2.4 Energy Changes: 30-minute Pack

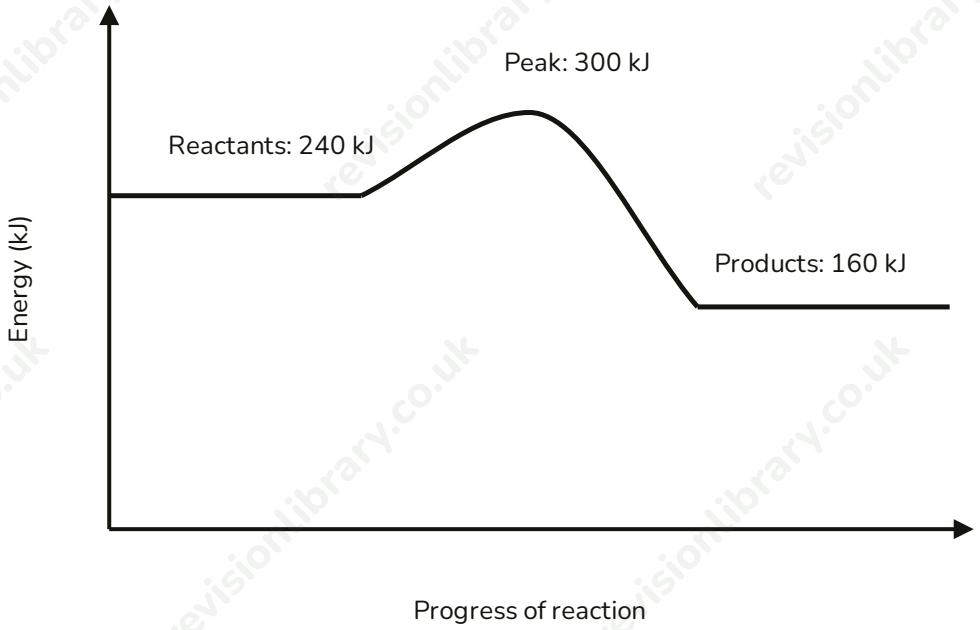
AQA 8462 · Calculator allowed · about 30 minutes

Total Marks

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 The diagram shows a reaction profile for an exothermic reaction.



(a) State, giving a reason from the diagram, whether the reaction is exothermic or endothermic. **(2)**

(b) Calculate the overall energy change for this reaction. **(2)**

(c) State the activation energy shown on the diagram. **(1)**

(Total for Question 1 is 5 marks)

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2 Give one variable that should be controlled, name one likely source of random error that explains the variation, and suggest one improvement to reduce the variation. (3 marks)

(Total for Question 2 is 3 marks)

3 State whether the reaction is exothermic or endothermic, and explain in one sentence how the positions of reactants and products on the profile show this.

(Total for Question 3 is 3 marks)

4 Calculate the temperature change and state whether the dissolution is exothermic or endothermic.

(Total for Question 4 is 2 marks)

5 Define the term 'exothermic reaction'.

(Total for Question 5 is 2 marks)

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6 Hydrogen fuel cells are used to generate electricity in some vehicles. The overall reaction in a hydrogen fuel cell is between hydrogen and oxygen, producing water.

(a) Write the balanced symbol equation for the overall reaction in a hydrogen fuel cell. **(2)**

(b) State one energy transfer that takes place inside a hydrogen fuel cell. **(1)**

(c) Give one advantage and one disadvantage of using hydrogen fuel cells instead of rechargeable batteries to power a vehicle. **(2)**

(Total for Question 6 is 5 marks)

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7 A car manufacturer is deciding whether to develop its new electric car using a rechargeable lithium-ion battery or a hydrogen fuel cell. Lithium-ion battery: range per charge = 300 km; time to refill/recharge = 35 minutes (rapid charger) or 8 hours (home charger); charging infrastructure = widespread (many public and home chargers); CO_2 released while driving = none. Hydrogen fuel cell: range per fill = 500 km; time to refuel = 5 minutes; refuelling infrastructure = very limited (few hydrogen stations); CO_2 released while driving = none (only water produced). Evaluate the advantages and disadvantages of using a rechargeable lithium-ion battery compared with a hydrogen fuel cell to power the car. Use the information given and your own knowledge of both technologies.

