Chem!stry

Multiple-Choice Questions on Rate of Reaction

1. Which graph corresponds to the catalytic decomposition of 1mole of hydrogen peroxide?

$$2H_2O_2 \rightarrow 2H_2O + O_2$$

A

total number
of moles
of oxygen
produced

B

total number
of moles
of oxygen
produced

C

total number
of moles
of oxygen
produced

D

total number
of moles
of oxygen
produced
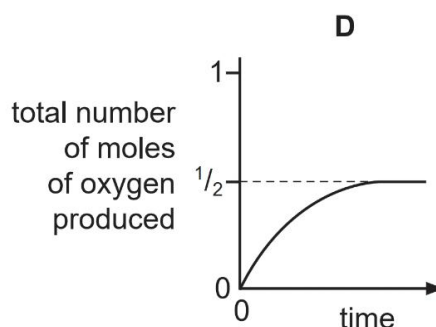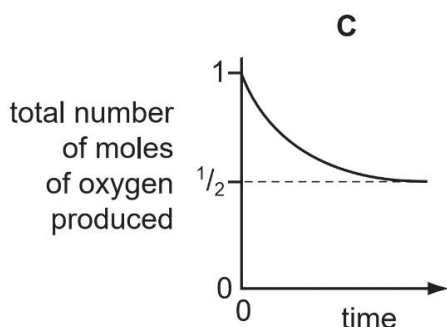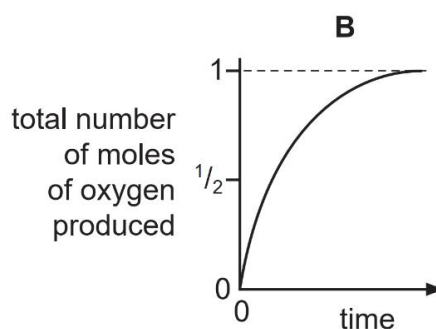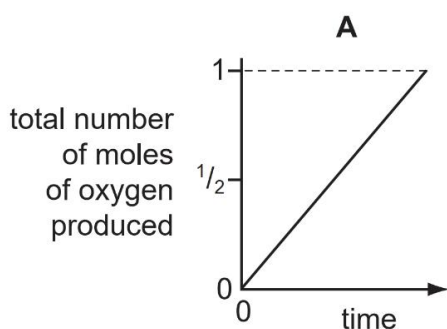
2. Which change in conditions increases the energy of particles in a reaction?

   A   Increase in concentration   **B**   Increase in pressure

   C   Increase in temperature   **D**   Presence of a catalyst

3. Which changes will speed up a chemical reaction?

   1   Decreasing the pressure in a reaction between gases.

   2   Increasing the size of the solid particles in a reaction involving solids.

   3   Increasing the temperature of any reaction.

   4   Increasing the concentration of a solution.

   A   1 and 3   **B**   2, 3 and 4   **C**   3 and 4 only   **D**   4 only

4. A student investigates how the concentration of a reagent affects the rate of a chemical reaction. Which piece of apparatus is essential for all rate investigations?

A Balance
B Gas syringe

C Measuring cylinder
D Stopwatch

5. 18 Gold is used as a catalyst in some chemical reactions.

In these reactions, gold…

- Helps reduce the energy costs of the reaction.

- Increases the yield of the reaction.

- Is unchanged at the end of the reaction.

- Speeds up the rate of the reaction.

How many of these statements are correct?

A 1
B 2
C 3
D 4

6. A chemist investigated the rate of the reaction between ethene and hydrogen using a nickel catalyst.

$$\overset{\text{Ni}}{C_2H_4(g) \ + H_2(g) \quad \rightarrow \quad C_2H_6(g)}$$

The chemist carried out three experiments under different conditions.

experiment number	pressure / atmospheres	particle size of catalyst
1	1	powder
2	0.5	powder
3	1	large pieces

Which row is correct?

	comparison of the rates of experiments 1 and 2	comparison of the rates of experiments 1 and 3
A	1 greater than 2	1 greater than 3
B	1 greater than 2	3 greater than 1
C	2 greater than 1	1 greater than 3
D	2 greater than 1	3 greater than 1

7. Which row shows the correct catalyst for each industrial process?

	manufacture of sulfuric acid	manufacture of ammonia	manufacture of margarine
A	nickel	iron	vanadium(V) oxide
B	nickel	vanadium(V) oxide	iron
C	vanadium(V) oxide	iron	nickel
D	vanadium(V) oxide	nickel	iron

8. The equation shows the reaction for the manufacture of ammonia.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$
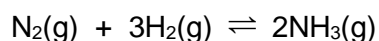
Which change will decrease the activation energy of the reaction?

A Addition of a catalyst

B Decrease in temperature

C Increase in concentration

D Increase in pressure

9. Calcium carbonate reacts with dilute hydrochloric acid to produce carbon dioxide. The carbon dioxide is collected using the apparatus shown.
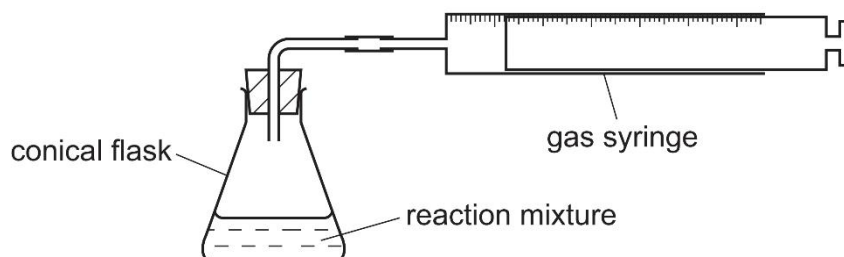
The reaction is done four times. For each reaction, 25 g of calcium carbonate and an excess of hydrochloric acid are used.

Which reaction mixture fills the gas syringe with carbon dioxide in the shortest time?

A Lumps of calcium carbonate with 1 mol/dm^3 hydrochloric acid

B Lumps of calcium carbonate with 2 mol/dm^3 hydrochloric acid

C Powdered calcium carbonate with 1 mol/dm^3 hydrochloric acid

D Powdered calcium carbonate with 2 mol/dm^3 hydrochloric acid

10. Which statement about catalysts is correct for a typical equilibrium reaction?

A A catalyst can be either an inorganic or an organic species.

