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CHEMISTRY

Physical Chemistry

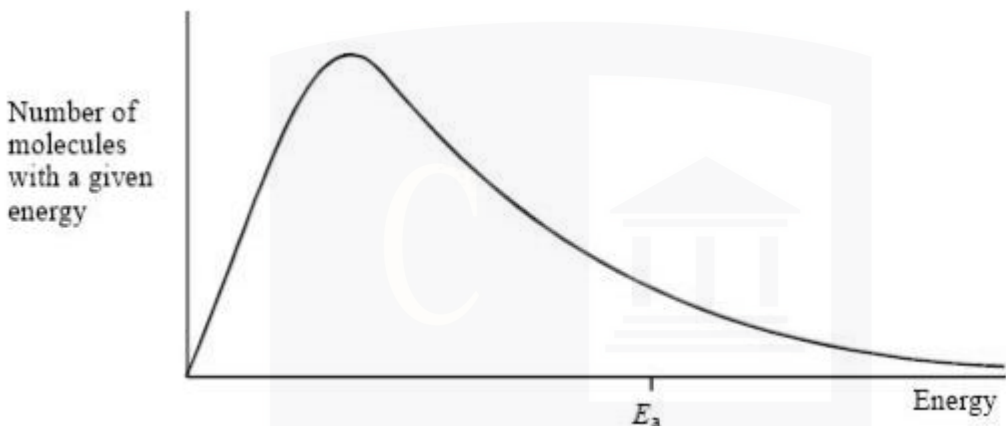
Level & Board	AQA (A-LEVEL)
TOPIC:	KINETICS
PAPER TYPE:	QUESTION PAPER - 2
TOTAL QUESTIONS	10
TOTAL MARKS	47

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Kinetics - 2

1. The diagram below shows the Maxwell–Boltzmann energy distribution curve for a sample of gas at a fixed temperature.

E_a is the activation energy for the decomposition of this gas.



- (a) On this diagram sketch the distribution curve for the same sample of gas at a higher temperature.

(3)

- (b) What is the effect of an increase in temperature on the rate of a chemical reaction?

Explain your answer with reference to the Maxwell–Boltzmann distribution.

(3)

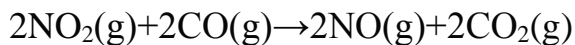
- (c) What is the effect of the addition of a catalyst on the rate of a chemical reaction?

Explain your answer with reference to the Maxwell–Boltzmann distribution.

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(3)

2. Consider the gas-phase reaction between nitrogen dioxide $\text{NO}_2(\text{g})$ and carbon monoxide CO



(a) Define the term activation energy.

(2)

(b) Give one reason why the reaction between nitrogen dioxide and carbon monoxide is very slow at room temperature.

(1)

(c) Explain why an increase in pressure, at constant temperature, increases the rate of reaction between nitrogen dioxide and carbon monoxide.

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(2)

(d) Explain why a small increase in temperature can lead to a large increase in the rate of reaction between nitrogen dioxide and carbon monoxide.

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(2)

(e) Give the meaning of the term catalyst.

(1)

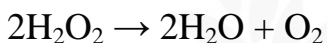
(f) Suggest one reason why a solid catalyst for a gas-phase reaction is often in the form of a powder.

(1)

3. Define the term activation energy for a chemical reaction.

(2)

4. An equation for the decomposition of hydrogen peroxide is shown below.

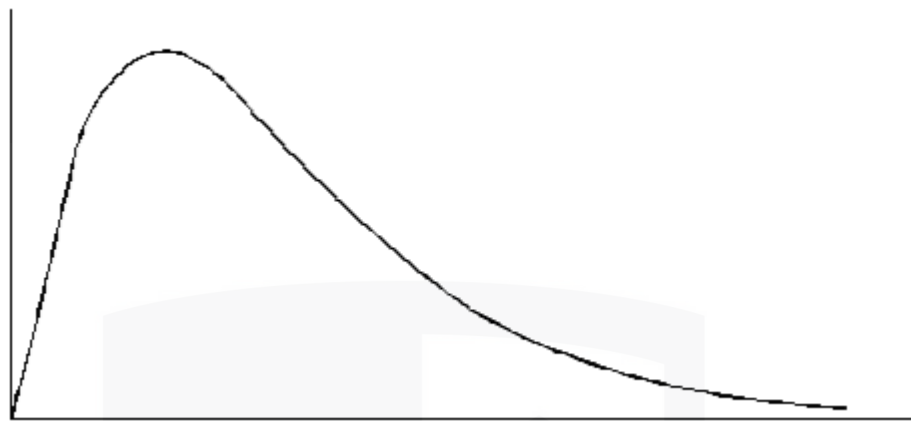


State the measurements you would take in order to investigate the rate of this reaction.

(2)

5. Below is a Maxwell–Boltzmann curve showing the distribution of molecular energies for a sample of gas at a temperature T

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(a) Label the axes on the diagram above.

(1)

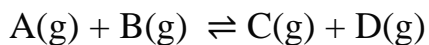
(b) What does the area under the curve represent?

(1)

(c) State why this curve starts at the origin.

