Chapter 15: Hydrocarbons

Homework questions

1 2-methylbutane and 2,2-dimethylpropane are isomeric hydrocarbons with the molecular formula C_5H_{12}.

a **i** Define the term **isomer** and explain how it applies to these two compounds. [2]

ii Draw the skeletal formulae of both compounds. [2]

b In an experiment to find the standard enthalpy of combustion (ΔH_c^{θ}) of both compounds, the temperature of 200 g of water was raised by 30 °C. The mass of 2-methylbutane burned was found to be 0.626 g and the volume of 2,2-dimethylpropane burned was 171 cm³.

i Calculate (in kJ) the heat given out by the 2-methylbutane in the experiment. [2]

ii Use the data to calculate the standard enthalpy of combustion of 2-methylbutane and give your answer to 3 significant figures. [3]

iii Calculate the standard enthalpy of combustion of 2,2-dimethylpropane. [4]

c Construct a Hess's cycle to find the standard enthalpy change of reaction for the conversion of 2-methylbutane to 2,2-dimethylpropane. Use the two values for the standard enthalpies of combustion to calculate the enthalpy change for the reaction:

2-methylbutane → 2,2-dimethylpropane [4]

d Suggest why 2-methylbutane is a liquid at room temperature whilst 2,2-dimethylpropane is a gas at room temperature. [3]

Total = 20

2 When bromine water was added to a hydrocarbon, X, the bromine was decolorised. Analysis of X showed that it contained 85.7% carbon and 14.3% hydrogen. When 50 cm³ of gaseous X were burned completely in oxygen, 250 cm³ of carbon dioxide were formed.

a Find the empirical formula of X. [2]

b Calculate the molecular formula of X, showing all your working. [3]

c Name the homologous series to which X belongs. Explain your answer. [3]

d There are **four** structural isomers of X.

i Define the term **structural isomerism**. [2]

ii Write down the four skeletal formulae and name each isomer. [4]

e One of these isomers exhibits a form of stereoisomerism.

i Name the compound. [1]

ii Name the type of stereoisomerism exhibited by the compound. [1]

iii Draw the skeletal formulae of the two stereoisomers. [2]

iv Explain why the stereoisomerism is possible with these two compounds. [2]

v Draw a four-carbon-atom section of the addition polymer formed from this compound. [2]

Total = 22

3 But-1-ene and cyclobutane are isomeric hydrocarbons. Although they have the same molecular formula, they react very differently with bromine.

a Draw the displayed formulae of both compounds. [2]

b In the presence of ultraviolet (UV) light, cyclobutane reacts with bromine to form 1-bromocyclobutane.

i Write down the equation for the reaction. [2]

ii Use equations to describe and explain the mechanism for the reaction, naming each step in the process. [7]

c But-1-ene reacts with bromine to give 1,2-dibromobutane. Draw the mechanism for the reaction (including curly arrows). [5]

d But-1-ene reacts with hydrogen bromide to give **two** organic products.

i Give the skeletal formulae of both products. [2]

ii Identify the major product and explain why more of it is formed than the other product. [3]

e If bromine water is shaken with a liquid hydrocarbon such as cyclohexane, the red/orange bromine water fades and the cyclohexane becomes bright orange/red in colour. Explain this observation. [3]

Total 24 marks