B A catalyst does not take part in the reaction.

C A catalyst only speeds up the forward reaction.

D A catalyst provides the energy required to start a reaction.

11. Gas P decomposes to form gas Q.

$$xP \rightarrow yQ$$
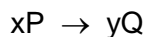
Two experiments are carried out to investigate the rate of reaction. The conditions are the same except that two different temperatures, T_1 and T_2, are used.

The results are plotted on graphs, drawn to the same scale.
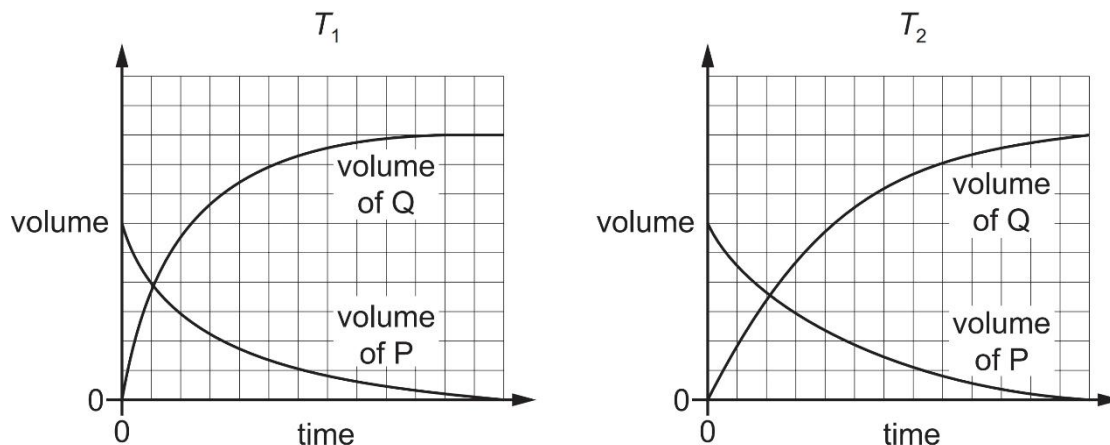
Which row is correct?

	x	y	temperature
A	2	3	T_1 is higher than T_2
B	2	3	T_2 is higher than T_1
C	3	2	T_1 is higher than T_2
D	3	2	T_2 is higher than T_1

12. The oxide of an element **X** increases the rate of decomposition of hydrogen peroxide. At the end of the reaction the oxide of **X** is unchanged.

Which details are those of **X**?

	proton number	mass number
A	18	40
B	20	40
C	25	55
D	82	207

13. How does a catalyst increase the speed of a reaction?

   A   By increasing the collision frequency of particles.

   B   By increasing the speed of the particles.

   C   By increasing the temperature of the reaction.

   D   By lowering the activation energy.

14. In experiment 1, an excess of finely powdered marble is added to 20 cm³ of dilute hydrochloric acid. In experiment 2, carried out under the same conditions of temperature and pressure, an excess of marble chips is added to 20 cm³ of dilute hydrochloric acid of the same concentration. The total volumes of carbon dioxide given off are determined at intervals and plotted against time.
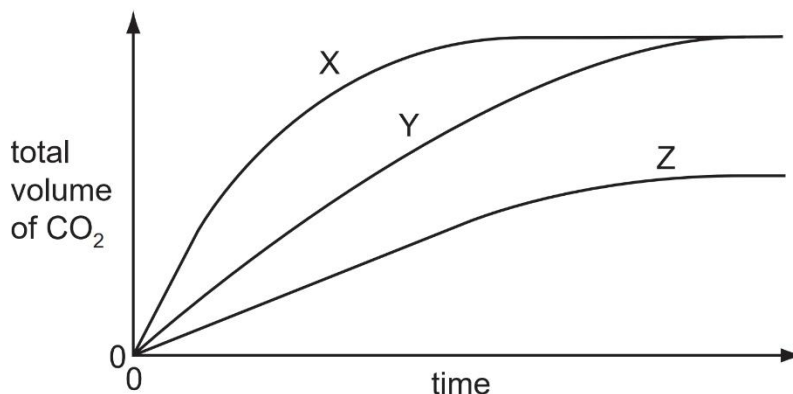
Which pair of curves is obtained in the two experiments?

	experiment 1	experiment 2
A	X	Z
B	X	Y
C	Y	Z
D	Y	X

15. Two solutions are prepared.

- Solution **P** is 0.050 mol/dm³ hydrochloric acid.
- Solution **Q** is 0.100 mol/dm³ butanoic acid.

A 2 cm strip of magnesium ribbon is put into 100 cm³ of each solution. Effervescence is seen in both solutions but the effervescence is faster in solution **P** than it is in solution **Q**.

Which statement helps to explain this observation?

A Magnesium reacts with solution **P** to form a salt, but does not form a salt with solution **Q**.

B More particles are dissociated in solution **P** than are dissociated in solution **Q**.

C Solution **Q** contains a stronger acid than solution **P**.

D The particles are closer together in solution **Q** than they are in solution **P**.

