2.16 Rates of Reaction: 30-minute Pack

AQA 8464 · Calculator allowed · about 30 minutes

Total Marks

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

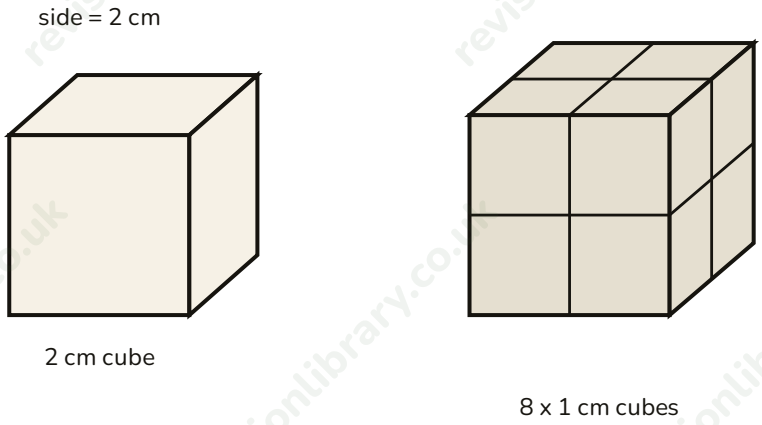
1 Increasing the temperature of a reaction mixture increases the rate of reaction more than most students expect, because temperature affects particles in two separate ways.

(a) Explain, using ideas about collision theory, why increasing the temperature of a reaction mixture increases the rate of reaction. **(5)**

(Total for Question 1 is 5 marks)

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2 A cube of solid reactant of side length 2 cm is cut up into 8 identical smaller cubes, each of side length 1 cm, so that the total volume of solid stays the same.



(a) Calculate the total surface area of the single cube before it is cut up. **(2)**

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(b) Calculate the total surface area of all 8 smaller cubes added together, and state whether it is greater or smaller than your answer to part (a). **(2)**

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(c) Explain, in terms of collision theory, why cutting the reactant into smaller pieces increases the rate of reaction with a surrounding acid. **(1)**

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(Total for Question 2 is 5 marks)

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3 Pressure is a factor that affects the rate of reactions involving gases.

(a) Increasing the pressure of a gaseous reaction mixture increases the rate of reaction. Explain why, in terms of particles. **(3)**

(b) Give one everyday or industrial situation where controlling the rate of a reaction is important, and explain whether a faster or slower rate is more desirable in that situation. **(2)**

(Total for Question 3 is 5 marks)

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4 Rate of reaction describes how quickly reactants are converted into products, and can be explained using collision theory.

(a) State what is meant by the term 'rate of reaction'. **(1)**

(b) According to collision theory, state two conditions that must be met for a reaction to occur between two particles. **(2)**

(Total for Question 4 is 3 marks)

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5 A different student investigates the same reaction (marble chips and dilute hydrochloric acid) by measuring the loss in mass of the reaction flask over time, using a balance. The flask is loosely plugged with a small piece of cotton wool. The initial mass of the flask and its contents was 150.00 g. After 80 seconds, the reaction was complete and the final mass was 149.12 g.

(a) Explain the purpose of the cotton wool plug in this experiment. **(2)**

(b) Calculate the total loss in mass during the reaction. **(1)**

(c) Calculate the mean rate of reaction, in g/s, over the 80 seconds. Give your answer to 2 significant figures. **(2)**

(d) Explain why the total mass of the flask and its contents decreases during the reaction, even though mass is conserved overall in the chemical reaction. **(1)**

(Total for Question 5 is 6 marks)

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Mark scheme · 2.16 Rates of Reaction: 30-minute Pack

Question 1

(a) at a higher temperature, particles have more kinetic energy and move faster (oe) **B1**

(a) faster-moving particles collide more frequently (more collisions per second) (oe) **B1**

(a) a greater proportion of particles have energy greater than or equal to the activation energy (oe) **B1**

(a) so a greater proportion of collisions are successful (result in a reaction) (oe) **B1**

(a) both effects (more frequent collisions and a greater proportion being successful) combine to increase the rate of reaction (oe, linking mark) **B1**

(a) Answer: Particles move faster and collide more often, and a greater proportion of collisions have energy above the activation energy, so more collisions are successful. Both effects together increase the rate of reaction.

Question 2

(a) area of one face = 2 x 2 = 4 (cm^2), and a cube has 6 faces **M1**

(a) 24 cm^2 (cao) **A1**

(a) Answer: 24 cm^2

(b) area of one small cube = 6 x 1^2 = 6 cm^2, and there are 8 small cubes **M1**

(b) 48 cm^2 (cao), which is greater than the answer to (a) (ecf) **A1**

(b) Answer: 48 cm^2, which is greater than in part (a).

(c) more surface area is exposed to the acid, so there are more frequent collisions between reacting particles per unit time (oe) **B1**

(c) Answer: More surface area is exposed to the acid, so collisions between reacting particles are more frequent, increasing the rate.

Question 3

(a) increasing the pressure means the same number of gas particles occupy a smaller volume (oe) **B1**

(a) so the gas particles become more crowded together, increasing their (effective) concentration (oe) **B1**

(a) this increases the frequency of collisions between reacting particles per unit time, increasing the rate of reaction (oe) **B1**

(a) Answer: Higher pressure squeezes the same number of gas particles into a smaller volume, increasing their concentration, so collisions between reacting particles are more frequent.

(b) a valid situation identified, e.g. the catalytic converter in a car exhaust, food spoilage, setting of a bone-repair cement, or an industrial reaction vessel (any one, oe) **B1**

(b) correct reasoning about why a faster or slower rate is desirable for the chosen situation (e.g. a fast rate is needed in a catalytic converter so harmful gases fully react in the short time they are in contact with the catalyst; a slow rate is desirable for food spoilage so food lasts longer) **B1**

(b) Answer: Example: a catalytic converter needs a fast rate so that harmful exhaust gases fully react before leaving the exhaust system.

Question 4

(a) the rate of reaction is a measure of how fast a reactant is used up, or how fast a product is formed (oe: change in amount of reactant/product per unit time) **B1**

(a) Answer: The rate of reaction is how fast a reactant is used up or a product is formed (change in amount per unit time).

(b) the particles must collide with each other (oe) **B1**

(b) the collision must have energy greater than or equal to the activation energy (oe: a minimum amount of energy needed to react) **B1**

(b) Answer: The particles must collide, and the collision must have energy greater than or equal to the activation energy.

Question 5

(a) it allows the gas (carbon dioxide) produced to escape from the flask, so the mass loss can be measured (oe) **B1**

(a) while stopping any acid spray/splashes from escaping (or preventing loss of solid/liquid), so the measured mass loss is due only to the gas escaping (oe) **B1**

(a) Answer: The cotton wool lets carbon dioxide gas escape (so mass loss can be measured) while stopping acid spray from escaping, so the mass loss recorded is due only to gas leaving.

(b) 0.88 g (cao) **A1**

(b) Answer: 0.88 g

(c) rate = 0.88 / 80 (ecf from (b)) **M1**

(c) 0.011 g/s (awrt 0.011, ecf) **A1**

(c) Answer: 0.011 g/s

(d) the carbon dioxide gas produced escapes into the surrounding air (through the cotton wool), so the mass remaining inside the (open) flask decreases, even though no mass is actually created or destroyed overall (oe) **B1**

(d) Answer: Carbon dioxide gas escapes into the air, reducing the mass remaining in the open flask, even though total mass is conserved overall.

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