

20 Fractional distillation is used in industry to obtain alkanes from crude oil.

(a) (i) On what physical property of alkanes does this process depend?

(1)

(ii) The alkanes are then processed by **cracking** or **reforming** to produce other hydrocarbons.

Explain the meaning of these terms.

(2)

Cracking

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Reforming

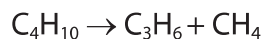
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(iii) The equation for a cracking reaction of butane is



Use the following standard enthalpy changes of combustion to calculate the enthalpy change of this cracking reaction. Show your method, which may involve the use of a Hess cycle. Include a sign and units in your answer.

Compound	Standard enthalpy change of combustion / kJ mol^{-1}
butane	-2877
propene	-2058
methane	-890

(3)

(iv) Butane can also be cracked to form products other than propene and methane. Write an equation for this reaction.

(1)

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- (b) (i) The enthalpy change of combustion of a liquid hydrocarbon, pentane, was determined in an experiment.

A sample of pentane was burned in a spirit burner and the energy produced used to heat water in a calorimeter.

The results of the experiment are as follows:

Mass of spirit burner and pentane at start	85.6 g
Mass of spirit burner and pentane after burning	84.6 g
Mass of water in calorimeter	200 g
Initial temperature of water	22.0 °C
Final temperature of water	56.0 °C
Mass of 1 mole of pentane	72.0 g

Heat energy transferred (J) = mass of water \times temperature change \times 4.18

Calculate the enthalpy change of combustion of pentane. Include a sign and units in your answer.

(3)

- (ii) Give **one** reason, other than heat loss, why the enthalpy change determined in this experiment differs substantially from the Data Booklet value.

(1)

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(iii) Suggest a reason why this experiment would be too hazardous to carry out in a school laboratory.

(1)

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(c) (i) Write an equation for the complete combustion of pentane. State symbols are not required.

(1)

(ii) Identify the type and number of bonds broken and formed during the combustion of a molecule of pentane.

(2)

(iii) Explain why the enthalpy change of combustion of pentane is exothermic.

(1)

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(Total for Question 20 = 16 marks)

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