16. Which element is **most** likely to be used as an industrial catalyst?
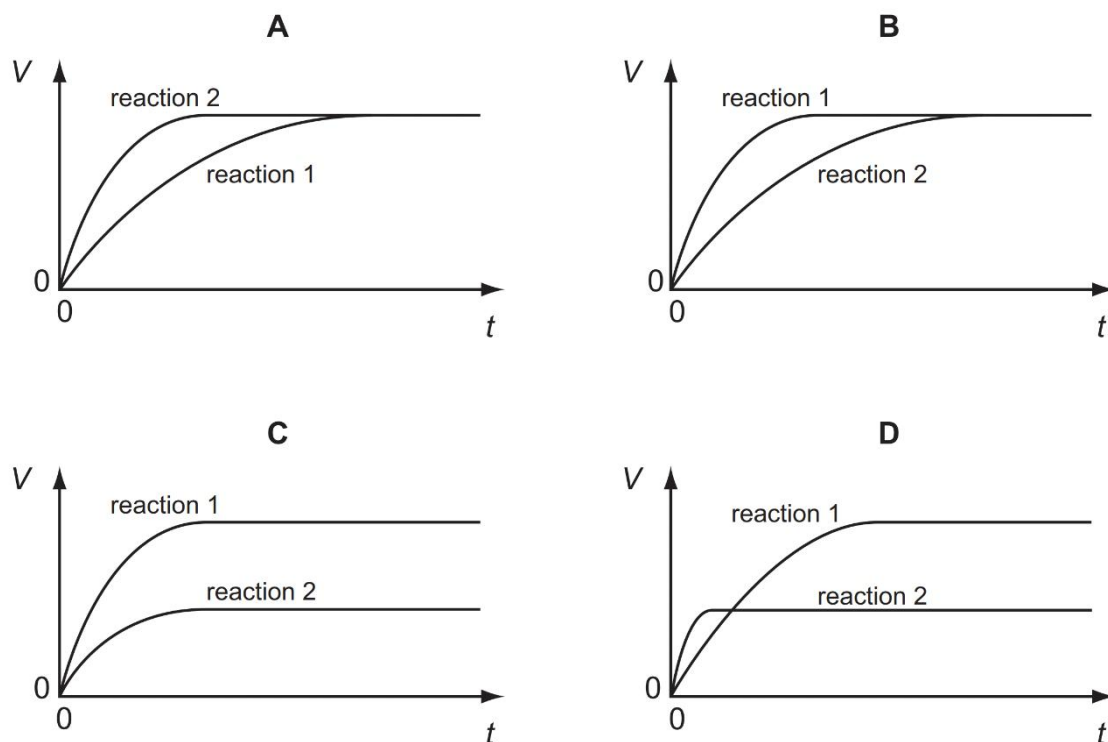
A Na **B** Ni **C** Pb **D** Sr

17. A student performs two reactions.

Reaction 1   10 g of magnesium ribbon with excess 2.0 mol/dm³ hydrochloric acid.

Reaction 2   5 g of magnesium powder with excess 2.0 mol/dm³ hydrochloric acid.

In both experiments, the volume of hydrogen produced, V, is measured against time, t, and the results plotted graphically.

Which set of graphs is correct?

18. The following changes could be made to the conditions in the reaction between zinc and hydrochloric acid.

    1   Increase in concentration of the acid

    2   Increase in particle size of the zinc

    3   Increase in pressure on the system

    4   Increase in temperature of the system

Which pair of changes will increase the rate of reaction?

A   1 and 2   **B**   1 and 4   **C**   2 and 3   **D**   3 and 4

19. Which industrial reaction does not involve a catalyst?

A   The cracking of hydrocarbons.

B   The extraction of iron from haematite in a blast furnace.

C   The production of ammonia from nitrogen and hydrogen.

D   The redox reaction involving the removal of combustion pollutants from car exhausts.

20. A student measured the rate of reaction between calcium carbonate and dilute hydrochloric

6

acid. A graph showing the volume of gas produced against time is shown.
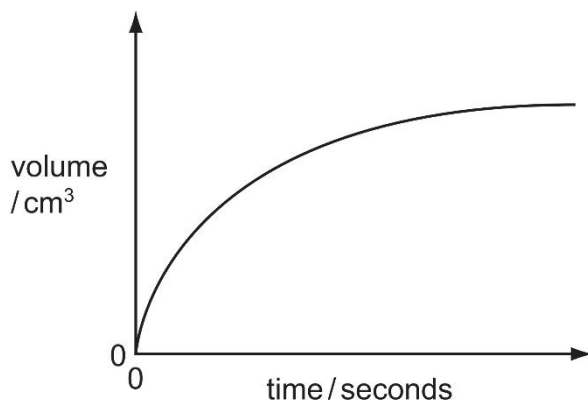
Which apparatus was used to measure the variables shown on the graph?

A   Balance and gas syringe.

B   Burette and pipette.

C   Gas syringe and stop watch.

D   Pipette and stop watch.

21. How does a catalyst increase the speed of a reaction?

A   By increasing the collision frequency of particles.

B   By increasing the speed of the particles.

C   By increasing the temperature of the reaction.

D   By lowering the activation energy.

22. Copper(II) carbonate powder was heated. The loss in mass was plotted against time as shown on the graph.
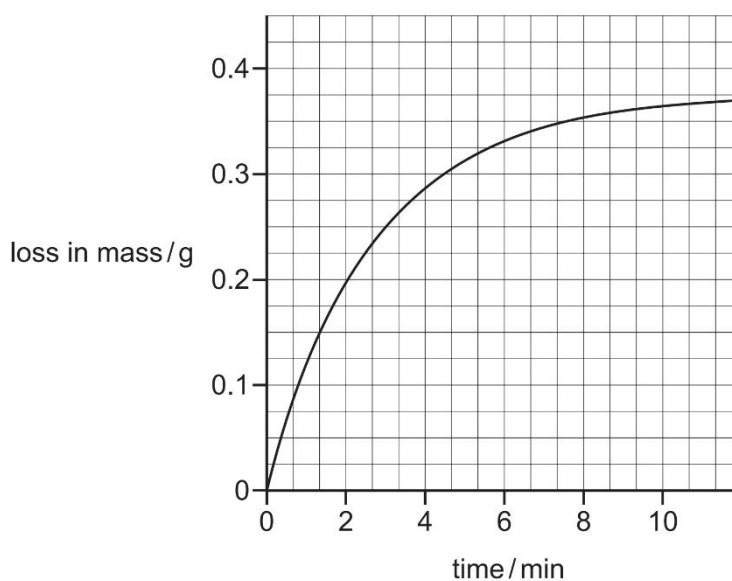
During which time interval is the reaction fastest?

