RATE OF REACTION

1.

The table below gives factors which affect the value of reaction

$Zn(s) + 2\ HCl(aq) \rightarrow ZnCl_2(aq) + H_2\ (g)$

Complete the table to show how the factors given affect the rate of reaction and give an explanation (2 mks)

Factors	Effect on rate	Explanation
Using Zinc powder instead of granules		
Heat the reactants		

2.

The equation below represents two processes that take place without any change in temperature

I. $H_2O_{(s)} \rightarrow H_2O_{(l)}$

II. $CdCL_{2(s)} \rightarrow Cd^{2+}{}_{(l)} + 2Cl^{-}{}_{(l)}$

(a) Explain why although heat is required for each of the process to take place the temperature remains constant in both processes (1 mk)

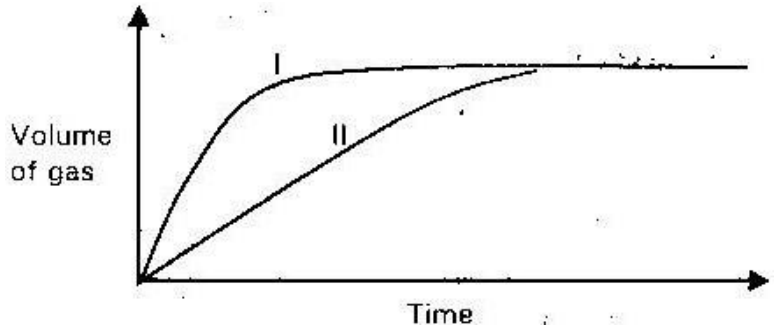
(b) Which of the two has a higher enthalpy change (H)? Give a reason (2 mks)

3. The curves below represents the changes in the concentrations of substances "E" and "F" with tie in the reaction

(i) Which curve represents the change in the concentration of substance F? Give a reason (2 mks)

(ii) Give a reason for the shapes of the curves after t minutes

The curves shown below were obtained when two equal volumes of hydrogen peroxide of same concentration were allowed to decompose separately in one case, manganese (IV) oxide was added to hydrogen peroxide.



Which curve represents the decomposition of hydrogen peroxide with manganese (IV) oxide? Explain (2 mks)

4. State and explain how the rate of reaction between zinc granules and steam can be increased. (2 mks)

5. The table below gives three experiments on the reaction of excess sulphuric acid and 0.5g of zinc done under different condition. In each case the volume of gas was recorded at different time internals.

Experiment	Term of zinc	Conclusion of sulphuric acid
I	Powder	0.8m
II	Powder	1.0m
III	Granules	0.8m

On the same axis draw and label the three curves that could be obtained from such results (3 mks)

7. During the production of hydrogen iodide, hydrogen reacts with iodine according to the equation

$H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$ $\Delta H = +52.0$ kj

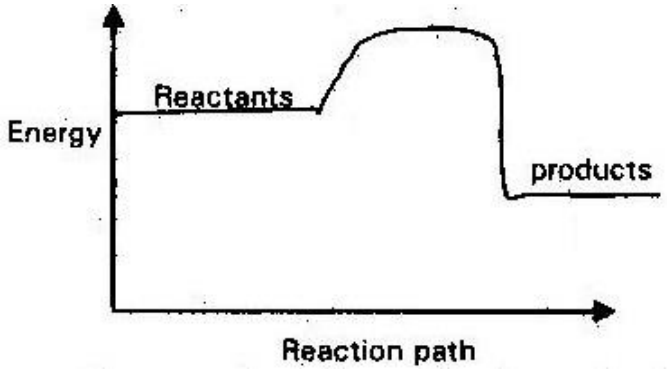
Explain how the following would affect the yield of hydrogen iodide

(a) Increase in temperature (1 mk)

(b) Decrease in pressure (1 mk)

8. Ammonia can be converted to nitrogen (II) oxide as shown in the equation below

$4NH_3(g) + 5O_2 \rightleftharpoons 4NO_2 + 6H_2O(g)$



The energy level diagram for the reaches is given above

(a) Explain how an increase in temperature would affect the yield of Nitrogen (II) oxide (2 mks)

9. The decomposition of calcium carbonate can be represented by the equation

$CaCo_3(s) \rightleftharpoons CaO(s) + Co_2(g)$

Explain how an increase in pressure would affect the equilibrium position (2 mks)

