



eduresourceza.com

Rates and extent of reactions

Homework/Classwork 1

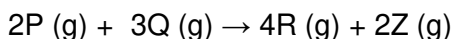
Date: _____

1. Define the term *reaction rate* in words.
2. List the factors which affect the rate of chemical reactions.

Homework/Classwork 2

Date: _____

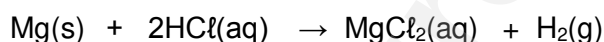
1. Study the hypothetical reaction below:



The rate of the reaction in terms of the number of moles of substance **P** used up, is $1 \times 10^{-3} \text{ mol}\cdot\text{dm}^{-3}\cdot\text{s}^{-1}$. What is the rate (in $\text{mol}\cdot\text{dm}^{-3}\cdot\text{s}^{-1}$) at which product **R** is formed?

- A 1×10^{-3}
- B $4(1 \times 10^{-3})$
- C $\frac{1 \times 10^{-3}}{2}$
- D $2(1 \times 10^{-3})$

2. Consider the chemical reaction represented by the equation below:



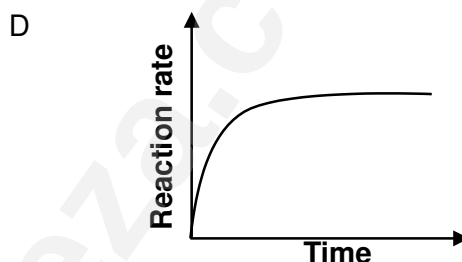
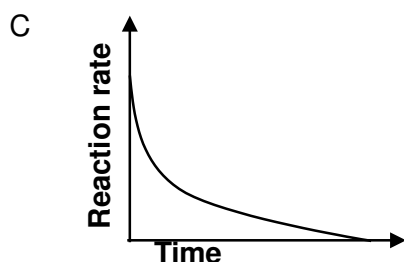
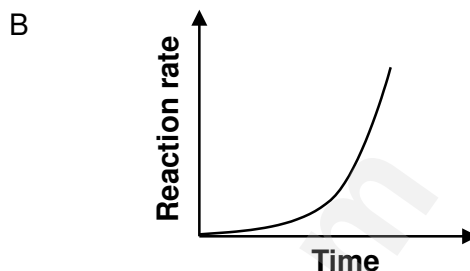
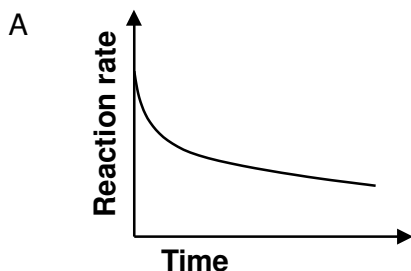
Which ONE of the following changes will increase the rate of production of $\text{H}_2\text{(g)}$?

- A Increase in pressure
- B Increase in volume of HCl(aq)
- C Decrease in concentration of HCl(aq) .
- D Increase in temperature.
3. 50 cm³ of a 0,1 mol.dm⁻³ solution of hydrochloric acid is poured on to 5 g of granulated zinc which is inside a glass beaker at room temperature.
- Which one of the following factors will not increase the initial rate of the reaction?
- A Grinding the granulated zinc into powder.
- B Using 30 cm³ of a 0,2 mol.dm⁻³ hydrochloric acid at room temperature.
- C Increasing the temperature of the acid solution to 50 °C.
- D Using 100 cm³ of a 0,1 mol.dm⁻³ solution of hydrochloric acid at room temperature

Homework/Classwork 3

Date: _____

1. Which ONE of the reaction rate versus time graphs below best represents the reaction between magnesium and EXCESS dilute hydrochloric acid?



2. Learners use the reaction between IMPURE POWDERED calcium carbonate and excess hydrochloric acid to investigate reaction rate. The balanced equation for the reaction is:



They perform four experiments under different conditions of concentration, mass and temperature as shown in the table below. They use identical apparatus in the four experiments and measure the volume of gas released in each experiment.

	EXPERIMENT			
	1	2	3	4
Concentration of acid ($\text{mol}\cdot\text{dm}^{-3}$)	1	0,5	1	1
Mass of impure calcium carbonate (g)	15	15	15	25
Initial temperature of acid ($^{\circ}\text{C}$)	30	30	40	40

- 2.2 The results of experiments 1 and 3 are compared in the investigation.