A   0 to 2 min   **B**   2 to 4 min   **C**   6 to 8 min   **D**   8 to 10 min

23. In the graph, curve 1 was obtained by observing the decomposition of 100 cm^3 of 1.0 mol/dm^3 hydrogen peroxide solution, catalysed by manganese(IV) oxide.

$$2H_2O_2 \rightarrow 2H_2O + O_2$$
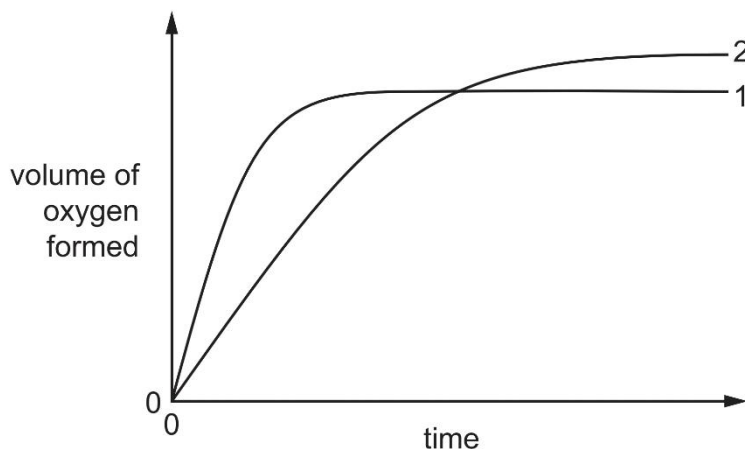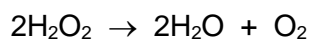
Which alteration to the original experimental conditions would produce curve 2?

A   Adding some 0.1 mol/dm^3 hydrogen peroxide solution.

B   Lowering the temperature.

C   Using less manganese(IV) oxide.

D   Using a different catalyst.

24. The diagram shows the apparatus used to measure the rate of the reaction between calcium carbonate and dilute hydrochloric acid.

The mass of the flask and the contents is measured at regular intervals of time.
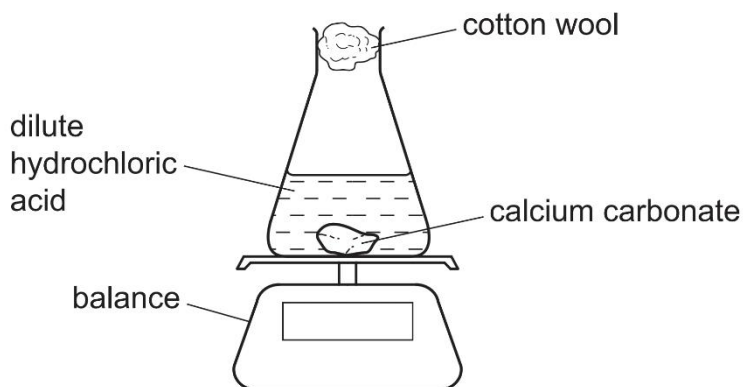
Which graph correctly shows how the mass of the flask and contents changes with time?
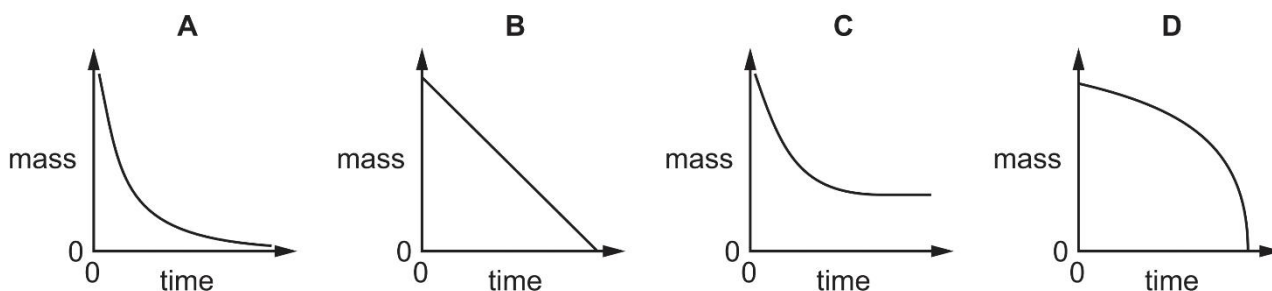
25. Which process does **not** involve the use of a catalyst?

   A   The extraction of iron from haematite in a blast furnace.

   B   The manufacture of sulfur trioxide.

   C   The production of ammonia from nitrogen and hydrogen.

   D   The redox reactions that remove combustion pollutants from car exhausts.

26. At the start of a reaction, a $1.00 \ dm^3$ solution contains 0.300 mol of ethanol.

After 100 seconds the concentration of the ethanol has decreased to $0.296 \ mol/dm^3$.

What is the rate of reaction over the first 100 seconds?

   A $2.96 \times 10^{-3} \ mol/dm^3/s$ **B** $3.00 \times 10^{-5} \ mol/dm^3/s$

   C $4.00 \times 10^{-5} \ mol/dm^3/s$ **D** $8.00 \times 10^{-5} \ mol/dm^3/s$

27. In four separate experiments, 1, 2, 3 and 4, nitric acid was added to excess marble chips and the volume of carbon dioxide formed was measured.

In all four experiments the same volume of nitric acid was used.

Its concentration, or temperature, or both concentration and temperature, were changed.

The results of the experiments are shown on the graph.
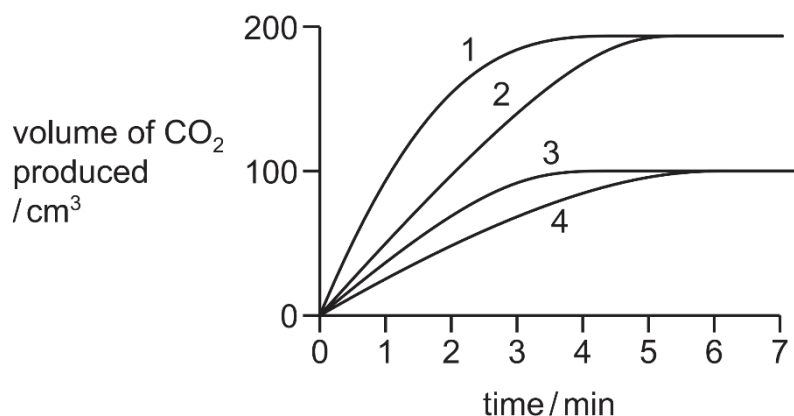
Which statement is correct?

   A   A lower concentration of acid was used in experiment 3 than in experiment 1.

   B   Experiment 4 was faster than experiment 3.

   C   The acid used in experiment 2 was of a lower concentration than in experiment 1.

   D   The temperature of the acid was the same in experiments 1 and 2.

28. Which change in conditions, for the reaction between zinc and dilute sulfuric acid, increases the rate of reaction by lowering the activation energy?

   A   Adding a catalyst.

   B   Increasing the concentration of the acid.

   C   Increasing the surface area of the zinc.

