

**Q1.** Some oil-fired heaters use paraffin as a fuel.

One of the compounds in paraffin is the straight-chain alkane, dodecane ( $C_{12}H_{26}$ ).

- (a) Give the name of the substance from which paraffin is obtained.  
State the name of the process used to obtain paraffin from this substance.

Substance .....

Process .....

(2)

- (b) The combustion of dodecane produces several products.

Write an equation for the **incomplete** combustion of dodecane to produce gaseous products only.

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(1)

- (c) Oxides of nitrogen are also produced during the combustion of paraffin in air.

- (i) Explain how these oxides of nitrogen are formed.

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(2)

- (ii) Write an equation to show how nitrogen monoxide in the air is converted into nitrogen dioxide.

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(1)

- (iii) Nitric acid ( $HNO_3$ ) contributes to acidity in rainwater.

Deduce an equation to show how nitrogen dioxide reacts with oxygen and water to form nitric acid.

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(1)

(d) Dodecane ( $C_{12}H_{26}$ ) can be cracked to form other compounds.

(i) Give the general formula for the homologous series that contains dodecane.

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(1)

(ii) Write an equation for the cracking of one molecule of dodecane into equal amounts of two different molecules each containing the same number of carbon atoms.

State the empirical formula of the straight-chain alkane that is formed.  
Name the catalyst used in this reaction.

Equation .....

Empirical formula of alkane .....

Catalyst .....

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(3)

(iii) Explain why the melting point of dodecane is higher than the melting point of the straight-chain alkane produced by cracking dodecane.

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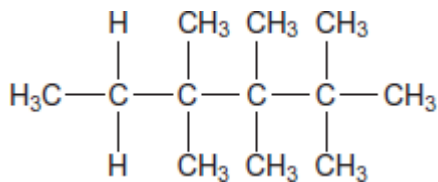
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(2)

(e) Give the IUPAC name for the following compound and state the type of structural isomerism shown by this compound and dodecane.



IUPAC name .....

Type of structural isomerism .....

(2)

(f) Dodecane can be converted into halododecanes.


Deduce the formula of a substance that could be reacted with dodecane to produce 1-chlorododecane and hydrogen chloride only.

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(1)

(Total 16 marks)

**Q2.** The following table gives the names and structures of some structural isomers with the molecular formula  $\text{C}_5\text{H}_{10}$ .

	Name of isomer	Structure
Isomer 1	pent-2-ene	$\text{CH}_3\text{CH} = \text{CHCH}_2\text{CH}_3$
Isomer 2	cyclopentane	
Isomer 3	3-methylbut-1-ene	$(\text{CH}_3)_2\text{CHCH} = \text{CH}_2$
Isomer 4	2-methylbut-2-ene	$(\text{CH}_3)_2\text{C} = \text{CHCH}_3$
Isomer 5	2-methylbut-1-ene	$\text{H}_2\text{C} = \text{C}(\text{CH}_3)\text{CH}_2\text{CH}_3$

(a) Isomer 1 exists as E and Z stereoisomers.

(i) State the meaning of the term **stereoisomers**.

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(2)

(ii) Draw the structure of the E stereoisomer of Isomer 1.

(1)

(b) A chemical test can be used to distinguish between separate samples of Isomer 1 and Isomer 2.

Identify a suitable reagent for the test.

State what you would observe with Isomer 1 and with Isomer 2.

Reagent.....

Observation with Isomer 1.....

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Observation with Isomer 2.....

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(3)

(c) Use **Table A** on the Data Sheet when answering this question.  
Isomer 3 and Isomer 4 have similar structures.

(i) State the infrared absorption range that shows that Isomer 3 and Isomer 4 contain the same functional group.

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- (ii) State **one** way that the infrared spectrum of Isomer 3 is different from the infrared spectrum of Isomer 4.

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(1)

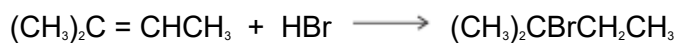
- (d) Two alcohols are formed by the hydration of Isomer 4.

Draw the **displayed formula** for the alcohol formed that is oxidised readily by acidified potassium dichromate(VI).

(1)

- (e) Isomer 4 reacts with hydrogen bromide to give two structurally isomeric bromoalkanes.

- (i) Name and outline a mechanism for the reaction of Isomer 4 with hydrogen bromide to give 2-bromo-2-methylbutane as the major product.



Name of mechanism.....

Mechanism

(5)

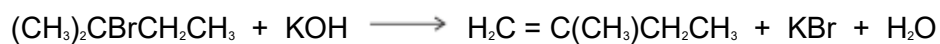
- (ii) The minor product in this reaction mixture is 2-bromo-3-methylbutane.

Explain why this bromoalkane is formed as a minor product.

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(2)

- (f) Name and outline a mechanism for the following reaction to form Isomer **5**. State the role of the hydroxide ion in this reaction.



Name of mechanism .....

Mechanism

Role of hydroxide ion .....

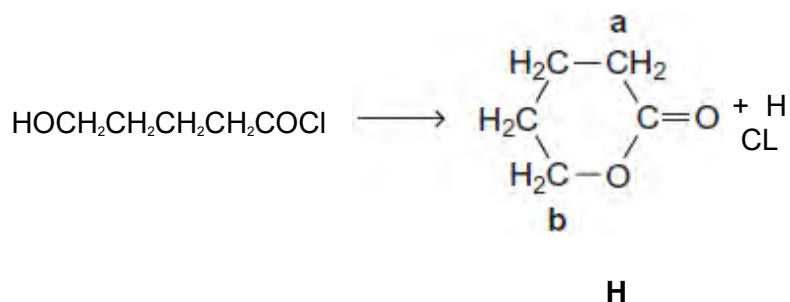
(5)

(Total 21 marks)

**Q3.** This question is about some isomers of  $\text{C}_5\text{H}_8\text{O}_2$

- (a) Compound **H** is a cyclic ester that can be prepared as shown.

On the structure of **H**, two of the carbon atoms are labelled.



(i) Name and outline a mechanism for this reaction.

Use **Table C** on the Data Sheet to give the  $^{13}\text{C}$  n.m.r.  $\delta$  value for the carbon atom labelled **a** and the  $\delta$  value for the carbon atom labelled **b**.

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(ii)  $\text{HOCH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{COCl}$  can also react to form a polyester in a mechanism similar to that in part (i).

Draw the repeating unit of the polyester and name the type of polymerisation involved.

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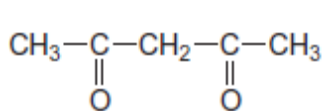
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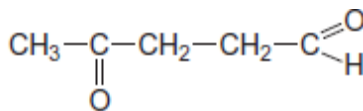
(2)

- (b) State how you could distinguish between compounds **J** and **K** by a simple test-tube reaction.

State how you could distinguish between **J** and **K** by giving the number of peaks in the  $^1\text{H}$  n.m.r. spectrum of each compound.



**J**



**K**

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(5)

- (c) Draw the structure of each of the following isomers of  $\text{C}_5\text{H}_8\text{O}_2$ .  
Label each structure you draw with the correct letter **L**, **M**, **N**, **P** or **Q**.

**L** is methyl 2-methylpropenoate.

**M** is an ester that shows E-Z stereoisomerism.

**N** is a carboxylic acid with a branched carbon chain and does **not** show stereoisomerism.

**P** is an optically active carboxylic acid.

**Q** is a cyclic compound that contains a ketone group and has only two peaks in its  $^1\text{H}$  n.m.r. spectrum.



(5)  
(Total 19 marks)