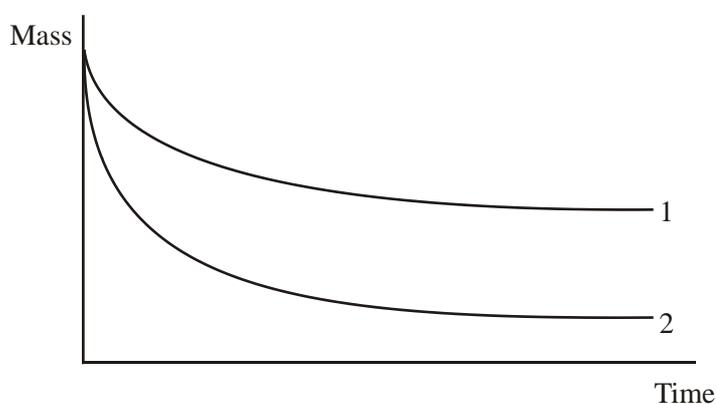




IB Chemistry – SL Topic 6 Questions

- Which of the following is (are) important in determining whether a reaction occurs?
 - Energy of the molecules
 - Orientation of the molecules
 - I only
 - II only
 - Both I and II
 - Neither I nor II
- Consider the reaction between solid CaCO_3 and aqueous HCl . The reaction will be speeded up by an increase in which of the following conditions?
 - Concentration of the HCl
 - Size of the CaCO_3 particles
 - Temperature
 - I only
 - I and III only
 - II and III only
 - I, II and III
- Excess magnesium was added to a beaker of aqueous hydrochloric acid on a balance. A graph of the mass of the beaker and contents was plotted against time (line 1).





What change in the experiment could give line 2?

- I. The same mass of magnesium but in smaller pieces
- II. The same volume of a more concentrated solution of hydrochloric acid
- III. A lower temperature

- A. I only
- B. II only
- C. III only
- D. None of the above

4. The rate of a reaction between two gases increases when the temperature is increased and a catalyst is added. Which statements are both correct for the effect of these changes on the reaction?

	Increasing the temperature	Adding a catalyst
A.	Collision frequency increases	Activation energy increases
B.	Activation energy increases	Activation energy does not change
C.	Activation energy does not change	Activation energy decreases
D.	Activation energy increases	Collision frequency increases

5. Which of the following is (are) altered when a liquid at its boiling point is converted to a gas at the same temperature?

- I. The size of the molecules
- II. The distance between the molecules
- III. The average kinetic energy of the molecules

- A. I only
- B. II only
- C. III only
- D. I and II only

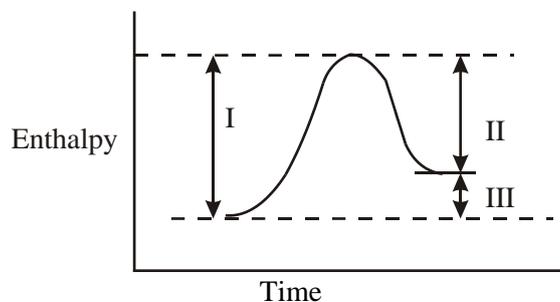
6. Based on the definition for rate of reaction, which units are used for a rate?

- A. mol dm^{-3}
- B. mol time^{-1}
- C. dm time^{-1}



D. $\text{mol dm}^{-3} \text{ time}^{-1}$

7. Which of the quantities in the enthalpy level diagram below is (are) affected by the use of a catalyst?



- A. I only
B. III only
C. I and II only
D. II and III only
8. In the Haber process for the synthesis of ammonia, what effects does the catalyst have?

	Rate of formation of $\text{NH}_3(\text{g})$	Amount of $\text{NH}_3(\text{g})$ formed
A.	Increases	Increases
B.	Increases	Decreases
C.	Increases	No change
D.	No change	Increases

9. Which statement is correct for a collision between reactant particles leading to a reaction?

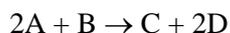
- A. Colliding particles must have different energy.
B. All reactant particles must have the same energy.
C. Colliding particles must have a kinetic energy higher than the activation energy.
D. Colliding particles must have the same velocity.

10. Which change of condition will decrease the rate of the reaction between excess zinc granules and dilute hydrochloric acid?