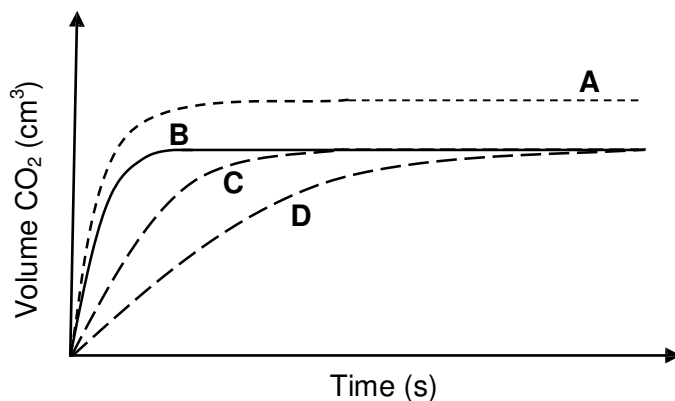
Write down the:

2.2.1 Independent variable (1)

2.2.2 Dependent variable (1)

- 2.3 Use the collision theory to explain why the reaction rate in experiment 4 will be higher than that in experiment 3. (3)

The learners obtain graphs **A**, **B**, **C** and **D** below from their results.



2.4 Which ONE of the graphs (**A**, **B**, **C** or **D**) represents experiment **1**? Fully explain the answer by comparing experiment **1** with experiments **2**, **3** and **4**. (6)

2.5 When the reaction in experiment **4** reaches completion, the volume of gas formed is $4,5 \text{ dm}^3$. Assume that the molar gas volume at 40°C is equal to $25,7 \text{ dm}^3$.

Calculate the mass of the impurities present in the calcium carbonate.

(5)
[18]

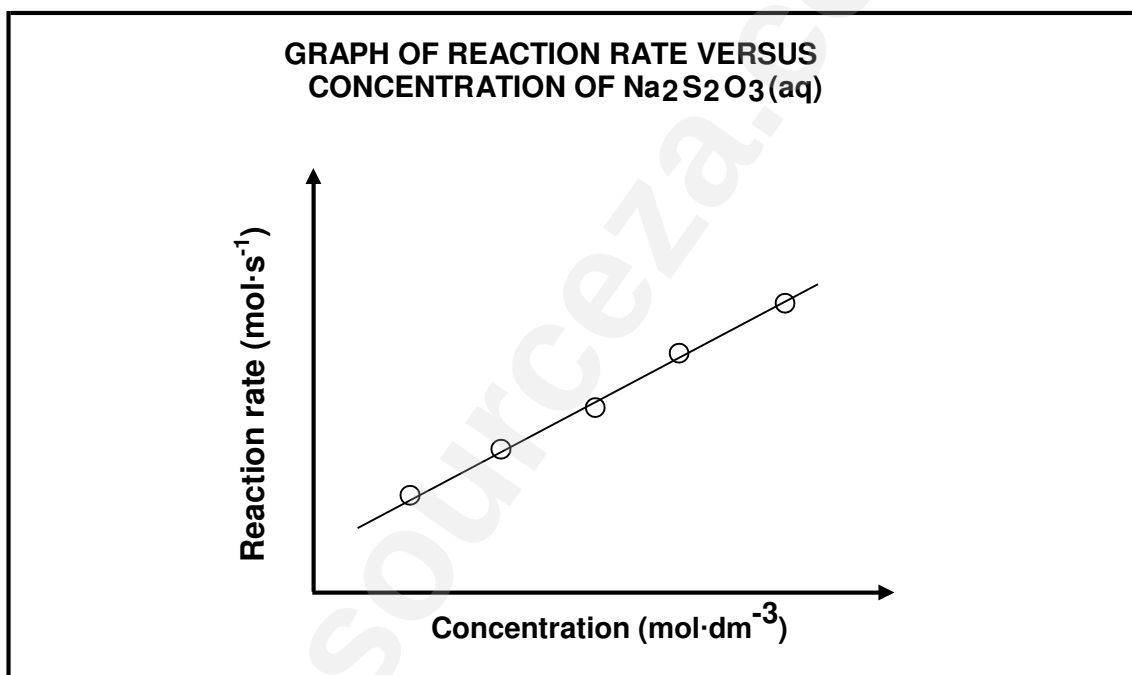
Learners use the reaction of a sodium thiosulphate solution with dilute hydrochloric acid to investigate several factors that affect the rate of a chemical reaction. The balanced equation for the reaction is:



Three investigations (I, II and III) are carried out.

