Page 273 Exam practice questions

1 a) Apparatus described in words or a diagram to include: flask, bung and delivery tube [1] leading to a gas syringe or to a graduated cylinder inverted over water. [1] Any appropriate technique for adding the catalyst after the bung is in place, such as standing a small sample tube containing the catalyst in the flask until the bung is in place [1], and then shaking to tip over the tube and mix the catalyst with the solution. [1]

b) $2H_2O_2(aq) \rightarrow 2H_2O(l) + O_2(g)$ [1]

c) Appropriately labelled axes with scale [1]; accurate plot with smooth curve. [1]

d) The reaction is fastest at the start so that is when the graph is steepest. [1]

As the hydrogen peroxide concentration falls the rate decreases [1] and the graph becomes less steep finally levelling off when the reaction stops. [1]

e) i) Graph steeper at the start [1] but levelling off to the same final volume of gas collected at room temperature. [1]

ii) Initial rate unchanged [1] but final volume of gas is 80 cm^3. [1]

iii) Slower initial rate [1] but the final volume of gas is unchanged at 40 cm^3. [1]

iv) Slower initial rate [1] and the final volume of gas is 20 cm^3. [1]

2 a) Only collisions with energy greater than the activation energy lead to reaction. [1] The activation energy is typically well to the right of the Maxwell–Boltzmann distribution, so only a minority of colliding molecules have enough energy to react. [1]

b) By raising the concentration or increasing the pressure so that reactant molecules are closer together. [1]

c) Raising the temperature shifts the Maxwell–Boltzmann distribution to the right. [1]

The value of the activation energy does not change [1] but the area under the curve of the distribution representing the number of molecules with enough energy to react can increase markedly for a small rise in temperature. [1]

3 Graph similar to Figure 9.16(b) in the Student's Book, but differing in detail:

- curve with two peaks showing reactants, intermediate and products [1]
- products at a higher energy level than the reactants [1]
- activation energy for the change from reactants to intermediate greater than the activation energy for the change of the intermediate to products. [1]

4 a) Maxwell–Boltzmann distribution sketched with the right shape and with labelled axes as in Figure 9.15 in the Student's Book. [2]

b) Two activation energies drawn in to the right-hand end of the distribution [1] with the activation energy for the reaction with the catalyst being lower than that for the uncatalysed reaction as in Figure 9.15. [1]

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c) Area under the distribution to the right of the activation energy indicates the number of molecules with enough energy to react. [1] This area is greater when the activation energy is lower in the presence of a catalyst [1] so more collisions can lead to reaction. [1]

5 a) Up to 4 marks for key points such as the following: Energy of collisions not great enough to break bonds at room temperature. [1] A spark raises the temperature of the gas mixture. [1] At a higher temperature more molecular collisions have enough energy for reaction. [1] Platinum acts as a catalyst for the reaction [1] by providing a reaction pathway with a lower activation energy [1] such that collisions at room temperature have enough energy for reaction. The reaction is highly exothermic so it gets hotter and hotter once it starts so that the reaction gets very fast. [1]

b) Up to 4 marks for key points such as the following: Double bond in oxygen molecules and triple bond in nitrogen molecules are strong. [1] Nitrogen is a relatively inert gas. [1] At room temperature molecular collisions do not have enough energy for reaction. [1] In the cylinder of an engine the gas mixture is hot and under pressure. [1] Under these conditions there is enough energy in the molecular collisions to overcome the activation energy. [1]

c) Up to 4 marks for key points such as the following: Lumps of coal or sacks of flour are combustible but they burn slowly. [1] In a mine or mill some of the coal or flour becomes finely divided so that it has a high surface area making it potentially much more reactive. [1] Activity in mine or mill can raise dust unless care is taken to damp it down. [1] The mixture of air and finely divided fuel can lead to a very rapid reaction if ignited. [1]

6 This question assesses a student's ability to show a coherent and logically structured answer with linkages and fully sustained line of reasoning. Assess the quality of the answer taking into account both the key points made (*up to 4 marks*) and the logic and coherence of the discussion (*up to 2 marks*).

Points to make in the answer:

- an outline of collision theory and …
- … the concept of activation energy
- the Maxwell–Boltzmann distribution and the values of activation energies in relation to the energies of the bulk of the molecules in a gas mixture
- reasons why activation energies vary depending on the chemical nature of the reactants
- the effects of temperature, concentration, catalysts and …
- … the explanation of these effects in terms of collision theory, activation energy and the Maxwell–Boltzmann distribution
- the state of the reactants (solid, liquid, gas) and the factors affecting rates at the interface between phases.

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7 This question assesses a student's ability to show a coherent and logically structured answer with linkages and fully sustained line of reasoning. Assess the quality of the answer taking into account both the key points made (*up to 4 marks*) and the logic and coherence of the discussion (*up to 2 marks*).

Points to make in the answer:

- Models are the basis for explanations for observed patterns/generalisations.
- For example: the gas laws summarise patterns in observations; or the kinetic theory explains the patterns; or observations of the effect of different factors on the rates of reaction are explained in terms of collision theory.
- Models are based on a set of assumptions which may too simple and not fully reflect reality.
- This is illustrated by the assumptions underlying kinetic theory which apply to ideal gases but not exactly to real gases.
- Good models can explain a wide range of phenomena.
- For example: kinetic theory can account for the differing effects of pressure, temperature and volume changes on a gas; or collision theory can account for the effects of changes in temperature, concentration surface area and catalysts on the rates of reactions.
- Models can be used to make predictions that can be tested.
- Ideally models make possible quantitative predictions that can be tested this applies to both these models (though this has not been covered in this chapter).

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