$\rightleftharpoons$

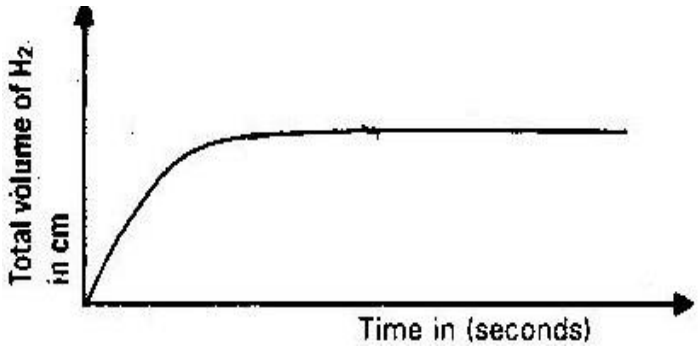
10. In the Haber process, the optimum yield of ammonia obtained when a temperature of 4500C a pressure of 200 atmospheres and iron catalyst are used

$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$ $\Delta H = -92kj$

(a) How would the yield of ammonia be affected if the temperature raised to 6000C. (2 mks)

(b) Give one use of ammonia (1 mk)

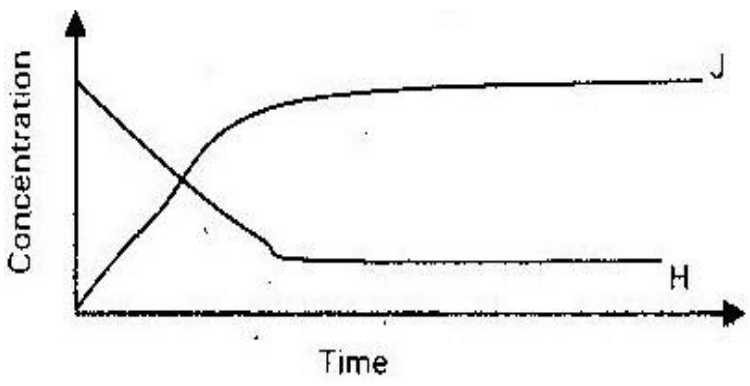
11. The reaction between a piece of magnesium ribbon with excess 2m hydrochloric acid was investigated at 25^0C by measuring the volume of hydrogen gas produced as the reaction progressed. The sketch below represents the graph that was obtained



(a) Name one piece of apparatus that may be used to measure the volume of hydrogen gas produced (1 mk)

(b) On the same diagram. Sketch the curve that would be obtained if the experiment was repeated at 35^0C. (2 mks)

12. The sketch below shows the rate at which substance "H" is converted to "J Study it and answer the question that follows



Why do the two curves become horizontal after some time (1 mk)

13. (a) What conditions is necessary for an equilibrium to be established? (1 mk)

(b) When calcium carbonate is heated, the equilibrium shown below is established

$CaCO_3(s) \rightleftharpoons CaO(s) + CO_2(g)$

How would be the position of the equilibrium be affected if a small amount of dilute potassium hydroxide is added to the equilibrium mixture? Explain (2 mks)

14. Equal volume of 1m monobasic acids I and "M" were each reacted with excess magnesium turnings. The table below shows the volumes of the gas produced after one minutes.

Acid	Volume of gas (cm^3)
L	40
M	100

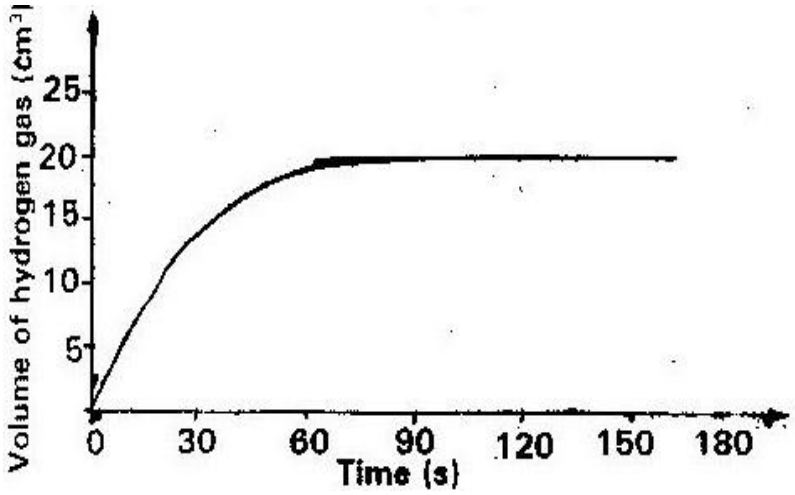
Explain the difference in the volumes of the gas produced (2 mks)