1. **INVESTIGATION I**

The results obtained in INVESTIGATION I are shown in the graph below.



For this investigation, write down the:

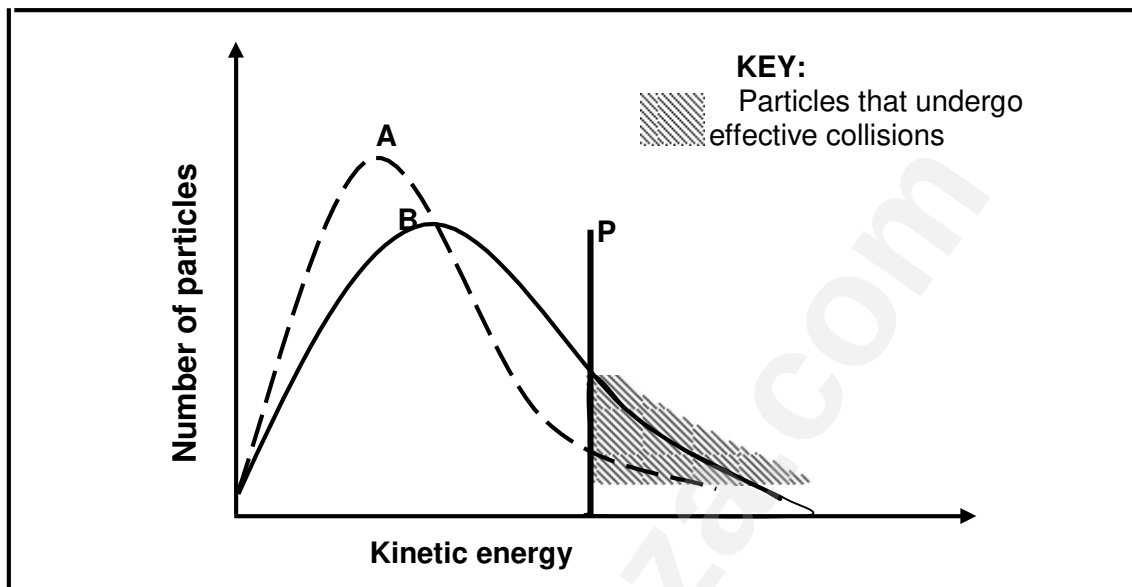
1.1 Dependent variable (1)

1.2 Conclusion that can be drawn from the results (2)

1.3

INVESTIGATION II

The Maxwell-Boltzmann distribution curves, **A** and **B**, below represent the number of particles against kinetic energy for the reaction at two different temperatures.

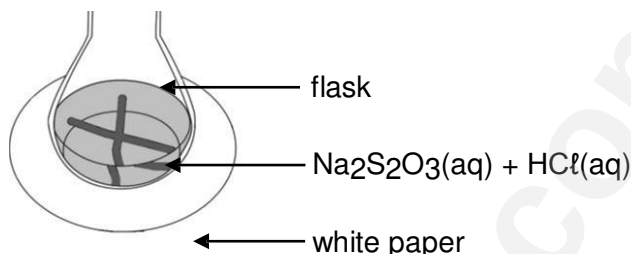


- 1.3.1 What does line **P** represent? (1)
- 1.3.2 Which curve (**A** or **B**) was obtained at the higher temperature? (1)
- 1.3.3 Explain, in terms of the collision theory, how an increase in temperature influences the rate of a reaction. (4)

The reaction between dilute hydrochloric acid and sodium thiosulphate ($\text{Na}_2\text{S}_2\text{O}_3$) is used to investigate one of the factors that influences reaction rate. The balanced equation for the reaction is:



The hydrochloric acid solution is added to the sodium thiosulphate solution in a flask. The flask is placed over a cross drawn on a sheet of white paper, as shown in the diagram below. The time that it takes for the cross to become invisible is measured to determine the reaction rate.



Four experiments, **A** to **D**, are conducted during this investigation. The volumes of reactants used in each of the four experiments and the times of the reactions are summarised in the table below.