   D   Increasing the temperature.

29. Magnesium reacts with dilute sulfuric acid.

$$Mg(s) \; + \; H_2SO_4(aq) \; \rightarrow \; MgSO_4(aq) \; + \; H_2(g)$$
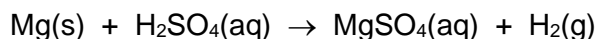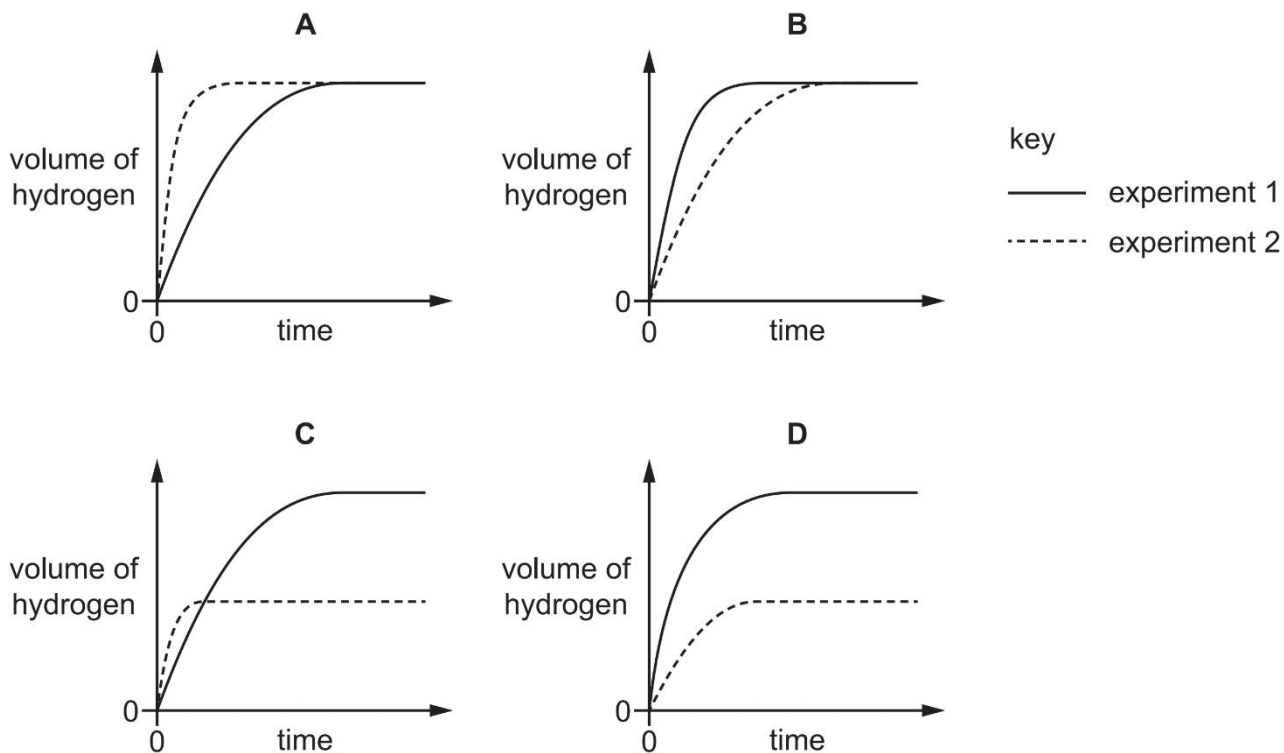
Two experiments were carried out:

Experiment 1   24.0 g of magnesium was reacted with 100 cm^3 of 1.0 mol/dm^3 sulfuric acid.

Experiment 2   24.0 g of magnesium was reacted with 50 cm^3 of 2.0 mol/dm^3 sulfuric acid.

In each experiment the volume of hydrogen was measured at various times. The results were plotted on a graph. Which graph is correct?

30. A student wrote two conclusions about calcium carbonate.

Conclusion 1   The reaction with dilute hydrochloric acid is faster with powdered calcium carbonate than with larger pieces of calcium carbonate.

Conclusion 2   Grinding large pieces of calcium carbonate to form a powder increases the surface area.
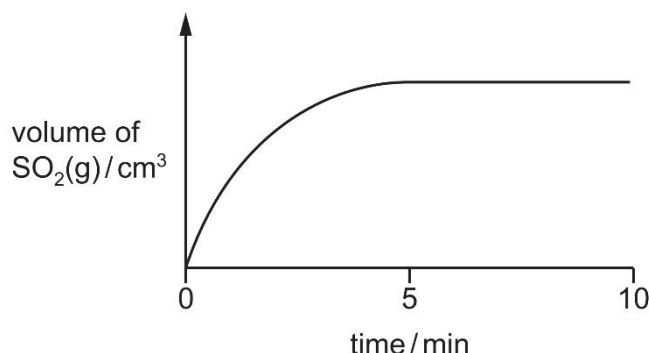
Which statement is correct?

A   Both conclusions are correct and conclusion 2 explains conclusion 1.

B   Both conclusions are correct but conclusion 2 does not explain conclusion 1.

C   Conclusion 1 is correct but conclusion 2 is not correct.

D   Conclusion 2 is correct but conclusion 1 is not correct.

31. Compound **X** reacts with an acid to produce sulfur dioxide gas.

A sample of **X** is placed in a flask and acid is added. The sulfur dioxide produced is collected and its volume is measured at various times.

A graph of the results is plotted.

Which statement about this experiment is correct?

A The gas can be collected by displacing water from a measuring cylinder.

B The mass of the reaction flask and its contents decreases as the reaction proceeds.

C The rate of the reaction increases as time increases.

D The reaction is still proceeding after eight minutes.

32. An experiment is carried out to measure the rate of reaction between magnesium and dilute hydrochloric acid under two different conditions. The mass of magnesium and the number of moles of hydrochloric acid are the same in both experiments.