- A. increasing the amount of zinc
B. increasing the concentration of the acid
C. pulverize the zinc granules into powder
D. decreasing the temperature



11. The table shows the concentrations of reactants and products during this reaction.



	[A] / mol dm ⁻³	[B] / mol dm ⁻³	[C] / mol dm ⁻³	[D] / mol dm ⁻³
at the start	6	3	0	0
after 1 min	4	2	1	2

The rate of reaction can be measured by reference to any reactant or product. Which rates are correct for this reaction?

- I. rate = $-2 \text{ mol dm}^{-3} \text{ min}^{-1}$ for A
- II. rate = $-1 \text{ mol dm}^{-3} \text{ min}^{-1}$ for B
- III. rate = $-1 \text{ mol dm}^{-3} \text{ min}^{-1}$ for C

- A. I and II only
 - B. I and III only
 - C. II and III only
 - D. I, II and III
12. In general, the rate of a reaction can be increased by all of the following **except**
- A. increasing the temperature.
 - B. increasing the activation energy.
 - C. increasing the concentration of reactants.
 - D. increasing the surface area of the reactants.
13. At 25°C, 100 cm³ of 1.0 mol dm⁻³ hydrochloric acid is added to 3.5 g of magnesium carbonate. If the sample of magnesium carbonate is kept constant, which conditions will **not** increase the initial rate of reaction?

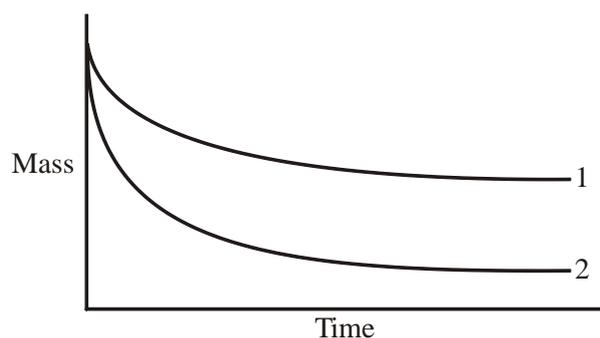
	Volume of HCl / cm ³	Concentration of HCl / mol dm ⁻³	Temperature / °C
A.	200	1.0	25
B.	100	2.0	25
C.	100	1.0	35
D.	200	2.0	25



14. At 25°C, 100 cm³ of 1.0 mol dm⁻³ hydrochloric acid is added to 3.5 g of magnesium carbonate. If the sample of magnesium carbonate is kept constant, which conditions will **not** increase the initial rate of reaction?

	Volume of HCl / cm ³	Concentration of HCl / mol dm ⁻³	Temperature / °C
A.	100	1.0	25
B.	100	2.0	25
C.	100	1.0	35
D.	200	2.0	25

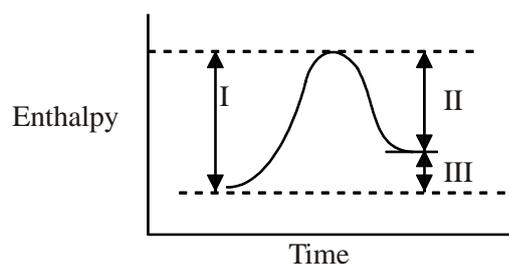
15. Which statement is correct with regard to the catalysed and uncatalysed pathways for a given reaction?
- A. The enthalpy change of the catalysed reaction is less than the enthalpy change for the uncatalysed reaction.
 - B. The enthalpy change of the catalysed reaction is greater than the enthalpy change for the uncatalysed reaction.
 - C. The enthalpy change of the catalysed reaction is equal to the enthalpy change for the uncatalysed reaction.
 - D. The activation energy of the catalysed reaction is greater than the activation energy for the uncatalysed reaction.
16. Which changes increase the rate of a chemical reaction?
- I. Increase in the concentration of an aqueous solution
 - II. Increase in particle size of the same mass of a solid reactant
 - III. Increase in the temperature of the reaction mixture
- A. I and II only
 - B. I and III only
 - C. II and III only
 - D. I, II and III
17. Excess magnesium, was added to a beaker of aqueous hydrochloric acid. A graph of the mass of the beaker and contents was plotted against time (line 1).



What change in the experiment could give line 2?