Experiment	Volume of $\text{Na}_2\text{S}_2\text{O}_3(\text{aq})$	Volume of $\text{H}_2\text{O}(\text{l})$	Volume of $\text{HCl}(\text{aq})$ (cm^3)	Time (s)
A	25	0	5	50,0
B	20	5	5	62,5
C	15	10	5	83,3
D	10	15	5	125,0

- 1.1 State TWO factors that can influence the rate of the reaction above. (2)
- 1.2 Write down the NAME or FORMULA of the product that causes the cross to become invisible. (1)
- 1.3 Give a reason why water is added to the reaction mixture in experiments **B** to **D**. (1)
- 1.4 Write down an investigative question for this investigation. (2)
- 1.5 In which experiment (**A**, **B**, **C** or **D**) is the reaction rate the highest? (1)

1.6 Use the collision theory to explain the difference in reaction rate between experiments **B** and **D**. (3)

1.7 The original $\text{Na}_2\text{S}_2\text{O}_3$ solution was prepared by dissolving 62,50 g $\text{Na}_2\text{S}_2\text{O}_3$ crystals in distilled water in a 250 cm^3 volumetric flask.

Calculate the mass of sulphur, S, that will form in experiment **D** if $\text{Na}_2\text{S}_2\text{O}_3$ is the limiting reactant

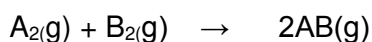
(7)
[17]

eduresourceza.com

1. Activation energy can best be described as the minimum energy required to ...

- A cause effective collisions.
- B make reactant molecules collide.
- C change the orientation of reactant molecules.
- D increase the kinetic energy of reactant molecules.

2. Consider the reaction represented by the balanced equation below:



The activation energy for the forward reaction is 180 kJ and that for the reverse reaction is 200 kJ.

The heat of reaction (ΔH) is...

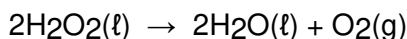
- A + 20kJ.
- B - 20kJ
- C + 380kJ.
- D -- 380kJ.

3. The activation energy for a certain reaction is $50\text{kJ}\cdot\text{mol}^{-1}$. Energy is adsorbed when this reaction takes place.

Which ONE of the following is CORRECT for the REVERSE reaction?

ACTIVATION ENERGY (E_A)	HEAT OF REACTION (ΔH)
A. $E_A > 50\text{kJ}\cdot\text{mol}^{-1}$	$\Delta H > 0$
B. $E_A > 50\text{kJ}\cdot\text{mol}^{-1}$	$\Delta H < 0$
C. $E_A < 50\text{kJ}\cdot\text{mol}^{-1}$	$\Delta H < 0$
D. $E_A < 50\text{kJ}\cdot\text{mol}^{-1}$	$\Delta H > 0$

Hydrogen peroxide, H_2O_2 , decomposes to produce water and oxygen according to the following balanced equation:



- 1 The activation energy (E_A) for this reaction is 75 kJ and the heat of reaction (ΔH) is – 196 kJ.

1.1 Define the term *activation energy*. (2)

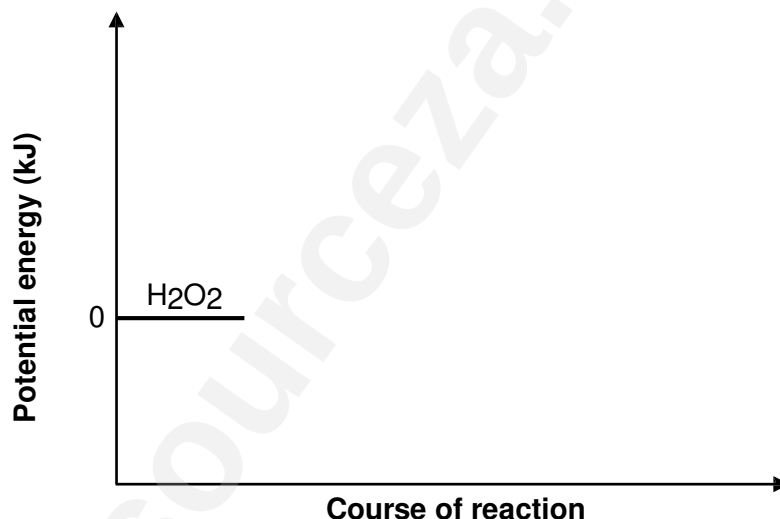
1.2 Redraw the set of axes below in your ANSWER BOOK and then complete the potential energy diagram for this reaction.

Indicate the value of the potential energy of the following on the y-axis:

☐ Activated complex

☐ Products

(The graph does NOT have to be drawn to scale.)



