# AS LEVEL CHEMISTRY

# 2.3.2 RATES AND EQUILIBRIUM

# TEST

Answer all questions

Max 50 marks

| | |
|---|---|
| Name | …….. |
| Mark | ……../50 ……....% Grade …… |

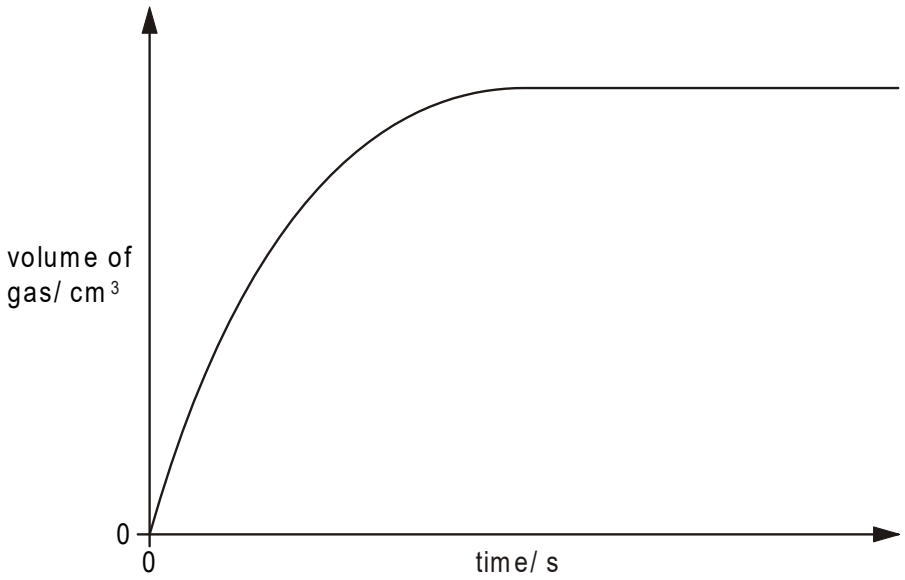
**1.** A group of students investigated the effect of concentration on the rate of a reaction. They used the reaction between magnesium carbonate and dilute hydrochloric acid and measured the rate at which the gas was collected.

(a) An incomplete equation for this reaction is given below. Complete the equation by balancing it and inserting state symbols.

....$MgCO_3$(.....) + ....HC*l*(.....) → ....Mg$C*l*_2$(.....) + ....$CO_2$(.....) + ....$H_2O$(.....)

[2]

(b) The students added dilute hydrochloric acid to some magnesium carbonate. The students collected the gas and measured the volume, at regular intervals, until after the reaction was complete. They then plotted a graph of their results.




Use collision theory to explain the changes in the rate of the reaction as it proceeds.

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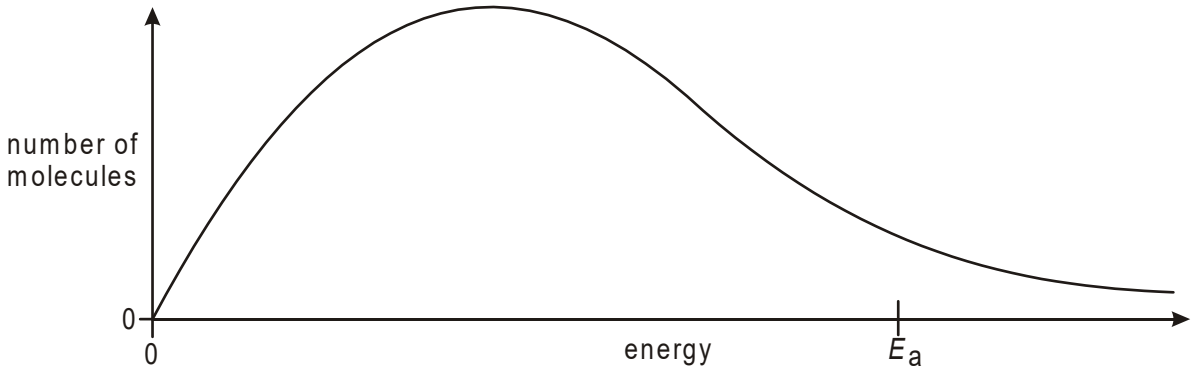
[3]

[Total 5 marks]

**2.** The diagram below shows the energy distribution of molecules at a particular temperature. $E_a$ represents the activation energy of the reaction.




(i) On the diagram, draw a second curve to represent the energy distribution of the same number of molecules at a higher temperature.

[2]

(ii) Using your completed diagram, explain how an increase in temperature causes the rate of reaction to increase.

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[2]

[Total 4 marks]

**3.** What is a catalyst?

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[Total 2 marks]

**4.** In this question, one mark is available for the quality of written communication.

What effect does a catalyst have on the rate of a reaction, and how does it achieve this effect?

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[4]

Quality of Written Communication [1]

[Total 5 marks]

**5.** State **two** characteristics of a dynamic equilibrium.

1 .....

2 .....

[Total 2 marks]

**6.** Nitrogen dioxide, $NO_2$, and dinitrogen tetroxide, $N_2O_4$, take part in the following equilibrium.

$$2NO_2(g) \rightleftharpoons N_2O_4(g) \quad \Delta H = -58 \text{ kJ mol}^{-1}$$

(a) State le Chatelier's principle.

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[2]

(b) Describe, and explain, what would happen to the position of the $NO_2/N_2O_4$ equilibrium if the following changes are made.

(i) The temperature is increased.

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[2]

(ii) The pressure is increased.

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[2]

(iii) A catalyst is added.

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[2]

[Total 8 marks]

**7.** A mixture of $N_2$ and $H_2$ was left until it had reached equilibrium as shown below.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) \qquad \Delta H = -92 \text{ kJ mol}^{-1}$$

At that stage, $N_2$, $H_2$ and $NH_3$ were present in the equilibrium mixture.

Explain how the following changes would affect the **amounts** of $N_2$, $H_2$ and $NH_3$ present in the equilibrium mixture.

(i) use of a catalyst

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.....

[1]

(ii) a higher temperature

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[2]

(iii) a lower pressure

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[2]

[Total 5 marks]

**8.** Methanol can be used as a fuel or as the feedstock for a variety of organic compounds. It is manufactured from carbon monoxide and hydrogen.

$$CO(g) + 2H_2(g) \rightleftharpoons CH_3OH(g) \qquad \Delta H = -129 \text{ kJ mol}^{-1}$$

(i) Describe and explain how the composition of the equilibrium mixture is affected by increasing the temperature

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increasing the pressure in the reaction.

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[4]

(ii) Describe and explain the effect of increasing the pressure on the **rate** of reaction.

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[2]

(iii) The reaction is carried out by passing gaseous reactants over a transition metal catalyst.

Suggest and explain the effect of a catalyst on the equilibrium position.

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[2]

[Total 8 marks]

**9.** Ammonia, $NH_3$, is made industrially by the Haber process. This is an equilibrium reaction.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) \quad \Delta H = -92 \text{ kJ mol}^{-1}$$

(a) State the pressure and temperature that are used in the Haber process.

*pressure* .....

*temperature* .....

[2]

(b) Describe and explain why these conditions are a compromise between rate and equilibrium.

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[9]

[Total 11 marks]