AS Level Chemistry B

H033/02 Chemistry in depth

Question Set 9

1 Catalytic cracking of hydrocarbons is carried out in the petrochemical industry.
Hot vaporised hydrocarbons and a powdered catalyst are fed into the bottom of a tube and forced upwards by steam.

(a) (i) Decane, $C_{10}H_{22}$, can be cracked to give an **alkene** with four carbon atoms and another alkane.

Write a chemical equation for this reaction using **molecular** formulae.

[1]

(ii) 2,2,3-Trimethylheptane is an isomer of decane.

Draw the **skeletal formula** of 2,2,3-trimethylheptane.

[1]

(b) A student wishes to crack a sample of liquid decane in the laboratory and collect the gaseous products.

Fig. 1.1 shows the apparatus that a student drew before doing this.

What modifications would be required for this apparatus to work?

Explain your answers.

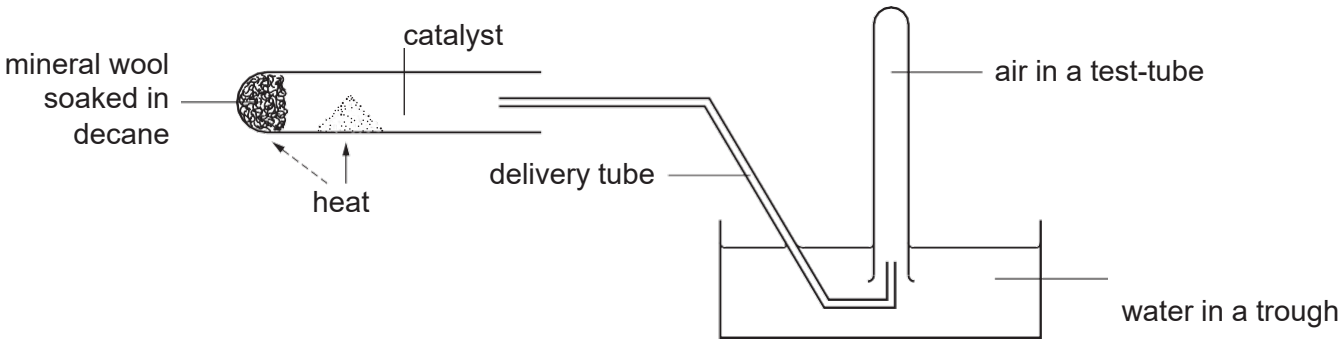


Fig. 1.1

..... **[4]**

(c) Small alkenes produced in cracking can be used for making polymers.

The structure of a polymer chain is shown in **Fig. 1.2**.

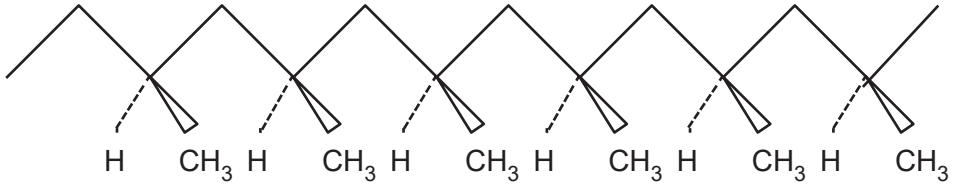


Fig. 1.2

Give the **name** of the monomer that forms the polymer in **Fig. 1.2**.

..... **[1]**

(d) Another alkene that can be polymerised is but-2-ene, $CH_3CH=CHCH_3$.

Explain why stereoisomerism can occur in but-2-ene.

..... **[2]**

(e) When but-1-ene, $CH_3CH_2CH=CH_2$, reacts with $IC\mathit{l}$ the main product is 1-iodo-2-chlorobutane, $CH_3CH_2CHC\mathit{l}CH_2I$.

Suggest a mechanism for this reaction.

Show full and partial charges and 'curly arrows'.

[3]

(f) Petrol contains hydrocarbons like octane, C_8H_{18}.

Equation 1.1 shows the complete combustion of octane.

$$C_8H_{18}(g) + 12½O_2(g) \longrightarrow 8CO_2(g) + 9H_2O(g) \qquad \textbf{Equation 1.1}$$

3.42 g of octane are burned per second in a vehicle engine.
The exhaust gases are produced at a temperature of 550 °C and a pressure of 1.50×10^5 Pa.

Calculate the volume of exhaust gases, in dm^3, produced per second.