Graphs of the results are shown.
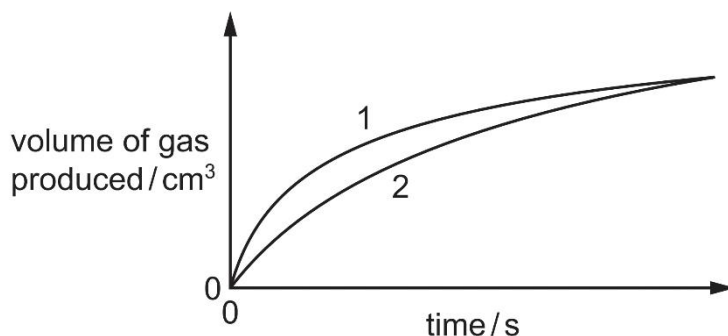
Which statements could explain the difference between graph 1 and graph 2?

1   Graph 1 results are obtained at a higher temperature.

2   Graph 1 results are obtained by using hydrochloric acid that is more concentrated.

3   Graph 1 results are obtained by using smaller pieces of magnesium.

A 1, 2 and 3   **B** 1 and 2 only   **C** 1 and 3 only   **D** 2 and 3 only

33. Three experiments are carried out in which the same mass of magnesium is reacted with the same volume of dilute sulfuric acid at room temperature. The magnesium is in excess.

Experiment 1   Large pieces of magnesium are used

Experiment 2   Small pieces of magnesium are used

Experiment 3   Large pieces of magnesium are used and the concentration of the acid is increased.
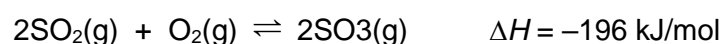
Graphs of the results are shown.
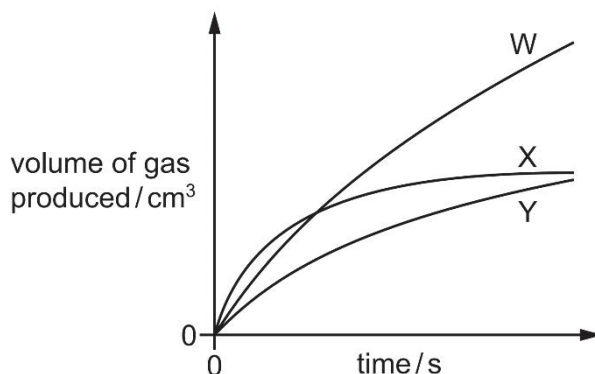
Which row is correct?

	experiment 1	experiment 2	experiment 3
A	W	X	Y
B	X	Y	W
C	Y	W	X
D	Y	X	W

34. Sulfur dioxide reacts with oxygen in the air.

$$2SO_2(g) \ + \ O_2(g) \ \rightleftharpoons \ 2SO3(g) \qquad \Delta H = -196 \ kJ/mol$$

The reaction is very slow if no catalyst is present. Which statement explains this?

A   Air contains only 21% oxygen so there is not enough oxygen for all the sulfur dioxide to react.

B   Only a small proportion of the sulfur dioxide and oxygen molecules have enough energy to react, even at high temperatures.

C   The reaction is exothermic and so at high temperatures the equilibrium shifts to the left.

D   The reaction is reversible and so products turn back to reactants; this happens more quickly at high temperatures.

35. Hydrogen peroxide decomposes slowly at room temperature.

$$2H_2O_2(aq) \rightarrow 2H_2O(l) + O_2(g)$$
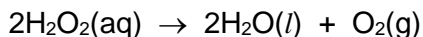
The reaction can be catalysed by adding manganese(IV) oxide.

The diagram shows the apparatus that can be used to monitor the rate of this reaction.
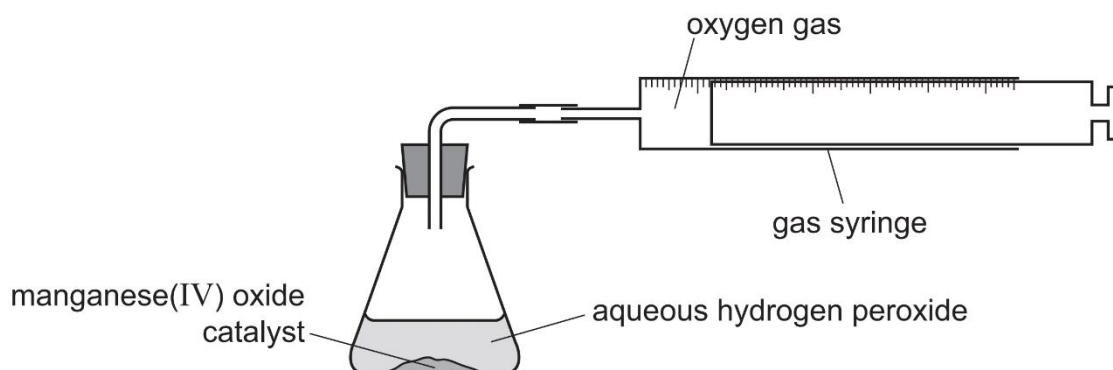
Which statement is correct when a catalyst is added to the aqueous hydrogen peroxide?

A   The catalyst increases the activation energy for the reaction.

B   The catalyst is used up during the reaction.

C   The gas syringe fills up more quickly when the catalyst is added.

D   The total amount of oxygen produced increases when the catalyst is added.

36. Aqueous sodium thiosulfate reacts with acid to make a precipitate of sulfur.

$$Na_2S_2O_3(aq) + 2HCl(aq) \rightarrow 2NaCl(aq) + H_2O(l) + SO_2(g) + S(s)$$

A student investigates the effect of temperature on the rate of this reaction. The student:

- Places a piece of paper with a cross on it below the reaction mixture.
- Measures the time taken for the cross to no longer be seen.
- Repeats the reaction at different temperatures.
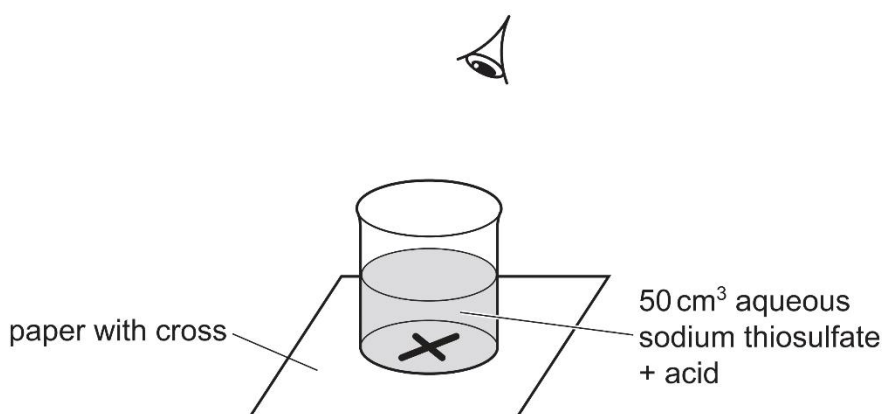
Which apparatus is needed for this investigation?

