HIGHER

C5H Energy Changes: Higher Tier Practice

AQA 8462 · Calculator allowed · about 40 minutes

Total Marks

Name: ________________________________ Date: ____ / ____ / ______

Answer ALL questions. Show all your working.

1 Define the term 'exothermic reaction'.

(a) Define the term 'exothermic reaction'. **(2)**

(Total for Question 1 is 2 marks)

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2 A student measures the temperature change when 25.0 cm3 of 1.00 mol dm-3 hydrochloric acid is neutralised by 25.0 cm3 of 1.00 mol dm-3 sodium hydroxide. The maximum temperature recorded is 5.8 degrees C higher than the initial temperature. The density of the solution is 1.00 g cm-3 and the specific heat capacity is 4.20 J g-1 degrees C-1. Use the equation q = m c deltaT and assume total solution mass is the sum of volumes times density.

(a) Calculate the heat energy change q for the reaction in joules (J). **(3)**

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(Total for Question 2 is 3 marks)

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3 Using the q value from question 2, calculate the molar enthalpy change for the neutralisation in kJ mol-1 of HCl (to 3 significant figures). Assume the reaction of 25.0 cm3 of 1.00 mol dm-3 HCl uses 0.0250 mol of HCl.

(a) Calculate the molar enthalpy change in kJ mol-1 (include sign and unit). **(3)**

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(Total for Question 3 is 3 marks)

4 Explain one reason why the experimentally determined molar enthalpy change for a neutralisation is often less exothermic than the accepted literature value.

(a) Explain one experimental cause for a lower magnitude of measured enthalpy change compared to literature value. **(4)**

(Total for Question 4 is 4 marks)

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5 A student investigates the combustion of ethanol. The bond energies relevant are: C-H 410 kJ mol-1, C-C 347 kJ mol-1, C-O 358 kJ mol-1, O-H 463 kJ mol-1, O=O 498 kJ mol-1, C=O 799 kJ mol-1. Ethanol formula CH_3CH_2OH. Use bond energy values to estimate the enthalpy change for combustion of one mole of ethanol:

(a) Calculate an estimate of deltaH for $C_2H_5OH + 3\ O_2 \rightarrow 2\ CO_2 + 3\ H_2O$ using the bond energies above. Give your answer in kJ mol-1 (to 3 significant figures). **(3)**

(Total for Question 5 is 3 marks)

Mark scheme · C5H Energy Changes: Higher Tier Practice

Question 1

- (a) **B1** a chemical reaction that transfers energy to the surroundings, oe
- (a) **B1** usually observed as a rise in temperature of the surroundings, oe
- **(a) Answer: A chemical reaction that transfers energy to the surroundings, usually observed as a rise in temperature of the surroundings.**

Question 2

- (a) **M1** substitutes mass = 50.0 g, c = 4.20 J g-1 degrees C-1 and deltaT = 5.8 into q = m c deltaT
- (a) **A1** calculates product: 50.0 x 4.20 x 5.8 = 1218.0
- (a) **A1** 1218 J cao
- **(a) Answer: 1218 J**

Question 3

- (a) **M1** uses q = 1218 J and identifies n = 0.0250 mol and sets up deltaH = -q / n (negative for exothermic)
- (a) **M1** performs division and converts J to kJ: -1218 / 0.0250 = -48720 J mol-1 = -48.720 kJ mol-1
- (a) **A1** -48.7 kJ mol-1 cao
- **(a) Answer: -48.7 kJ mol-1**

Question 4

- (a) **M1** identifies a plausible source of heat loss or systematic error (eg heat lost to the surroundings, incomplete mixing, not using polystyrene cup lid)
- (a) **A1** states how this reduces measured temperature change (eg some energy escapes, so deltaT is smaller)
- (a) **M1** identifies a linked procedural factor that could be changed to reduce the error (eg use insulating lid, minimise transfer time)
- (a) **A1** explains why the change would increase measured deltaT (eg reduces heat loss so recorded temperature rises closer to true value)
- **(a) Answer: Heat is lost to the surroundings during the reaction (for example through the cup walls or during transfer), so the recorded temperature rise is smaller. Using better insulation and reducing transfer time reduces heat loss so the measured deltaT is larger and the calculated enthalpy is closer to the literature value.**

Question 5

- (a) **M1** counts bonds broken and formed and sets up sum: deltaH = sum(bonds broken) - sum(bonds formed)
- (a) **M1** substitutes numbers correctly: bonds broken = 5 C-H + 1 C-C + 1 C-O + 1 O-H + 3 O=O; bonds formed = 4 C=O + 6 O-H
- (a) **A1** -1260 kJ mol-1 cao (accept -1262 kJ mol-1 before rounding)
- **(a) Answer: -1260 kJ mol-1**