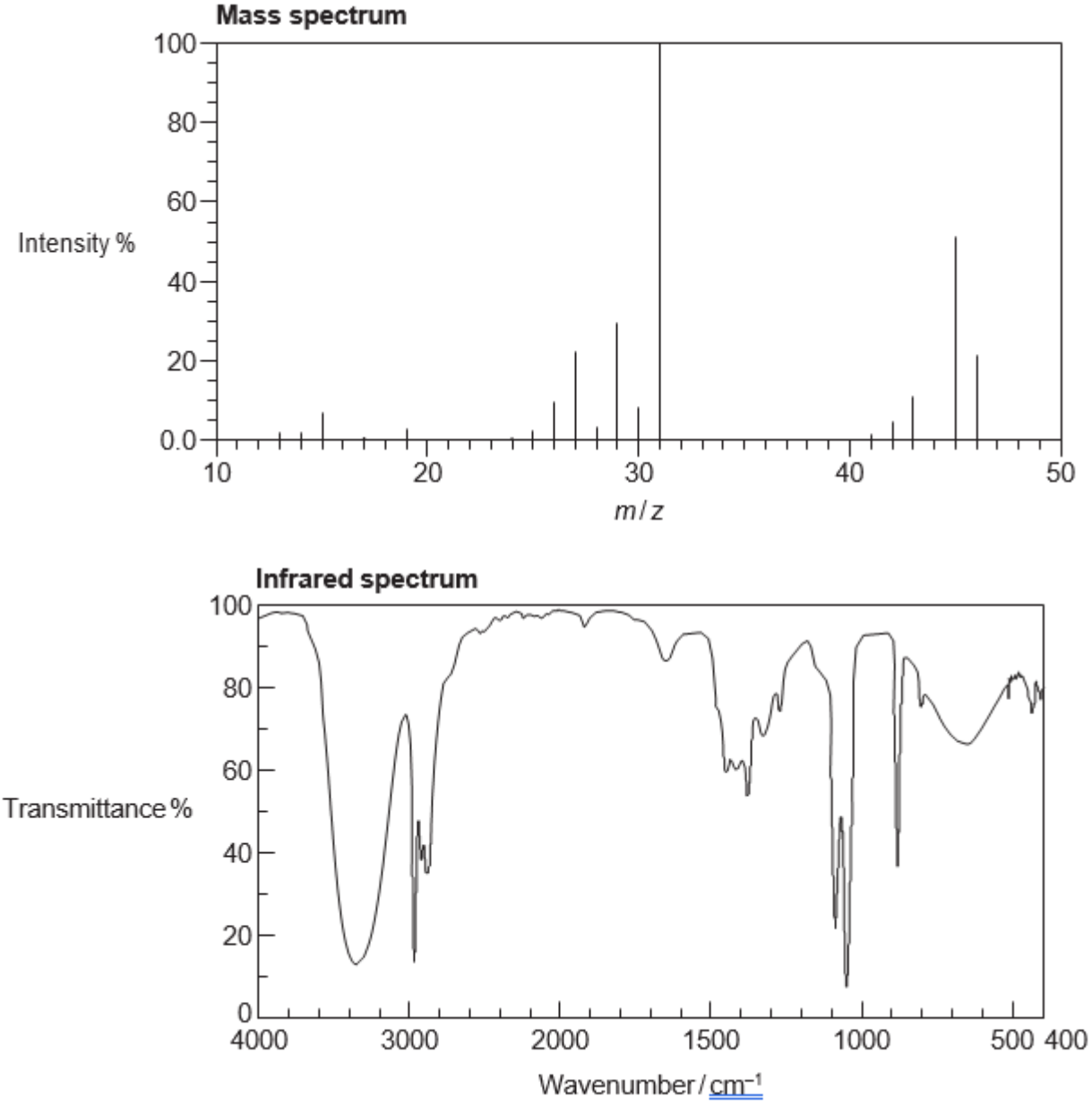
Assume that carbon dioxide and water vapour are the only gases present in the exhaust.

volume of exhaust gases = ... dm^3 **[4]**

(g) Biofuels are increasingly providing alternatives to petrol.

One of the compounds in a biofuel has the following mass spectrum and infrared spectrum.

The biofuel contains carbon, hydrogen and oxygen only.



(i) Identify the biofuel given by the mass spectrum and infrared spectrum.

[1]

(ii) Give **one** piece of evidence from the mass spectrum to support your answer to **(g)(i)**. **[1]**

(iii) Give **one** piece of evidence from the infrared spectrum to support your answer to **(g)(i)**. **[1]**

(h)* Discuss the advantages and disadvantages of using biofuels as fuels for cars compared with fossil fuels. **[6]**

Total Marks for Question Set 9: 25