A   Balance, pipette, stop-clock.

B   Balance, stop-clock, thermometer.

C   Burette, gas syringe, thermometer.

D   Measuring cylinder, stop-clock, thermometer.

37. The rate of reaction between calcium carbonate, $CaCO_3(s)$, and hydrochloric acid, $HCl(aq)$, is measured in three separate experiments.
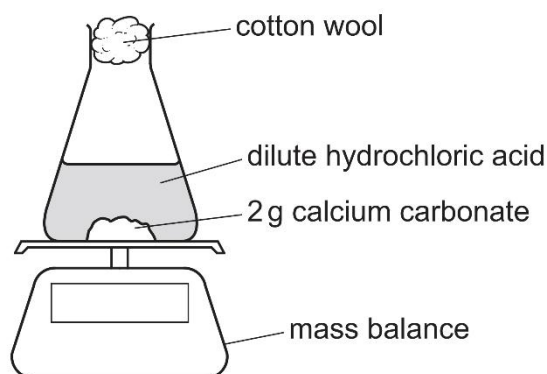
- In experiment 1, $CaCO_3(s)$ is powdered and an excess of $HCl(aq)$ is used.
- In experiment 2, $CaCO_3(s)$ is in lumps and an excess of $HCl(aq)$ is used.
- In experiment 3, $CaCO_3(s)$ is in lumps but insufficient $HCl(aq)$ is used.

The results of these experiments are shown.
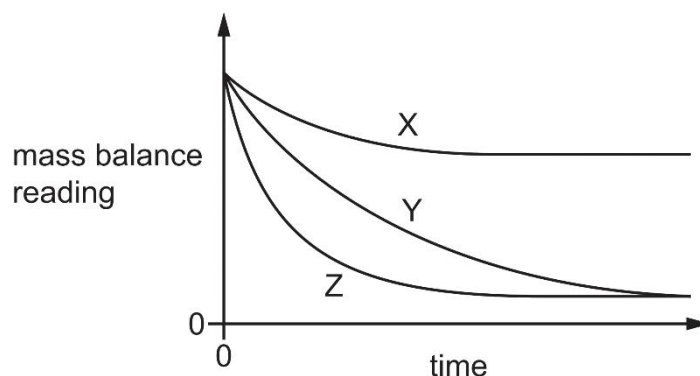
Which statement is correct?

A Experiment 1 is shown by curve X.

B Experiment 1 is shown by curve Y.

C Experiment 2 is shown by curve Y.

D Experiment 3 is shown by curve Z.

38. A sample of sulfuric acid is added to 10 g of zinc granules. A reaction occurs and a gas is produced. The rate of the reaction is increased if a small amount of copper is added. The copper is unchanged after the reaction.

Which statement about this reaction is correct?

A Copper acts as a biological catalyst in this reaction.

B Copper lowers the activation energy of this reaction.

C The rate of the reaction is greater as the particle size of the zinc is greater.

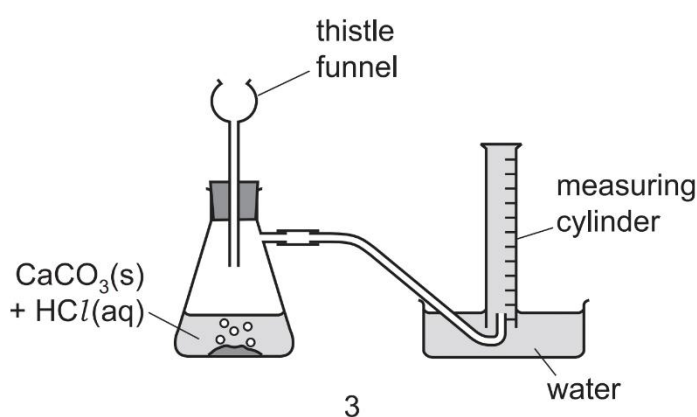**D** The rate of the reaction is greater if the pressure is increased.

39. When calcium carbonate is added to dilute hydrochloric acid, carbon dioxide gas is released.

Three sets of apparatus are shown.
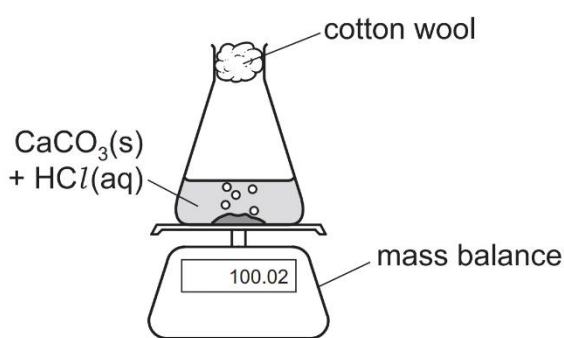
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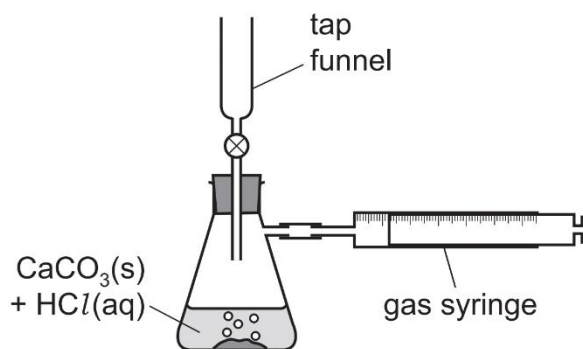
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3

Which sets of apparatus are suitable, together with a stop-watch, for following the rate of this reaction?

A 1, 2 and 3   **B** 1 and 2 only   **C** 2 only   **D** 2 and 3 only

40. Carbonates react with dilute acids to produce carbon dioxide. A student uses excess Carbonate and 100 cm^3 of 0.1 mol/dm^3 acid and measures the volume of gas produced at regular time intervals. The results give line X on the graph.
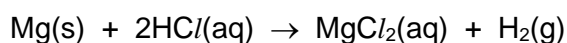
The student repeats the experiment using 50 cm^3 of 0.2 mol/dm^3 acid whilst keeping everything else the same.

