Practice Question Set For A-Level
Subject : Chemistry
Paper-2 Topic: Nuclear Magnetic Resonance Spectroscopy

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Name of the Student:_____
Max. Marks : 22 Marks **Time : 22 Minutes**

Q1.

This question is about hydrocarbons.

(a) Eicosane ($C_{20}H_{42}$) can be cracked by heating to 700 K in the presence of a catalyst.

The products are

- an aromatic hydrocarbon C_8H_{10}
- an alkane C_6H_{14}
- another alkane.

$$C_{20}H_{42} \longrightarrow C_8H_{10} + C_6H_{14} + _____$$

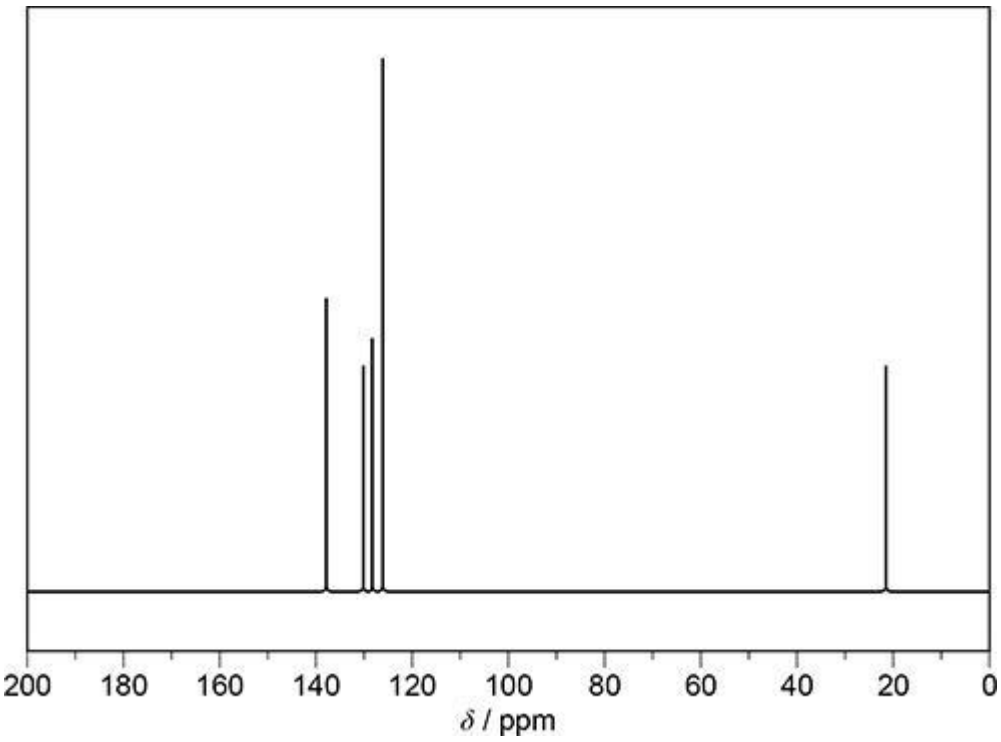
Complete the equation for this reaction.

Give a suitable catalyst for this reaction.

Catalyst _____

(2)

(b) The figure below shows the ^{13}C NMR spectrum for the aromatic hydrocarbon C_8H_{10}



Which of these is the structure of C_8H_{10}?

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Tick (✓) **one** box.

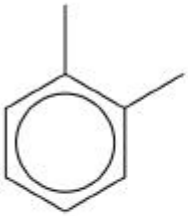
A

☐

B

☐

C



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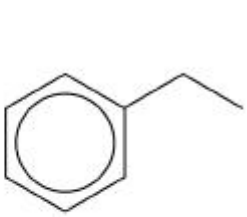
D



☐

(1)

(c) Cracking can also be done without a catalyst, using a temperature of 1200 K and a pressure of 7000 kPa

State the type of product that is formed in high percentage in this type of cracking.

_____

(1)

(d) A sample of butane has a volume of 20 cm^3 at room temperature and pressure.

The sample is burned completely in 1350 cm^3 of air.

The final mixture is cooled to room temperature and pressure.

$$C_4H_{10} + 6\tfrac{1}{2}\ O_2 \longrightarrow 4\ CO_2 + 5\ H_2O$$

Calculate the total volume of gas in the final mixture.
Assume that air contains 21% by volume of oxygen.

Total volume of gas remaining _____ cm^3

(4)

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(e) Natural gas is used in power stations to produce electricity.

Natural gas contains sulfur impurities. Sulfur dioxide forms when these impurities are burned.

State an environmental problem caused by sulfur dioxide.

Give the formula of a compound that is used to help remove sulfur dioxide from the combustion products.

Environmental problem _____

Formula of compound _____

_____

(2)

(Total 10 marks)

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Q2.

Compounds **V**, **W**, **X** and **Y** are isomers with the molecular formula $C_5H_{10}O_2$

Isomers **V** and **W** are carboxylic acids with formulas that can be written as C_4H_9COOH

(a) Give an equation for the reaction of C_4H_9COOH with sodium hydrogencarbonate.

_____

(1)

(b) Isomer **V** has an asymmetric carbon atom.

Deduce the structure of **V**.

(1)

(c) Isomer **W** has four peaks in its ^1H NMR spectrum.

Deduce the structure of **W**.

Deduce the integration ratio for the four peaks in the ^1H NMR spectrum of **W**.

Structure

Integration ratio _____

(2)

(d) Isomer **X** has three singlets with integration ratio 1:3:6 in its ^1H NMR spectrum.

Deduce the structure of **X**.

Explain why the peaks in the ^1H NMR spectrum are singlets.

Structure

Explanation _____

_____

_____

(2)

(e) The table below shows information about the peaks in the ^1H NMR spectrum of isomer **Y**.

Chemical shift δ / ppm	**Integration ratio**	**Splitting pattern**
3.65	2	singlet

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1.19	3	singlet

Draw the parts of the structure of **Y** that can be deduced from each of these peaks.

Deduce the structure of **Y**.

State how many peaks are in the ^{13}C NMR spectrum of **Y**.

Part of structure from peak at δ = 3.65 ppm

Part of structure from peak at δ = 1.19 ppm

Structure of **Y**

Number of peaks in ^{13}C NMR spectrum of **Y** _____

(6)

(Total 12 marks)

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