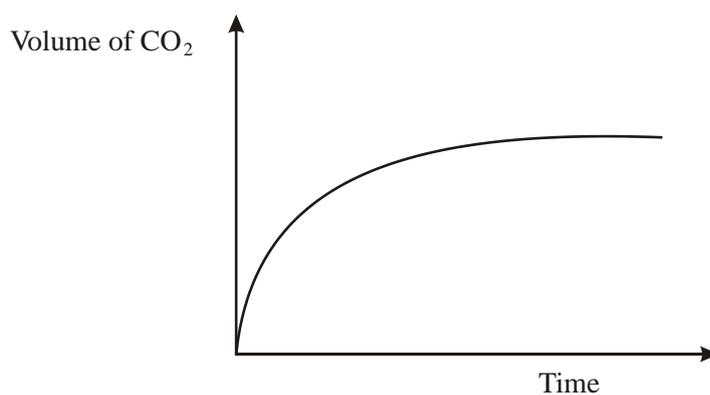
- A. The same mass of magnesium in smaller pieces
- B. The same volume of a more concentrated solution of hydrochloric acid
- C. A lower temperature
- D. A more accurate instrument to measure the time

18. Which quantities in the enthalpy level diagram are altered by the use of a catalyst?



- A. I and II only
- B. I and III only
- C. II and III only
- D. I, II and III

19. The graph below shows the volume of carbon dioxide gas produced against time when excess calcium carbonate is added to $x \text{ cm}^3$ of 2.0 mol dm^{-3} hydrochloric acid.





(i) Write a balanced equation for the reaction.

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(1)

(ii) State and explain the change in the rate of reaction with time. Outline how you would determine the rate of the reaction at a particular time.

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(4)

(iii) Sketch the above graph on an answer sheet. On the same graph, draw the curves you would expect if:

I. the same volume ($x \text{ cm}^3$) of 1.0 mol dm^{-3} HCl is used.

II. double the volume ($2x \text{ cm}^3$) of 1.0 mol dm^{-3} HCl is used.

Label the curves and explain your answer in each case.

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(5)

(Total 10 marks)

20. When excess lumps of magnesium carbonate are added to dilute hydrochloric acid the following reaction takes place.



(a) Outline **two** ways in which the rate of this reaction could be studied. In each case sketch a graph to show how the value of the chosen variable would change with time.

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(4)

(b) State and explain **three** ways in which the rate of **this** reaction could be increased.

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(6)

(c) State and explain whether the total volume of carbon dioxide gas produced would increase, decrease or stay the same if

(i) more lumps of magnesium carbonate were used.

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(2)

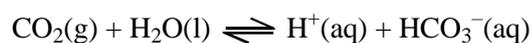
(ii) the experiments were carried out at a higher temperature.

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(2)

(Total 14 marks)

21. Carbon dioxide gas in the atmosphere reacts slightly with rainwater as shown below.



(i) State the meaning of the \rightleftharpoons sign.

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(1)

(ii) Predict the effect, if any, of the presence of a catalyst on the acidity of rainwater. Give a reason for your answer.

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(2)

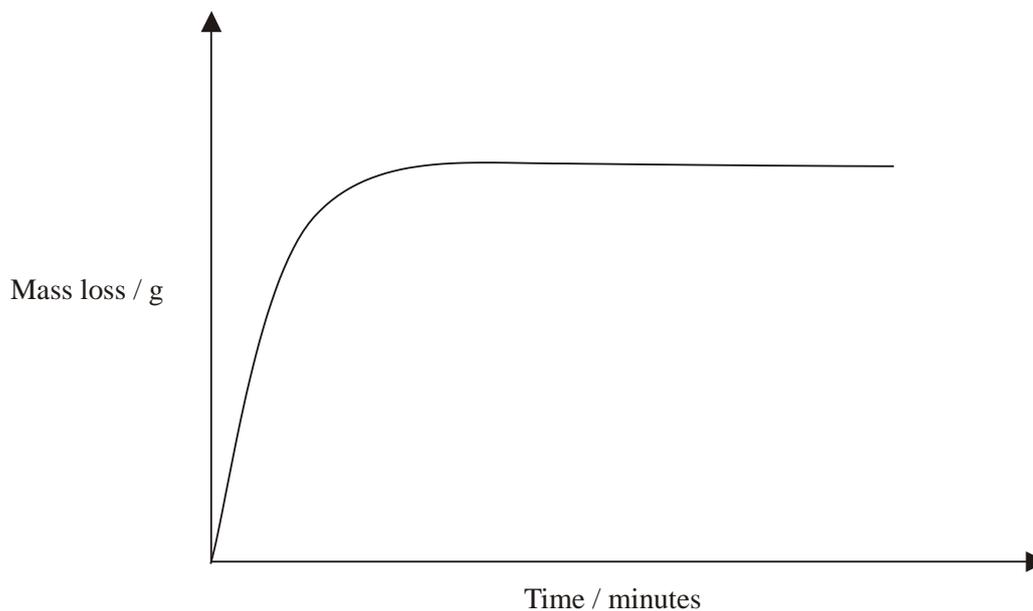
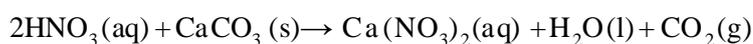
- (iii) Use Le Chatelier's principle to predict the effect of the addition of a small quantity of an alkali on the acidity of rainwater. Explain what effect, if any, this would have on the equilibrium constant, K_c .