Which line shows the results for the second experiment?
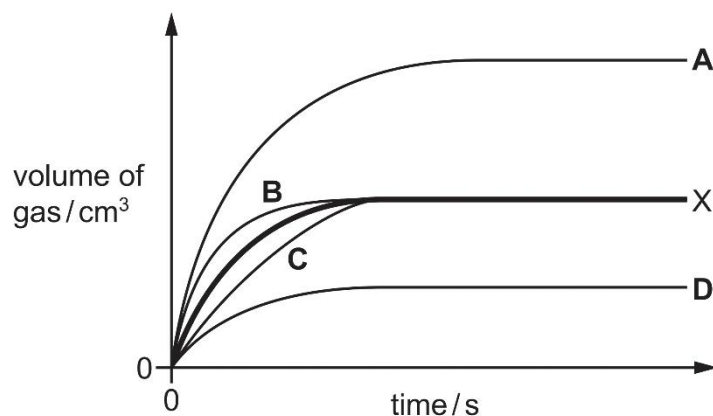
41. The rate of reaction between magnesium and dilute hydrochloric acid is investigated.

The equation is shown.

$$Mg(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2(g)$$

A known mass of magnesium is added to an excess of dilute hydrochloric acid.

The concentration of the hydrochloric acid and the volume of hydrogen produced is measured at regular time intervals.

Which pair of graphs correctly shows the experimental results?

A
concentration of HCl   volume of hydrogen

B
concentration of HCl   volume of hydrogen

C
concentration of HCl   volume of hydrogen

D
concentration of HCl   volume of hydrogen
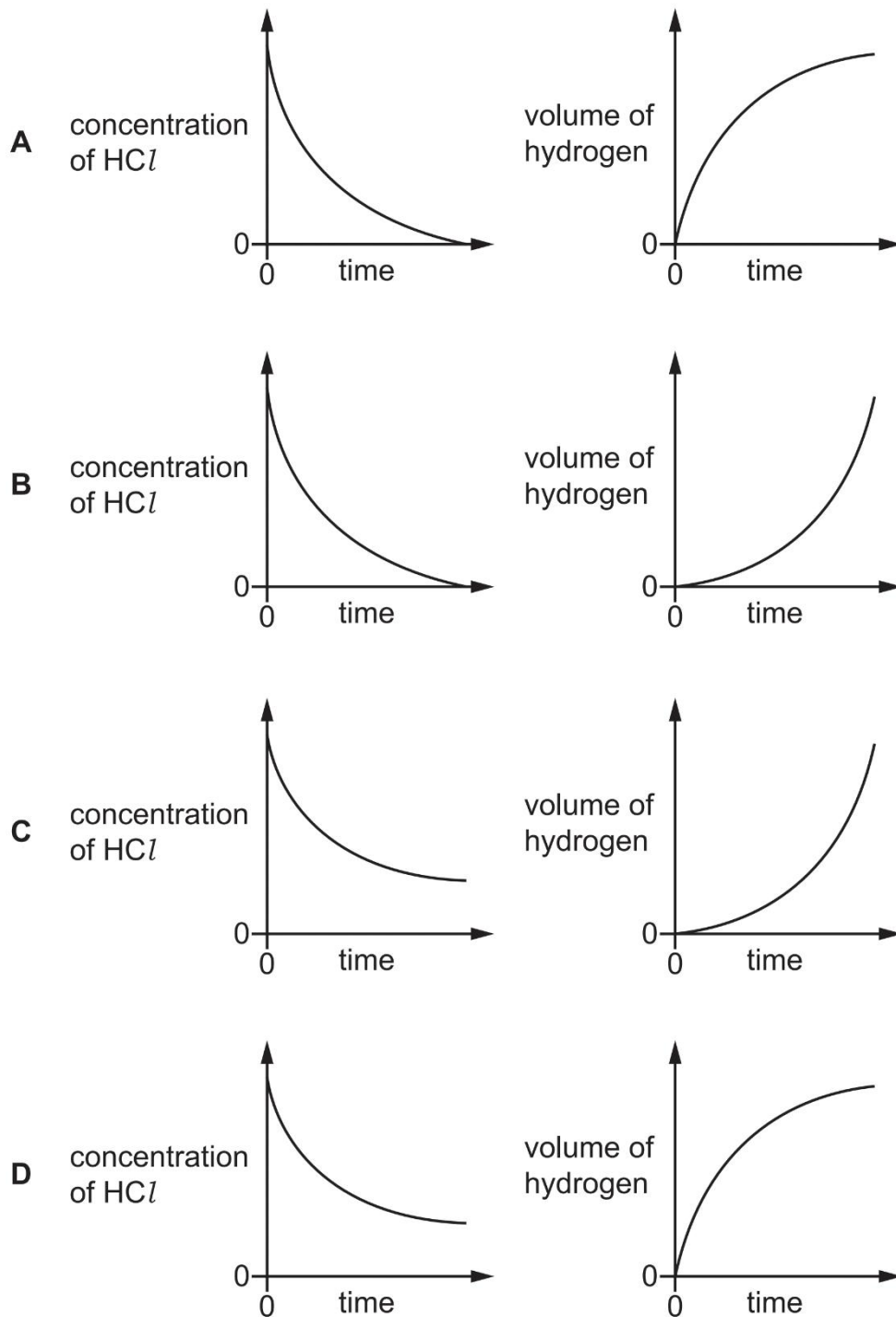
42. Magnesium reacts with dilute sulfuric acid.

$$Mg(s) + H_2SO_4(aq) \rightarrow MgSO_4(aq) + H_2(g)$$
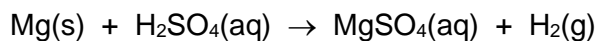
Which changes in the conditions will result in the lowest rate of production of hydrogen?

	acid concentration	solid particle size	temperature
A	decrease	decrease	increase
B	decrease	increase	decrease
C	increase	decrease	increase
D	increase	increase	decrease

• Scan the QR Code below to view the answers to this assignment.

http://www.chemist.sg/rate_of_reaction/rate_three_ans.pdf