15. In a closed system, aqueous iron (III) chloride reacts with hydrogen sulphide gas as shown in the equation below

$2FeCL_3(aq) + H_2S(g) \rightleftharpoons 2FeCl_2(aq) + 2HCl(aq) + S(s)$

State and explain the observation that would be made if dilute hydrochloric acid is added to the system at equilibrium (2 mks)

16. A certain mass of a metal E1 reacted with excess dilute hydrochloric acid at 25^0C. The volume of hydrogen gas liberated was measured after every 30 seconds. The results were presented as shown in the graph below



(a) Name one piece of apparatus that may have been used to measure the volume of the gas liberated. (1 mk)

(b) (i) On the same axis, sketch the curve that would be obtained if the experiment was repeated at 35^0C (1 mk)

(ii) Explain the shape of your curve in b(i) above (1 mk)

17. Sodium thiosulphate reacts with dilute hydrochloric acid according to the following equation

$S_2O_3^{-2} + 2H^+ (aq) \rightarrow H_2O (l) + SO_2(g) + S(s)$

In an experiment to study how the rate of reaction varies with concentration, 10cm3 of 0.4M sodium thiosulphate was mixed with 10 cm3 of 2M hydrochloric acid in a flask. The flask was then placed on white paper marked with a cross (x). The time taken for the cross (x) to become invisible when viewed from above was noted and recorded in the table below. The experiment was repeated three times at the same temperature using the volumes in the table below.

Experiment	Volume (in cm3 of 0.4m thiosulphate	Volume of water cm3	Volume of 2mHcl	Time in seconds
1	10.0	0	10	16
2	7.5	2.5	10	23
3	5.0	5.0	10	32
4	2.5	7.5	10	72

(a) (i) Plot a graph of the volume of thiosulphate (vertical axis) against time taken for the cross (x) to become invisible (3 mks)

(ii) From the graph, determine how long it would take for the cross to become invisible if the experiment was done

I. Using 6cm3 of the 0.4m thiosulphate solution (1 mk)

II. Using 6cm3 of 0.2 m thiosulphate solution. Explain (1 mk)

(b) (i) Using the values for experiment 1. Calculate

(I) Moles of thiosulphate used

(II) Moles of hydrochloric acid used

(ii) (Which of the time reactants in experiment 1 controlled the rate of

the reaction? Explain

(c) Give two precautions which should be taken in the experiments above to ensure that constant results are obtained. (2 mks)

18. The table below gives the volumes of the gas produced when different volumes of 2m hydrochloric acid were reacted with 0.6g of magnesium powder at room temperature.

Volume of hydrochloric acid	Volume of gas cm3
0	0
10	240
20	480
30	600
40	600
50	600

(a) Write an equation for the reaction between magnesium and hydrochloric acid (1mk)

(b) On the grid provided plot a graph of the volume of gas produced (vertical axis) against the volume of acid added. Note that before the reaction produced is directly proportional to the volume of acid added (3mks)

(c) From the graph, determine:

(i) The volume of the gas produced if 12.5 cm^3 of 2M hydrochloric acid had been used

(ii) The volume of 2M hydrochloric acid which reacted completely with 0.6 g of magnesium powder. (1mk)

(c) (i) State and explain the effect on the rate of production of the gas if 0.6g of magnesium ribbon were used instead of magnesium powder (2mks)

(ii) 3M hydrochloric acid was used instead of 2M hydrochloric acid

(d) Given that one mole of the gas occupies 24000 cm3 at room temperature, calculate the relative atomic mass of magnesium (3mks)

19. In an experiment to study the rate of reaction between duralumin (alloy of aluminium, magnesium and copper) and hydrochloric acid 0.5g of the alloy were reacted with excess 4M hydrochloric acid. The data in the table below were recorded; use it to answer the question that follows:

Time (minutes)	Total volume of gas cm3)
0	0
1	220
2	410
3	540
4	620
5	640
6	640
7	640

(a) (i) From the graph determine the volume of gas produced at the end of 2 ½ minutes (1 mk)

(b) Determine the rate of reaction between 3rd and 4th minutes (1 mk)

(c) Give a reason why some solid remained at the end of the experiment (2 mks)

(d) Given that $2.5m^3$ of the total volume of the gas was magnesium and aqueous hydrochloric acid, calculate the percentage mass of aluminium present in 0.5g of an alloy. (Al = 27) (H=1)

(e) State the properties of duralumin that make it more suitable than pure aluminum in aeroplane construction. (2 mks)

20. Excess marble chips (calcium carbonate) was put in a beaker containing 100 cm3 of dilute hydrochloric acid. The beaker was then placed on a balance and the total loss in mass recorded after every two minutes as shown in the table below

Time (minutes)	0	2	4	6	8	10
Total loss in mass (g)	0	1.8	2.45	2.95	3.2	3.3

(a) Why was there less in mass (1 mk)

(b) Calculate the average rate of loss in mass between

(i)) 0 and 2 minutes (1 mk)

(ii) 6 and 8 minutes (1 mk)

(iii) Explain the difference in the average rates of reaction in (b) (i) and (ii) above (2 mks)

(c) Write the equation for the reaction which takes place in the beaker (1 mk)

(d) State three ways in which the rate of the reaction above could be increased. (3 mks)

(e) The solution in the beaker was evaporated to dryness explain what would happen if the beaker and its contacts were left in the laboratory overnight (2 mks)

(f) Finally some water was added to the contents of the beaker when aqueous sodium sulphate was added to the content of the beaker a white precipitate was formed

(i) State one use of the substances identified in (f)(i) above

21. The table below shows the volumes of nitrogen (IV) oxide gas produced when different volumes of 1m nitric acid were each reacted with 2.07g of lead at room temperature.

Volume of 1m nitric acid	Volume of nitrogen (IV) oxide gas cm^3
5	60
15	180
25	300
35	450
45	420
55	480

(a) Give a reason why nitric acid is not used to prepare hydrogen gas (1 mk)

(b) Explain how the rate of reaction between lead and nitric acid would be affected if the affected if the temperature of the reaction mixture is raised (2 mks)

(c) On the grid provided below plot a graph of the volume of the gas produced vertical axis against the volume of acid (3 mks)

(d) Using the graph, determine the volume of

(i) Nitrogen (IV) oxide produced when 30 cm^3 of 1M nitric acid were acted with 2.07g of lead

(ii) 1M nitric acid which would react completely with 2.07g of lead

(1 mk)

(e) Using the answer in d (ii) above determine

(i) The volume of 1 m nitric acid that would react with one mole of Pb/lead (Pb = 207) (2 mks)

(ii) The volume of nitrogen (IV) oxide gas produced when one mole of lead reacts with excess 1M nitric at room temperature

(f) Calculate the number of moles of

(i) 1M Nitric acid that reacted with one mole of lead

(ii) Nitrogen (IV) oxide produced when one molar of lead were reacted with excess nitric acid. Molar gas volume = 24000 cm^3 (1 mk)

(iii) Using the answer in (21) (i) and (ii) above write the equation for the reaction between lead and nitric acid given that one mole of lead nitrate and two moles of water were also produced. (1 mk)

22. (a) Methanol is manufactured from carbon (IV) oxide and hydrogen gas according to the equation

$$CO_2(g) + 3H_2 \rightleftharpoons CH_3OH(g) + H_2O(g)$$

The reaction is carried out in the presence of a chromium catalyst at 700K and 30kpa. Under these conditions an equilibrium is reached when 2% of the carbon (IV) oxide is converted to methanol

(i) How does the rate of the forward reaction compare with that of the reverse reaction when 2% of the carbon (IV) oxide is converted to methanol? (1mk)

(ii) Explain how each of the following would affect the yield of methanol

- Reduction in pressure (2 mks)
- Using a more efficient catalyst (2 mks)

(iii) If the reaction is carried out at 500K and 30 kpa, the percentage of carbon (IV) oxide converted to methanol is higher than 2%

(I)What is the sign of Δ H for the reaction? Give a reason (2mks)

