2.22 Exothermic and Endothermic Reactions: Test Pack

AQA 8464 · Calculator allowed · about 35 minutes

Total Marks

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 Define the terms exothermic and endothermic reaction.

(a) Define exothermic reaction. **(1)**

(b) Define endothermic reaction. **(1)**

(Total for Question 1 is 2 marks)

2 Give one example of an exothermic chemical reaction and one example of an endothermic chemical reaction. For each, name the reaction and state whether energy is released or absorbed.

(a) Example of an exothermic reaction and energy direction. **(1)**

(b) Example of an endothermic reaction and energy direction. **(1)**

(Total for Question 2 is 2 marks)

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3 Sketches of energy profile diagrams are used to show activation energy and overall energy change.

(a) State which feature on an energy profile diagram represents the activation energy. **(1)**

(b) For an exothermic reaction, state whether the products are higher or lower in energy than the reactants and explain what this means for the overall energy change. **(2)**

(Total for Question 3 is 3 marks)

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4 A student measured that 0.0100 mol of a reactant produced 3150 J of heat in a small exothermic reaction. Calculate the enthalpy change in kJ per mol for the reaction, giving the sign.

(a) Calculate the molar enthalpy change and give the sign. **(3)**

(Total for Question 4 is 3 marks)

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5 This question has two parts.

(a) Identify one likely experimental error in the calorimetry experiment above that would make the measured molar enthalpy of combustion less exothermic than the true value, and state why. **(1)**

(b) Give one practical improvement to reduce this error. **(1)**

(Total for Question 5 is 2 marks)

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6 Required practical style question: Describe a method to determine the enthalpy change when magnesium reacts with excess dilute hydrochloric acid to form magnesium chloride and hydrogen gas. Include the main measurements, one control variable, and one safety precaution.

(a) Describe the method, main measurements and calculation. **(2)**

(b) State one control variable and one safety precaution. **(2)**

(Total for Question 6 is 4 marks)

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7 Use bond energies to calculate the enthalpy change for the reaction: $H_2(g) + Cl_2(g) \rightarrow 2\ HCl(g)$. Bond energies: H-H = 436 kJ mol-1, Cl-Cl = 243 kJ mol-1, H-Cl = 431 kJ mol-1. State whether the reaction is exothermic or endothermic.

(a) Calculate the enthalpy change using bond energies and give the sign. **(3)**

(Total for Question 7 is 3 marks)

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8 Explain why adding a catalyst to a reaction does not change whether the reaction is exothermic or endothermic.

(a) Explain why a catalyst does not change the enthalpy change of a reaction. **(2)**

(Total for Question 8 is 2 marks)

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9 Explain how the Maxwell-Boltzmann distribution of molecular energies shows why increasing temperature increases the rate of a chemical reaction. Include the effect of a catalyst in your answer. (Higher tier only)

(a) Explain temperature and catalyst effects using the Maxwell-Boltzmann concept. **(4)**

(Total for Question 9 is 4 marks)

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Mark scheme · 2.22 Exothermic and Endothermic Reactions: Test Pack

Question 1

(a) reaction that transfers energy to the surroundings (often as heat), oe **B1**

(a) Answer: A reaction that transfers energy to the surroundings, often as heat.

(b) reaction that takes in energy from the surroundings (often as heat), oe **B1**

(b) Answer: A reaction that takes in energy from the surroundings, often as heat.

Question 2

(a) combustion of methane ($CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$) with energy released, oe **B1**

(a) Answer: Combustion of methane, energy released.

(b) thermal decomposition of calcium carbonate ($CaCO_3 \rightarrow CaO + CO_2$) with energy absorbed, oe **B1**

(b) Answer: Thermal decomposition of calcium carbonate, energy absorbed.

Question 3

(a) the height of the peak above the reactants (the energy barrier), oe **B1**

(a) Answer: The activation energy is the height of the peak above the reactants, representing the energy barrier.

(b) states products are lower in energy than reactants **M1**

(b) states overall energy change is negative and energy is released to the surroundings, oe **A1**

(b) Answer: Products are lower in energy than reactants, so the overall energy change is negative and energy is released to the surroundings.

Question 4

(a) calculates per mole: 3150 J / 0.0100 mol **M1**

(a) converts to kJ: 315000 J mol-1 = 315 kJ mol-1 **M1**

(a) -315 kJ per mol cao **A1**

(a) Answer: -315 kJ per mol

Question 5

(a) heat lost to the surroundings (not all heat goes into the water), leading to smaller measured temperature rise **B1**

(a) Answer: Heat lost to the surroundings, so not all combustion heat is transferred to the water.

(b) insulate the calorimeter (use a lid and foam insulation) or use a bomb calorimeter to reduce heat loss, oe **B1**

(b) Answer: Insulate the calorimeter, for example use a lid and foam jacket or use a proper bomb calorimeter.

Question 6

(a) measure mass or volume and initial temperature of acid, add excess magnesium ribbon, stir and record maximum temperature reached **M1**

(a) use q = m x c x deltaT and moles of magnesium reacted to calculate enthalpy change per mole, oe **A1**

(a) Answer: Measure volume and initial temperature of dilute HCl, add excess magnesium, stir and record maximum temperature. Calculate q = m x c x deltaT for the solution and divide by moles of Mg reacted to get enthalpy per mole.

(b) control variable: concentration or volume of acid (or mass of water), oe **B1**

(b) safety: wear safety goggles and handle acid with care, oe **B1**

(b) Answer: Control variable: concentration of acid (keep it the same). Safety precaution: wear safety goggles and use gloves when handling acid.

Question 7

(a) calculates total energy for bonds broken: 436 + 243 = 679 kJ mol-1 **M1**

(a) calculates total energy for bonds formed: 2 x 431 = 862 kJ mol-1 **M1**

(a) -183 kJ mol-1 cao **A1**

(a) Answer: -183 kJ per mol

Question 8

(a) states catalyst provides an alternative pathway with lower activation energy **M1**

(a) states enthalpy change depends only on energy difference between reactants and products so it is unchanged by a catalyst, oe **A1**

(a) Answer: A catalyst provides an alternative pathway with lower activation energy but the enthalpy change depends only on the energy difference between reactants and products, so it does not change.

Question 9

(a) states increasing temperature shifts distribution so more particles have energy greater than activation energy **M1**

(a) states this increases the frequency of successful collisions hence rate increases **M1**

(a) states a catalyst provides an alternative pathway with lower activation energy so a larger fraction of particles exceed the lower threshold **M1**

(a) links both points to show why rate increases with temperature and with a catalyst, oe **A1**

(a) Answer: Higher temperature shifts the Maxwell-Boltzmann distribution so a greater fraction of molecules have energy above the activation energy, increasing successful collisions and reaction rate. A catalyst lowers the activation energy, so an even larger fraction of molecules can react, increasing the rate further.

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