(2)

6. A dynamic equilibrium is established when gas A is mixed with gas B at a given temperature.



(a) Give the meaning of the term dynamic in the context of a dynamic equilibrium.

(1)

(b) The total pressure on the system is increased at constant temperature.

- i. State and explain the effect, if any, of this change on the position of this equilibrium.

(2)

- ii. State and explain the effect, if any, of this change on the time taken to reach this equilibrium.

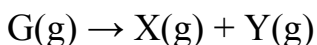
(3)

7. Which statement accurately describes the behavior of molecules in a sample of gas?

- A. At a specified temperature, they all move at a uniform speed.
B. At a specified temperature, their average kinetic energy remains consistent.
C. When the temperature rises, there is an increase in the number of molecules with the most probable energy.
D. When the temperature decreases, there is a reduction in the number of molecules with the mean energy.

(Total 1 mark)

8. Gas G decomposes as shown in the equation below.



State the effect, if any, of adding a catalyst on the time required for G to decompose, compared with a similar sample without a catalyst.
Explain in general terms how the catalyst has this effect.

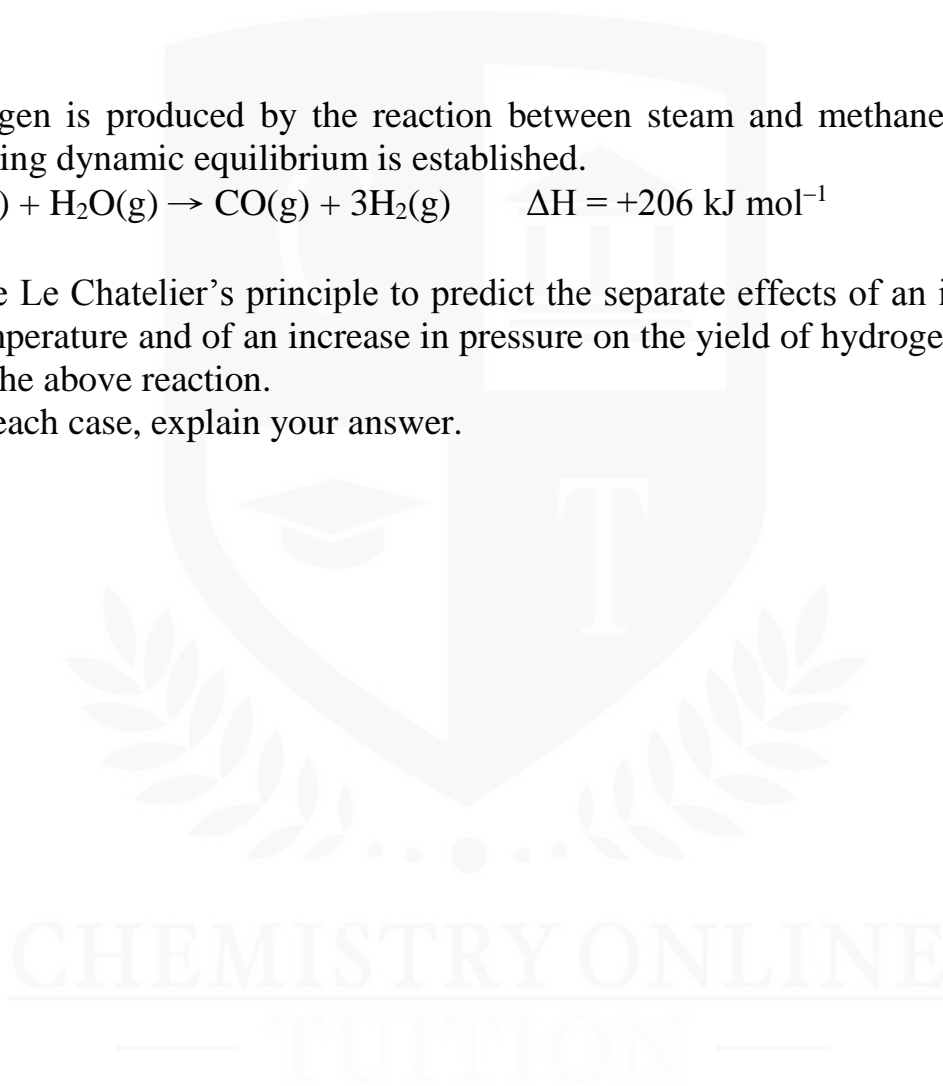
(3)

9. Hydrogen is produced by the reaction between steam and methane when the following dynamic equilibrium is established.



- (a) Use Le Chatelier's principle to predict the separate effects of an increase in temperature and of an increase in pressure on the yield of hydrogen obtained in the above reaction.

In each case, explain your answer.



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(6)

(b) State how, and explain why, the use of a catalyst might or might not change the equilibrium yield of hydrogen, and also the amount of hydrogen produced, in a given time.

(4)

10. When comparing the rate of a chemical reaction under different conditions, which statement is true?

- A.** The rate of reaction is unaffected by changes in concentration.
- B.** Increasing temperature generally decreases the rate of reaction.
- C.** Higher concentrations of reactants typically lead to a faster rate of reaction.
- D.** Lower surface area of reactants leads to a faster rate of reaction.

(Total 1 mark)

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