(II) Explain why in practice the reaction is carried out at 700J but NOT at 500K (1 mk)

(b) Hydrogen peroxide decomposes according to the following equation

$2H_2O_2(aq) \rightarrow 2\ H_2O(l) + O_2(g)$

In an experiment, the rate of decomposition of hydrogen peroxide was found to be 6.0×10^{-8} mol $dm^{-3}S^{-1}$

(i) Calculate the number of moles per dm^3 of hydrogen peroxide that had decomposed within the first 2 minutes (2 mks)

(ii) In another experiment the rate of decomposition was found to be 1.8×10^{-7} mol $dm^{-3}S^{-1}$. The difference in the two rates could have been caused by addition of a catalyst, State giving reasons one other factor that may have caused the difference in the two rates of decomposition.

(2 mks)

23. (a) (i) State the Le chatelier's principle (1 mk)

(ii) Carbon (II) oxide gas reacts with steam according to the reaction;

$CO(g) + H_2O(g) \rightleftharpoons H_2(g) + C0_2(g)$

What would be the effect of increasing the pressure of the system at equilibrium? Explain (2 mks)

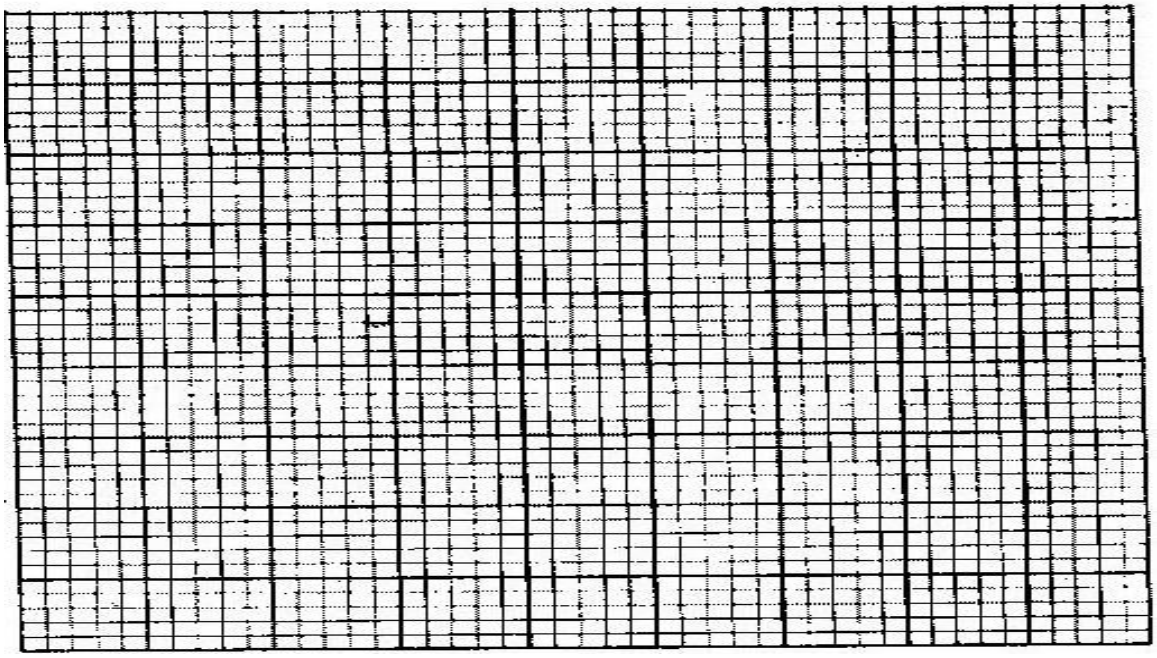
(iii) When the reaction in (ii) above was carried out at lower temperature, the yields of hydrogen and carbon (IV) oxide increased. What is the sign of ΔH for the reaction? Explain (2mks)

(b) The table below gives the volume of oxygen gas produced at different times when hydrogen peroxide decomposed in the presence of a catalyst.

Time (sec)	0	10	20	30	40	50	60
Volume of oxygen (cm^3)	0	66	98	110	119	120	120

(i) Name the catalyst used for this reaction (1 mk)

(ii) On the grid provided. Draw the graph of volume of oxygen gas produced (vertical axis) against time.



