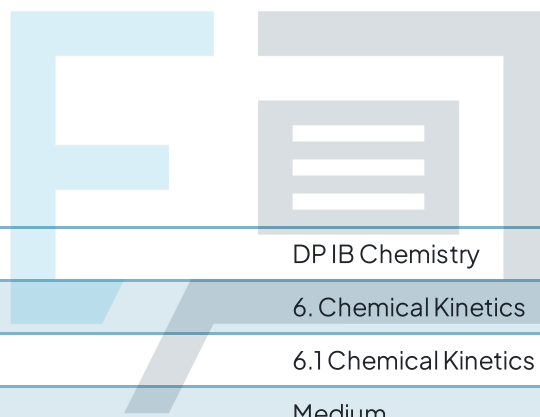




6.1 Chemical Kinetics

Mark Schemes



| | |
|------------|-----------------------|
| Course | DP IB Chemistry |
| Section | 6. Chemical Kinetics |
| Topic | 6.1 Chemical Kinetics |
| Difficulty | Medium |

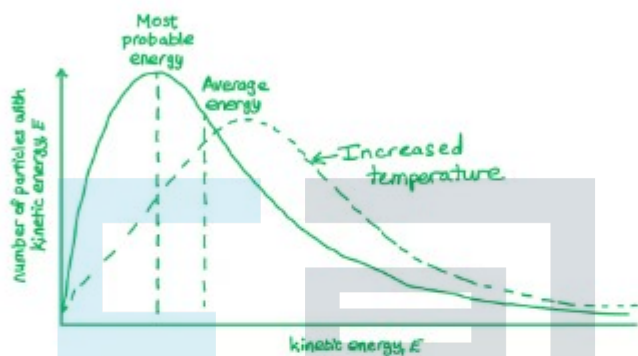
Exam Papers Practice

To be used by all students preparing for DP IB Chemistry HL
Students of other boards may also find this useful

1

The correct answer is **A** because:

- The Boltzmann distribution curve shows the peak as the most probable energy



- When the temperature is increased the number of particles with enough energy for a successful collision is increased
 - Shifting the peak of the graph down and to the right

B is incorrect as the graph would shift to the left when the particles have less energy and therefore further away from having the activation energy

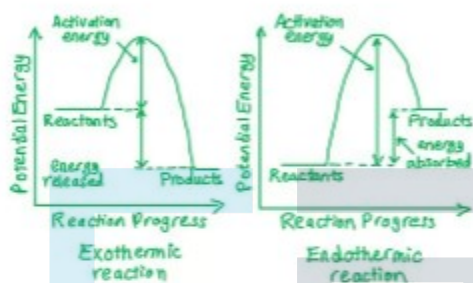
C is incorrect as if more particles have the most probable energy, then there will be fewer particles with the activation energy required for the reaction to take place

D is incorrect as the area under the graph is the number of particles, the area under the graph would only change if the number of particles changed

2

The correct answer is **B** because:

- The activation energy in an endothermic reaction is the energy needed for the reactants to react
- This is the energy from the reactants to the 'hump' in the line as shown in the diagram below



A is incorrect as this does not correspond to the activation energy

C is incorrect as this is the activation energy for the reverse reaction

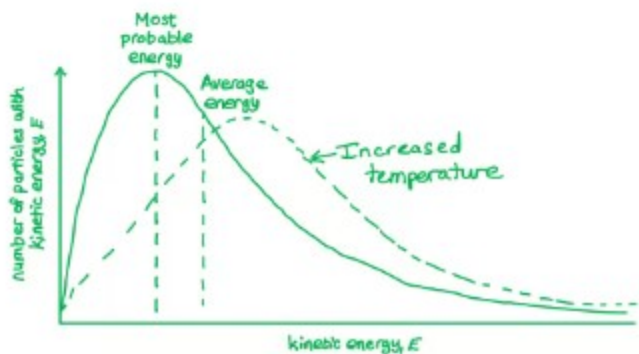
D is incorrect as this is the ΔH of the forward reaction

3

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The correct answer is **D** because:

- When the temperature is increased the number of particles with enough energy for a successful collision is increased
 - Shifting the peak of the graph down and to the right



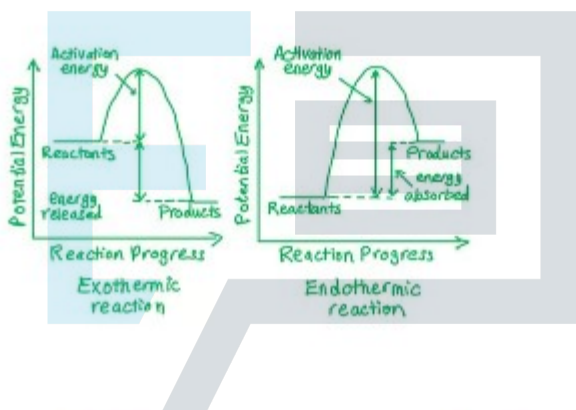
- The graph that matches this profile is **D**

All the other graphs do not move down and to the right

4

The correct answer is **D** because:

- The activation energy is minimum energy particles must possess to break bonds to start a chemical reaction
- This is the energy from the reactants to the 'hump' in the line; therefore $E_3 - E_2$



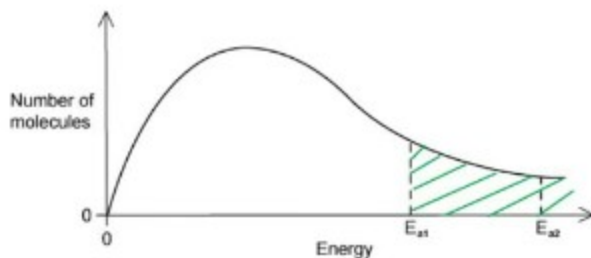
A & C is incorrect as this does not correspond to the activation energy