(Total for Question 7 is 6 marks)

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Mark scheme · 2.4 Energy Changes: 30-minute Pack

Question 1

(a) exothermic **M1**

(a) because the products (160 kJ) have less energy than the reactants (240 kJ) oe **A1**

(a) Answer: Exothermic, because the products have less energy (160 kJ) than the reactants (240 kJ).

(b) 160 - 240 oe **M1**

(b) -80 kJ (accept 80 kJ released) cao **A1**

(b) Answer: -80 kJ (80 kJ released per mole of reaction)

(c) 60 kJ (300 - 240) cao **B1**

(c) Answer: 60 kJ

Question 2

states a correct control variable, e.g. use same initial temperatures, same masses/volumes, or same concentration **B1**

names a likely random error, e.g. reaction not mixed consistently between repeats, thermometer reading varies, heat lost to surroundings variably **B1**

suggests a sensible improvement, e.g. use a lid on the cup, use a more accurate thermometer, stir the mixture the same way or repeat and take mean **B1**

Answer: Control variable: same initial temperature (or same volumes). Random error: inconsistent mixing/thermometer reading. Improvement: use a lid and stir consistently or use a more accurate thermometer and take repeats.

Question 3

states the reaction is exothermic **B1**

notes products are at lower energy than reactants **B1**

links lower energy of products to energy being released to the surroundings **B1**

Answer: Exothermic. The products are at lower energy than the reactants, so energy has been released to the surroundings.

Question 4

correct temperature change: 5.5°C (22.0 - 16.5) with sign or magnitude **M1**

identifies endothermic because the temperature decreases cao **A1**

Answer: Temperature change = 5.5°C; endothermic

Question 5

a chemical reaction that transfers energy to the surroundings, oe **B1**

usually observed as a rise in temperature of the surroundings, oe **B1**

Answer: A chemical reaction that transfers energy to the surroundings, usually observed as a rise in temperature of the surroundings.

Question 6

(a) correct formulae: H_2, O_2, H_2O **M1**

(a) correctly balanced: $2H_2 + O_2 \rightarrow 2H_2O$ cao **A1**

(a) Answer: $2H_2 + O_2 \rightarrow 2H_2O$

(b) chemical energy (store) is transferred to electrical energy (and some to thermal energy) oe **B1**

(b) Answer: Chemical energy (stored in the hydrogen and oxygen) is transferred to electrical energy (with some wasted as thermal energy).

(c) advantage, e.g. only water is produced at the point of use / can be refuelled much faster than batteries can be recharged / greater range per fill oe **B1**

(c) disadvantage, e.g. hydrogen is difficult/expensive to store and transport / few hydrogen refuelling stations exist / producing hydrogen may itself release CO_2 oe **B1**

(c) Answer: Advantage: only water is produced at the point of use, and the vehicle can be refuelled in a few minutes. Disadvantage: hydrogen is difficult and expensive to store safely, and there are very few hydrogen refuelling stations available.

Question 7

Level 1 Basic, isolated statements are made about the battery or the fuel cell (or both), with little or no linkage or comparison between them. No reasoned conclusion is given. **1-2**

Level 2 Some relevant comparisons are made between the battery and the fuel cell, using at least two factors (e.g. range, refuelling/recharging time, infrastructure). A conclusion is given but with limited justification. **3-4**

Level 3 A detailed and logically structured evaluation compares the battery and the fuel cell across several factors (e.g. range, refuelling/recharging time, infrastructure, wider environmental impact), using the given information and own knowledge. A justified conclusion is reached. **5-6**

Indicative content:

- Battery: produces no CO_2 while driving, but has a shorter range (300 km) than the fuel cell (500 km).
- Battery: rapid recharging still takes much longer (35 minutes) than refuelling a fuel cell (5 minutes); home charging takes even longer (8 hours).
- Battery: charging infrastructure is already widespread, making it more practical to use now.
- Fuel cell: produces no CO_2 at the point of use (only water), and can be refuelled almost as quickly as a petrol car.
- Fuel cell: has a longer range than the battery, useful for long journeys.
- Fuel cell: hydrogen refuelling infrastructure is currently very limited, making the car impractical for most drivers.
- Wider issues: producing hydrogen (e.g. from natural gas) may release CO_2 unless made using renewable electricity (electrolysis); mining lithium and disposing of batteries also has environmental impacts.
- A valid conclusion should weigh these points, e.g. the battery is currently more practical because of existing charging infrastructure, even though the fuel cell has a longer range and faster refuelling.

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