(iii) Using the graph determine the rate of decomposition of hydrogen peroxide after 24 seconds (2 mks)

(iv) Give a reason why the total volume of oxygen gas produced after 50 seconds remains constant (1 mk)

24. Define the term rate of reactions (1 mk)

25. State two methods used to measure rate of reactions (2mks)

26. When a metal oxide of element "w" react with hydrogen, the equation for the equation for the reaction is

$WO_3(s) + 3\ H_2(g) \rightarrow W(s) + 3H_2\ (I)O$

Comment on the reactivity of element "W" with respect to hydrogen (2mks)

27. 7.5g of calcium carbonate was placed in a conical flask containing $50cm^3$ of dilute hydrochloric acid. The flask kept at constant temperature and the volume of carbon (IV) oxide gas evolved was measured at 20 minutes intervals. Not all the calcium carbonate was used up during the reaction the results were recorded in the table below

Time from start of reaction (minutes)	Volume of Co2 evolved cm3
0	0
20	555
40	810
60	695
80	1000
120	1020

(a) Write an equation for the reaction between calcium carbonate and hydrochloric acid (1 mk)

(b) Plot a graph volume of carbon (IV) oxide produced against time (minutes)

(3 mks)

(c) What volume of carbon (IV) oxide were evolved during the 20^{th} minutes intervals (20- 40) minutes (1 mk)

(d) Why was there no increase in volume of the gas evolved after 100 minutes? (1 mk)

(e) Calculate the mass of 11. 2 cm^3 of carbon (IV) oxide gas evolved at stp: molar gas volume = 22.4 dm^3

(f) Determine the mass of calcium carbonate which had reacted after 120 minutes (1 mk)

28. Consider the equilibrium reaction below

$2SO_4 (g) + O_2 (g) \rightleftharpoons 2SO_3 (g)$ ΔH = -ve

Which of the following will increase the yield of sulphur (vi) oxide

- Addition of catalyst
- Increase in pressure
- Increase in temperature
- Doubling the volume of the system (1 mk)

29. (a) Why does the rate of reaction

(i) Increase with increase in temperature (1 mk)

(ii) Increase with use of a suitable catalyst (1 mk)

(b) The equation for gaseous reaction is

$A(g) + 2B (g) \rightarrow C(g) + D (g)$

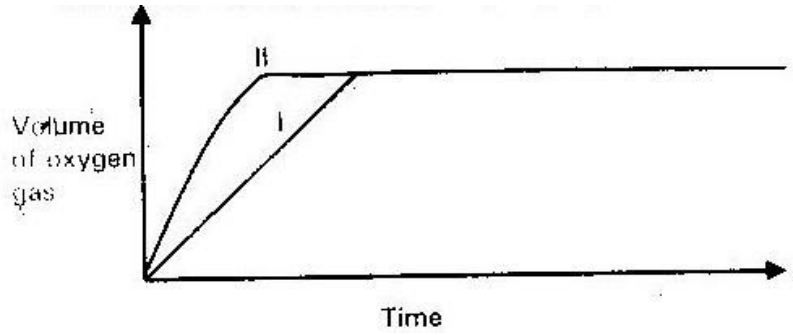
State the effect of the following on rate of reaction

(i) The pressure of "B" is doubled but of A is the same (1 mk)

(ii) The amount pressure of both A and B are doubled (1 mk)

(i) The amount of A and B remain unchanged but an inert gas is added to double the over all pressure

30. Below is a graph of the volume of oxygen collected (cm^3) against time when powdered and lump of manganese (IV) oxide were used to decompose hydrogen peroxide



Which one of the curves correspond to the results obtained by using powdered manganese (IV) oxide. Give reasons (2 mks)

31. Consider the following reaction

$nCH_2 = CH_2(g) \rightleftharpoons (CH_2 - CH_2-)n \quad \Delta H = -ve$

What conditions favours the process (2 mks)

32. Consider the reaction

$A(g) + B)g) \rightleftharpoons AB(g) \quad \Delta H = + ve$

Draw, an energy level diagram for this reaction, when un-catalyzed and when catalyzed (2 mks)

33. For the following gaseous reaction

$$E(g) + F(g) \rightleftharpoons G(g) + H(g) \quad \Delta H = +ve$$

What is the effect on the rate if the?

(a) Volume of the total reactants is doubled (1 mk)

(b) Temperature is doubled (1 mk)