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(3)

(Total 6 marks)

22. Excess $0.100 \text{ mol dm}^{-3}$ nitric acid is added to a certain mass of powdered calcium carbonate at 20°C . The rate of reaction is monitored by measuring the change in mass over time due to the loss of carbon dioxide.



- (a) Define the term *rate of reaction*.

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(1)



(b) Explain why the mass loss remains constant after a certain time.

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(1)

(c) Draw a line on the graph above, to show what the graph would look like if the same mass of calcium carbonate in larger pieces were reacted with excess $0.100 \text{ mol dm}^{-3}$ nitric acid.

(1)

(d) Explain in terms of the collision theory what would happen to the rate if the reaction was conducted at 50°C .

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(3)

(e) Determine the rate of formation of carbon dioxide when the nitric acid reacts at a rate of $2.00 \times 10^{-3} \text{ mol cm}^{-3} \text{ s}^{-1}$.

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(1)

(Total 7 marks)

23. (i) Draw a graph that shows the distribution of molecular energies in a sample of a gas at two different temperatures, T_1 and T_2 , such that T_2 is greater than T_1 .

(2)

(ii) Define the term *activation energy*.

(1)

(iii) State and explain the effect of a catalyst on the rate of an endothermic reaction.

(2)

(Total 5 marks)

24. (i) Magnesium is added to a solution of hydrochloric acid. Sketch a graph of acid concentration on the y-axis against time on the x-axis to illustrate the progress of the reaction.

(1)

(ii) Describe how the slope of the line changes with time.

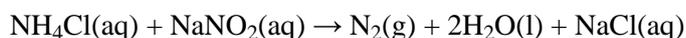
(1)

(iii) Use the collision theory to state and explain the effect of decreasing concentration on the rate of the reaction.

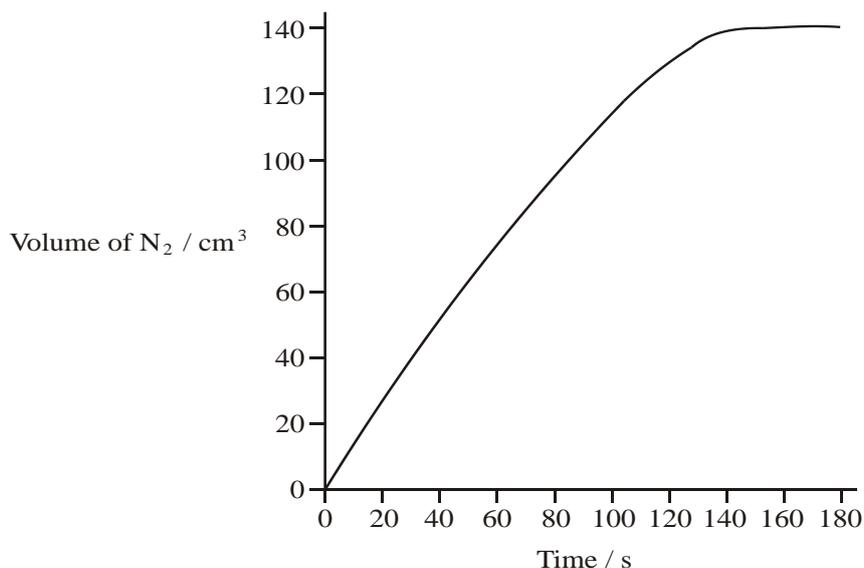


(2)
(Total 4 marks)

25. The reaction between ammonium chloride and sodium nitrite in aqueous solution can be represented by the following equation.



The graph below shows the volume of nitrogen gas produced at 30 second intervals from a mixture of ammonium chloride and sodium nitrite in aqueous solution at 20°C.



- (a) (i) State how the rate of formation of nitrogen changes with time. Explain your answer in terms of collision theory.

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(2)

- (ii) Explain why the volume eventually remains constant.

