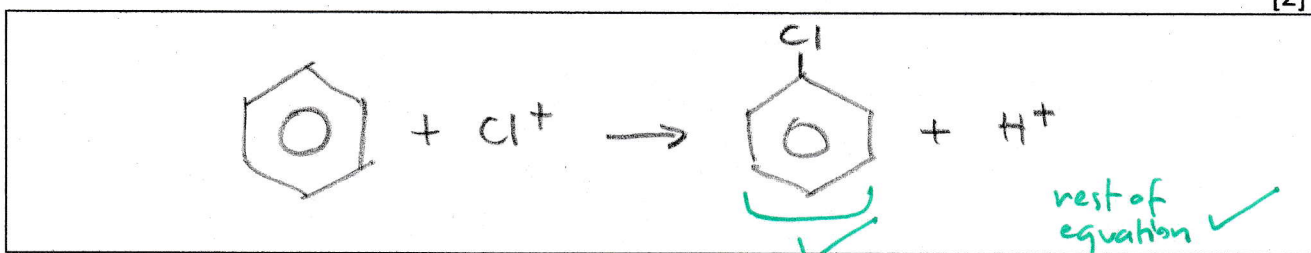
[2]

Physical evidence: <u>any 1</u>	Chemical evidence: <u>any 1</u>
<ul style="list-style-type: none"> <li>equal C-C bond lengths</li> <li>regular hexagon shape</li> <li>C-C bond order of 1.5</li> <li>C-C bond lengths are intermediate between single &amp; double.</li> </ul>	<ul style="list-style-type: none"> <li>does not undergo addition reactions e.g. with Bromine.</li> <li>substitution forms 1 isomer.</li> <li>more stable than</li> <li>enthalpy of hydrogenation less than compared to </li> </ul>

(b) Benzene will react with electrophiles in substitution reactions. A  $Cl^+$  electrophile can be produced using a catalyst called a halogen carrier.

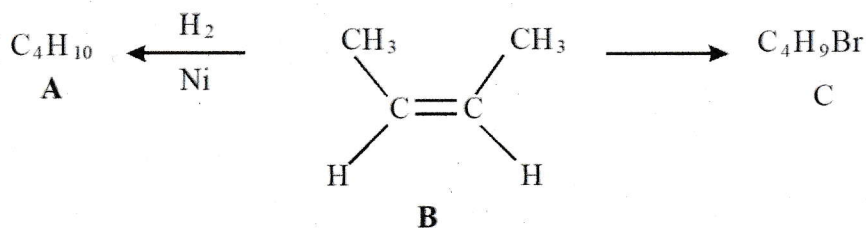
(i) Formulate an equation to show the substitution reaction of benzene with  $Cl^+$ .

[2]



PTO

4. (a) Two reactions of an alkene (B) are shown below:



(i) Name compounds A and C.

[2]

A Butane ✓

C 2-bromobutane ✓

(ii) State the type of reaction, and the reagent needed for the conversion of B into C.

[2]

Addition reaction; HBr ✓

(iii) Outline a simple laboratory test that could distinguish between A and B and state the results.

[2]

Shake with bromine water, it will decolourise for B but not for A. ✓

(or  $\text{KMnO}_4$  in acid solution - decolourises.) ✓

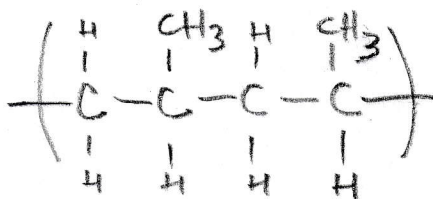
(iv) State the molecular formula of the organic product when compound C reacts with NaOH (aq).

[1]

$\text{C}_4\text{H}_9\text{OH}$  ✓ or  $\text{C}_4\text{H}_{10}\text{O}$  (or allow  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3$ ) ✓

(b) Propene is another alkene that undergoes polymerisation. Draw a section of the poly(propene) polymer showing two repeat units.

[2]



correct repeat unit ✓  
2 units ✓

Total Marks 32 (48 minutes)