(3)

When powdered manganese dioxide is added to the reaction mixture, the rate of the reaction increases.

1.3 On the graph drawn for QUESTION 1.2, use broken lines to show the path of the reaction when the manganese dioxide is added. (2)

1.4 Use the collision theory to explain how manganese dioxide influences the rate of decomposition of hydrogen peroxide. (3)

Homework/Classwork 8

Date: _____

1. Explain what is meant by:
 - 1.1 Open and closed systems
 - 1.2 A reversible reaction
 - 1.3 Dynamic equilibrium

Homework/Classwork 9

Date: _____

Write down the expressions for the equilibrium constant for each of the following reversible reactions:

1. $2\text{H}_2\text{O}_2(\text{aq}) \leftrightarrow 2\text{H}_2\text{O}(\text{l}) + \text{O}_2(\text{g})$
2. $2\text{HCl}(\text{aq}) + \text{CaCO}_3(\text{s}) \leftrightarrow \text{CaCl}_2(\text{aq}) + \text{H}_2\text{O}(\text{l}) + \text{CO}_2(\text{g})$

Homework/Classwork 10

Date: _____

Study the K_C values for each of the reactions that follow. Briefly explain in each case the meaning of the magnitude of the K_C value.

- | | | |
|------|---|---------------------------|
| 1.1. | $\text{H}_2(\text{g}) + \text{F}_2(\text{g}) \leftrightarrow 2\text{HF}(\text{g})$ | $K_C = 1 \times 10^{13}$ |
| 1.2. | $\text{SO}_2(\text{g}) + \text{NO}_2(\text{g}) \leftrightarrow \text{NO}(\text{g}) + \text{SO}_3(\text{g})$ | $K_C = 1 \times 10^2$ |
| 1.3 | $2\text{H}_2\text{O}(\text{g}) \leftrightarrow 2\text{H}_2(\text{g}) + \text{O}_2(\text{g})$ | $K_C = 6 \times 10^{-28}$ |

Homework/Classwork 11

Date: _____

1. A sealed 2 dm³ reaction container initially contains 0,5 mol of SO₃(g).

The sulfur(VI) oxide reacts according to the following balanced reaction equation:



The equilibrium mixture contains 0,245 mol of oxygen.

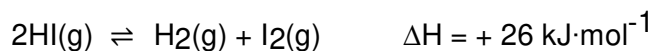
- 1.1. Calculate the quantity of mol of SO₃(g) at equilibrium
- 1.2. Calculate the **K_c** value.
- 1.3. What does the **K_c** value obtained in Question 1.2 mean?

Homework/Classwork

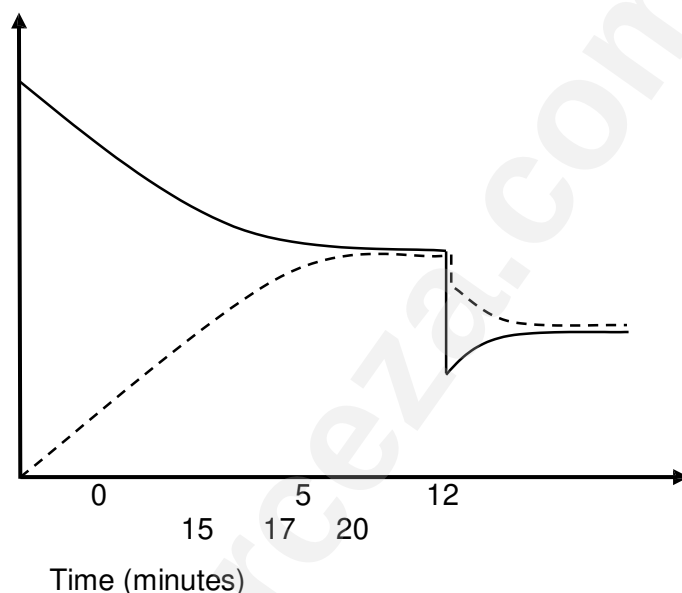
12

Date:

Pure hydrogen iodide, sealed in a 2 dm^3 container at 721 K , decomposes according to the following balanced equation:



The graph below shows how the reaction rate changes with time for this reversible reaction:



1. How does the concentration of the reactant change between the 12th and the 15th minute? Write down only INCREASES, DECREASES or NO CHANGE. (1)
2. The rates of both the forward and the reverse reactions suddenly change at $t = 15$ minutes.
 - 2.1 Give a reason for the sudden change in reaction rate. (1)
 - 2.2 Fully explain how you arrived at the answer to QUESTION 2.1. (3)

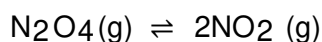
The equilibrium constant (K_C) for the forward reaction is 0,02 at 721 K .