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(1)

- (b) (i) State how the rate of formation of nitrogen would change if the temperature were increased from 20°C to 40°C.

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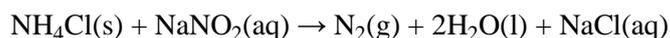
(1)

- (ii) State **two** reasons for the change described in (b)(i) and explain which of the two is more important in causing the change.

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(3)

- (iii) The reaction between **solid** ammonium chloride and aqueous sodium nitrite can be represented by the following equation.



State and explain how the rate of formation of nitrogen would change if the same amount of ammonium chloride was used as large lumps instead of as a fine powder.

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(2)

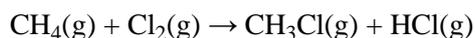
(Total 9 marks)

26. (a) Define the term *average bond enthalpy*, illustrating your answer with an equation for methane, CH₄.

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(3)

- (b) The equation for the reaction between methane and chlorine is



Use the values from Table 10 of the Data Booklet to calculate the enthalpy change for this reaction.

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(3)

(c) Explain why no reaction takes place between methane and chlorine at room temperature unless the reactants are sparked, exposed to UV light or heated.

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(2)

(d) Draw an enthalpy level diagram for this reaction.

(2)

(Total 10 marks)

27. (a) Identify **two** features of colliding molecules that react together in the gas phase.

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(2)

(b) For many reactions, the rate approximately doubles for a 10°C rise in temperature. State **two** reasons for this increase and identify which of the two is the more important.

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(3)

(Total 5 marks)

28. (a) Define the term *rate of reaction*.

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(1)

(b) The reaction between gases **C** and **D** is slow at room temperature.

(i) Suggest **two** reasons why the reaction is slow at room temperature.



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(2)

- (ii) A relatively small increase in temperature causes a relatively large increase in the rate of this reaction. State **two** reasons for this.

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(2)

- (iii) Suggest **two** ways of increasing the rate of reaction between **C** and **D** other than increasing temperature.

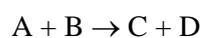
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(2)

(Total 7 marks)



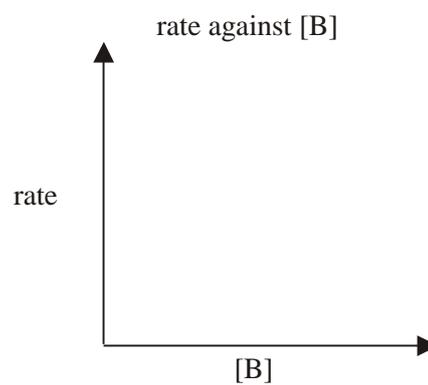
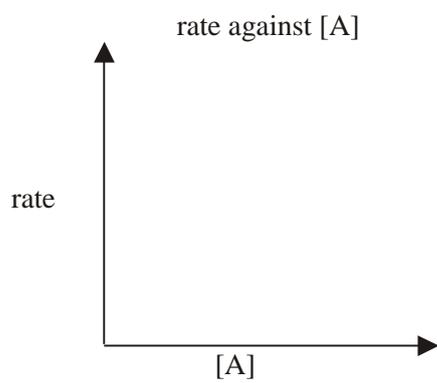
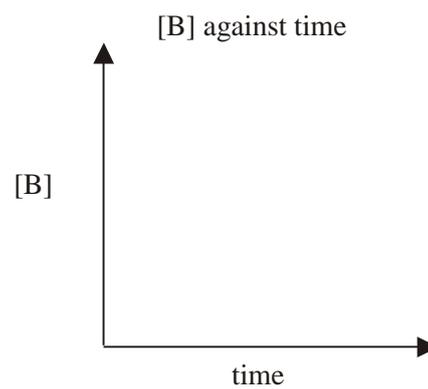
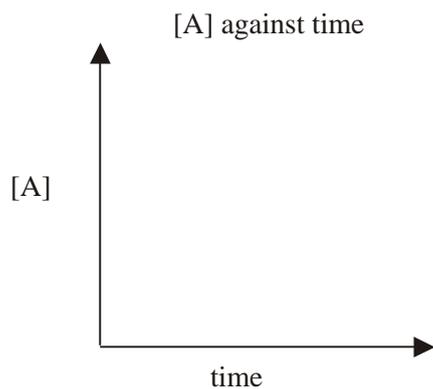
29. The reaction between two substances A and B



has the following rate expression:

$$\text{rate} = k [B]$$

Draw the graphical representation of:



(Total 3 marks)