Name of the Student:_____
Max. Marks : 18 Marks **Time : 18 Minutes**

Q1.

This question is about an equilibrium.

$$2\ \mathbf{P}(aq) + \mathbf{Q}(aq) \rightleftharpoons \mathbf{R}(aq) + 3\ \mathbf{S}(aq)$$

A 25.0 cm^3 sample of a solution of **P** is added to a 20.0 cm^3 sample of a solution of **Q**. The mixture is allowed to reach equilibrium.

The amounts in the equilibrium mixture are

P = 0.0145 mol **Q** = 0.0275 mol **R** = 0.0115 mol **S** = 0.0345 mol

(a) Calculate the amount, in moles, of **P** before the reaction with **Q**.

Use your answer to calculate the concentration, in mol dm^{-3}, of **P** in the initial 25.0 cm^3 sample.

Amount of **P** _____ mol

Concentration _____ mol dm^{-3}

(2)

(b) Give the expression for the equilibrium constant, K_c

Calculate the value of K_c and deduce its units.

K_c

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Value of K_c _____ Units _____

(4)

(c) Explain why the amount of **S** increases when water is added to the equilibrium mixture.

_____

_____

_____

_____

(2)

(Total 8 marks)

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Q2.

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.

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

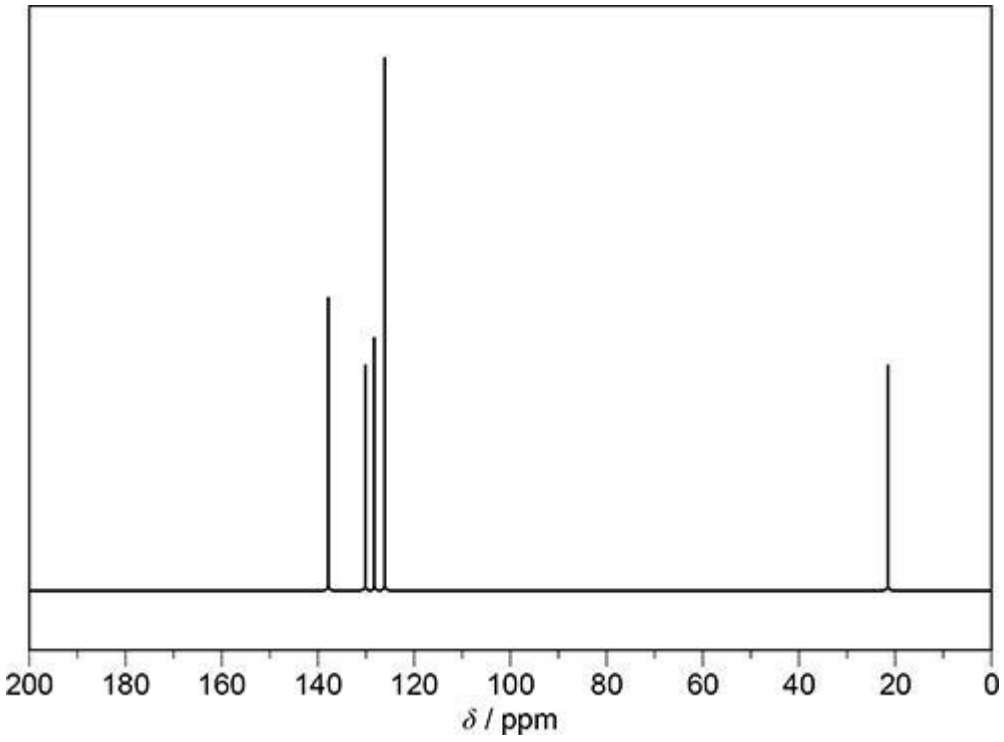
Complete the equation for this reaction.

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}?

Tick (✓) **one** box.

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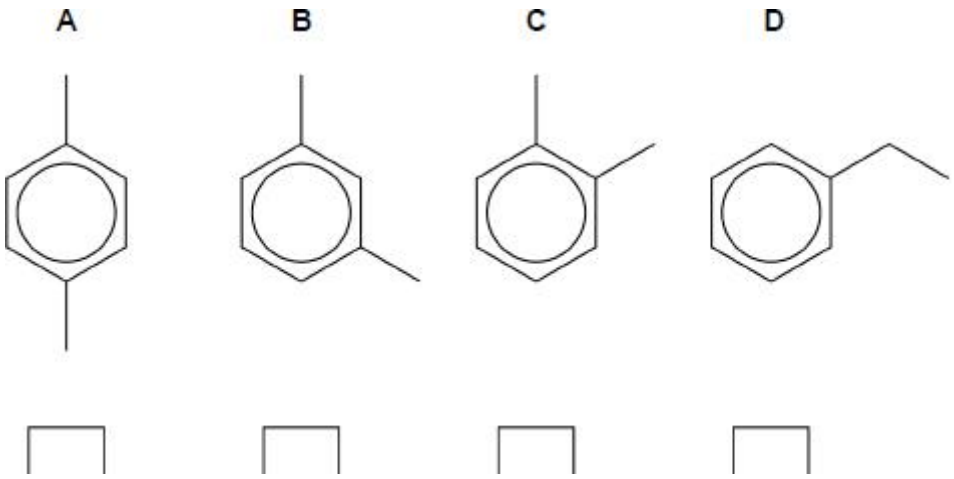

(1)

(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)

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

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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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