2.3 Energetics and Thermodynamics: 10-minute Pack

AQA 7405 · Calculator allowed · about 10 minutes

Total Marks

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 Methane reacts with chlorine in a substitution reaction: $CH_4(g) + Cl_2(g) \rightarrow CH_3Cl(g) + HCl(g)$. Mean bond enthalpies (kJ/mol): C-H = +413, Cl-Cl = +242, C-Cl = +346, H-Cl = +431.

(a) State what is meant by the term mean bond enthalpy. **(2)**

(b) Calculate the enthalpy change for this reaction using the mean bond enthalpies given. Show your working. **(3)**

(c) Explain why a value calculated using mean bond enthalpies may differ from the actual (experimentally measured) enthalpy change for this reaction. **(2)**

(d) State one other limitation of using mean bond enthalpies, in terms of the physical states of the reactants and products. **(1)**

(Total for Question 1 is 8 marks)

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Mark scheme · 2.3 Energetics and Thermodynamics: 10-minute Pack

Question 1

(a) the (average) energy required to break one mole of a specified covalent bond **B1**

(a) averaged over that type of bond in a range of different gaseous molecules/compounds oe **B1**

(a) Answer: The average energy needed to break one mole of a given covalent bond, averaged over many different gaseous compounds containing that bond.

(b) bonds broken = C-H + Cl-Cl = 413 + 242 (= 655 kJ/mol) **M1**

(b) bonds formed = C-Cl + H-Cl = 346 + 431 (= 777 kJ/mol) **M1**

(b) delta H = 655 - 777 = -122 (kJ/mol) cao **A1**

(b) Answer: delta H = -122 kJ/mol

(c) mean bond enthalpies are average values, taken across many different compounds containing that bond oe **M1**

(c) the actual bond enthalpy for a specific bond in this particular molecule may differ from the mean value used, so the calculated delta H is only an approximation oe **M1**

(c) Answer: Mean bond enthalpies are averaged over many compounds, so the true bond enthalpy in CH_4, CH_3Cl and HCl may differ slightly from the mean value used, making the calculated delta H only an approximate value.

(d) mean bond enthalpies apply only to gaseous species; they cannot be used directly if any reactant or product is not in the gas phase (e.g. a liquid or solid) oe **B1**

(d) Answer: Mean bond enthalpies are only valid for substances in the gaseous state, so cannot be used directly for reactions involving liquids or solids.

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