B is incorrect as this is the ΔH of the forward reaction

5

The correct answer is **B** because:

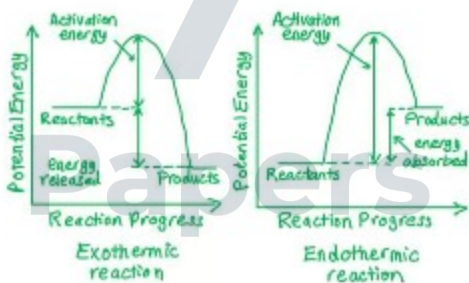
- The definition of a catalyst is that it **lowers the activation energy** by providing an **alternative pathway**; it does not form part of the products and is therefore not used in the reaction
- Therefore, more particles will have enough energy to react as shown in the shaded area in the graph below



6

The correct answer is **B** because:

- The question states that the profile must show the reaction that would proceed most rapidly and with the highest yield
- All the reactions are carried out at the same temperature
- We are looking for the graph with the smallest activation energy and the largest exothermic reaction
 - The diagrams below show energy profiles for an endothermic and exothermic reaction



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- The most exothermic profile, which is thermodynamically favourable, with the lowest activation energy is **B**

A is incorrect as it has higher activation energy than **B**

C & D are incorrect as they are both endothermic reactions and thermodynamically unfavourable

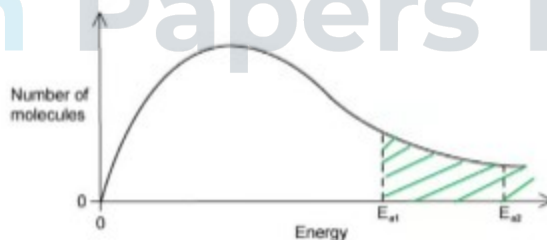
It's important to remember that thermodynamics predicts whether reactions will occur at a certain temperature, but kinetics controls them. Although enthalpy changes can be an indicator of likely reactions, it does not explain why some endothermic reactions proceed. For that you need to consider the **free energy** change of the reaction, but that is beyond what you need to study at standard level.

7

The correct answer is **A** because:

- The definition of a catalyst is that it **lowers the activation energy** by providing an **alternative pathway**; it does not form part of the products and is therefore not used in the reaction

Exam Papers Practice



- A catalyst does not change the number of particles at each energy so the peak of the graph will stay the same
- The activation energy moves to the left as a catalyst offers an alternative pathway



B is incorrect as the height of the peak does not change

C is incorrect as if the activation energy is moved to the right, then fewer particles would have the activation energy, and the rate of the reaction would go down

D is incorrect as the height of the peak does not change. If the activation energy is moved to the right, then fewer particles would have the activation energy, and the rate of the reaction would go down

8

The correct answer is **A** because:

- When the water is added in reaction 2 this dilutes the concentration of the hydrochloric acid
- When the concentration is diluted, there are less frequent collisions between reacting particles reducing the rate

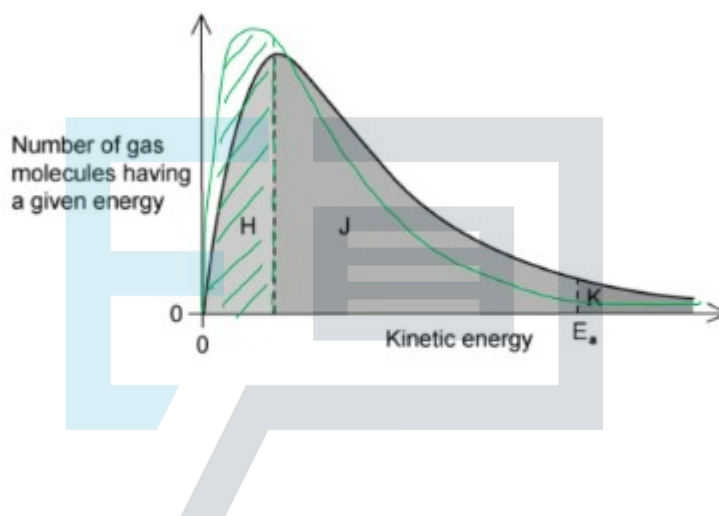
B & D are incorrect as the effectiveness of the collision is not determined by the concentration, but the orientation and the energy of the colliding particles

C is incorrect as diluting the concentration does not affect the activation energy

9

The correct answer is **C** because:

- As the temperature is decreased the line shifts to the left and the peak upwards
- This would mean a greater number of particles with less energy, so the area H increases and the other two areas decrease



10

The correct answer is **C** because:

- All of the properties can be used except for a change in volume
- Copper sulfate is a blue solution and zinc sulfate is colourless, so a colorimeter could be used to measure the loss in colour as the reaction proceeds
- The change in temperature could be measured as the reaction proceeds, although it could be tricky if there is only a small temperature change
- A change in volume is only appropriate when gases are produced
- The change in volume of reacting solutions is negligible

Extra Info

A change in colour can be measured using a colorimeter, but not all reactions with colour changes are suitable. Colorimeters work best when a solution is decolorizing or changing from colourless to coloured. Changing from one colour to another can be confusing to interpret. Solutions where a coloured precipitate is formed are not suitable either, as the precipitate blocks the path of light in the colorimeter so it cannot measure the true colour absorbance of the solution



Exam Papers Practice