- 2.3 At equilibrium it is found that $0,04 \text{ mol HI(g)}$ is present in the container. Calculate the concentration of $\text{H}_2\text{(g)}$ at equilibrium. (6)
- 2.4 Calculate the equilibrium constant for the reverse reaction. (1)
- 2.5 The temperature is now increased to 800 K . How will the value of the equilibrium constant (K_C) for the forward reaction change? Write down only INCREASES, DECREASES or REMAINS THE SAME. (1)

Dinitrogen tetraoxide, $\text{N}_2\text{O}_4(\text{g})$, decomposes to nitrogen dioxide, $\text{NO}_2(\text{g})$, in a sealed syringe of volume 2 dm^3 .



The mixture reaches equilibrium at $325\text{ }^\circ\text{C}$ according to the following balanced equation:



Colourless Brown

When equilibrium is reached, it is observed that the colour of the gas in the syringe is brown.

1. State Le Chatelier's principle. (2)
2. The syringe is now dipped into a beaker of ice water. After a while the brown colour disappears.

Is the forward reaction EXOTHERMIC or ENDOTHERMIC? Explain the answer using Le Chatelier's principle. (3)

3. The volume of the syringe is now decreased while the temperature is kept constant.

How will EACH of the following be affected? Choose from: INCREASES, DECREASES or REMAINS THE SAME.

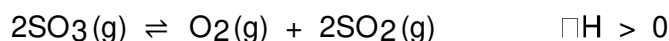
- 3.3.1 The number of moles of $\text{N}_2\text{O}_4(\text{g})$ (1)
- 3.3.2 The value of the equilibrium constant (1)
- 3.3.3 The rate of the forward and reverse reactions (1)
4. Initially X moles of $\text{N}_2\text{O}_4(\text{g})$ were placed in the syringe of volume 2 dm^3 . When equilibrium was reached, it was found that 20% of the $\text{N}_2\text{O}_4(\text{g})$ had decomposed.

If the equilibrium constant, K_c , for the reaction is 0,16 at $325\text{ }^\circ\text{C}$, calculate the value of X . (8)

Homework/Classwork 14

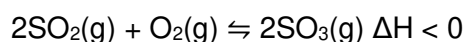
Date: _____

1. Study the following reaction at equilibrium at a certain temperature.



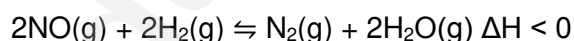
Which ONE of the following factors will change the K_c value?

- A Adding more $\text{SO}_2(\text{g})$.
 - B Adding a catalyst.
 - C Increasing the temperature.
 - D Increasing the pressure by decreasing the volume
2. The equilibrium in a closed container is represented by the following equation:



Which ONE of the following actions will increase both the K_c -value and the concentration of SO_3 present at equilibrium?

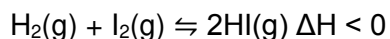
- A. Increasing the concentration of oxygen.
 - B. Decreasing the temperature.
 - C. Increasing the temperature.
 - D. Increasing the pressure at constant temperature
3. The following equilibrium is established in a closed container at constant temperature:



The conditions under which the yield of N_2 will be the highest, are when:

- A. pressure is decreased and the temperature is decreased.
- B. pressure is increased and the temperature is increased.
- C. pressure is decreased and the temperature is increased.
- D. pressure is increased and the temperature is decreased.

4. The reaction represented by the balanced equation below reaches equilibrium in a closed container:



How will the equilibrium be affected if, first the volume of the container is decreased and then the temperature is increased?

- A. At first no effect and then the reverse reaction is favoured.
- B. The reverse reaction is favoured by both changes.
- C. At first no effect and then the forward reaction is favoured
- D. A first the reverse reaction is favoured and then the forward reaction is favoured.
5. Which ONE of the following will NOT affect the equilibrium position of reversible chemical reactions?
- | | |
|----------------|------------------|
| A. Temperature | B. Catalyst |
| C. Pressure | D. Concentration |