FORM 5 PLANNING EXPERIMENTS

QUESTION 1

"A small sized charcoal is easier to light up compared to a big-sized charcoal"
Based on situation above, plan a laboratory experiment to investigate the effect of the size of reactants on the rate of reaction between a named metal and a named of acid.

(a) Problem statement : How does the size of the solid reactant affect the rate of reaction between zinc and hydrochloric acid?
OR Aim of the experiment : To study the effect of size of the reactant on the rate of reaction between zinc and hydrochloric acid.

(b) Hypothesis : When the total surface area of zinc becomes larger // When the size of zinc becomes smaller, the rate of reaction increases

(c) Variable : Manipulated: Size of zinc
Responding: Rate of reaction
Constant: Volume and concentration of hydrochloric acid/Temperature/Mass of zinc

(d) Materials :Zinc granules, zinc powder, 0.1 mol dm^{-3} hydrochloric acid and water
Apparatus :Conical flask, basin, rubber stopper with delivery tube, measuring cylinder, burette, electronic balance, stopwatch and retort stand and clamp

(e) Procedure :

1. Fill a basin with water.
2. Fill a burette with water and invert it over water in a basin.
3. Clamp the burette using retort stand and record its initial burette reading.
4. Measure 40 cm^3 of 0.1 mol dm^{-3} hydrochloric acid using a measuring cylinder and pour the acid into a conical flask.
5. Weigh 2 g of zinc granules and put the zinc granules into the conical flask.
6. Close the conical flask immediately with a stopper which is joined with delivery tube and start the stopwatch.
7. Swirl the conical flask throughout the experiment.
8. Record the burette readings at intervals of 30 seconds until the reaction stops.
9. Repeat steps 1 to 6 using 2 g of zinc powder to replace 2 g of zinc granules.

(f) Tabulation of data

Experiment I : using zinc granules

Time/s	0	30	60	90	120	150	180	210	240
Burette readings / cm^3									
Volume of gas/cm^3									

Experiment II : using zinc powder

Time/s	0	30	60	90	120	150	180	210	240
Burette readings / cm^3									
Volume of gas/cm^3									

QUESTION 2

TO STUDY THE EFFECT OF TEMPERATURE OF SODIUM THIOSULPHATE SOLUTION ON THE RATE OF REACTION

(a) Problem statement : How does different temperature of sodium thiosulphate solution affect the rate of reaction?

(b) Hypothesis : The higher the temperature of sodium thiosulphate solution, the higher the rate of reaction / the shorter the time taken for the 'X' mark to disappear from view.

(c) Variable :
Manipulated: Temperature of sodium thiosulphate solution
Responding: Rate of reaction
Constant: Volume and concentration of sulphuric acid/size of conical flask/ Volume and concentration of sodium thiosulphate solution

(d) Materials : 0.2 mol dm^{-3} sodium thiosulphate solution, 1.0 mol dm^{-3} sulphuric acid, a piece of white paper marked 'X' at the centre

Apparatus: Conical flask, stopwatch, 50 cm^3 measuring cylinder, 10 cm^3 measuring cylinder, thermometer, Bunsen burner, tripod stand and wire gauze

(e) Procedure :

1. Using 50 cm^3 measuring cylinder, measure 50 cm^3 of 0.2 mol dm^{-3} sodium thioulphate solution and pour it into a conical flask.
2. Measure and record the temperature of the solution.
3. Place the conical flask on top of a piece of white paper marked 'X' at the centre.
4. Measure 5 cm^3 of 1.0mol dm^{-3} sulphuric acid using 10 cm^3 measuring cylinder and pour it into the conical flask. At the same time, start the stopwatch.
5. Swirl the mixture in the conical flask. Observe the 'X' mark vertically from the top of the conical flask.
6. Stop the stopwatch once the 'X' mark disappears from view. Record the time taken.
7. Repeat steps 1 to 5 using same volume and concentration of sodium thiosulphate solution at 40°C, 50°C, 60°C, and 70°C by heating the solution before adding the sulphuric acid.

(f) Tabulation of data

Experiment	Temperature / °C	Time taken for 'X' mark to disappear from view /s	1/time(s^{-1})
1	30		
2	40		
3	50		
4	60		
5	70		

QUESTION 3

TO STUDY THE EFFECT OF CONCENTRATION OF SODIUM THIOSULPHATE SOLUTION ON THE RATE OF REACTION

(a) Problem statement : How does different concentration of sodium thiosulphate solution affect the rate of reaction?

(b) Hypothesis : The higher the concentration of sodium thiosulphate solution, the higher the rate of reaction / the shorter the time taken for the 'X' mark to disappear from view.

(c) Variable :
Manipulated: Concentration of sodium thiosulphate solution
Responding: Rate of reaction
Constant: Volume and concentration of sulphuric acid/size of conical flask/Temperature / Volume of sodium thiosulphate solution

(d) Materials : 0.2 mol dm^{-3} sodium thiosulphate solution, 1.0 mol dm^{-3} sulphuric acid, a piece of white paper marked 'X' at the centre

Apparatus: Conical flask, stopwatch, 50 cm^3 measuring cylinder, and 10 cm^3 measuring cylinder

(e) Procedure :

1. Using 50 cm^3 measuring cylinder, measure 50 cm^3 of 0.2 mol dm^{-3} sodium thiosulphate solution and pour it into a conical flask.
2. Place the conical flask on top of a piece of white paper marked 'X' at the centre.
3. Measure 5 cm^3 of 1.0mol dm^{-3} sulphuric acid using 10 cm^3 measuring cylinder and pour it into the conical flask. At the same time, start the stopwatch.
4. Swirl the mixture in the conical flask. Observe the 'X' mark vertically from the top of the conical flask.
5. Stop the stopwatch once the 'X' mark disappears from view. Record the time taken.
6. Repeat steps1 to 6 by using different concentration of sodium thiosulphate solution, 0.16 mol dm^{-3}, 0.12 mol dm^{-3}, 0.08 mol dm^{-3}, 0.04 mol dm^{-3} to replace 0.2 mol dm^{-3}.

(f) Tabulation of data

Experiment	Concentration of sodium thiosulphate solution /mol dm^{-3}	Time taken for 'X' mark to disappear from view, t /s	1/time, s^{-1}
1	0.2		
2	0.16		
3	0.12		
4	0.08		
5	0.04		

QUESTION 4

"An increase in the amount of catalyst will provide a larger total surface area for the reactants in a chemical reaction. How will this affect the rate of reaction?"
Based on situation above, plan a laboratory experiment to investigate the effect of the amount of catalyst on the rate of reaction.

(a) Problem statement : How does the difference mass of manganese(IV) oxide as a catalyst affect the rate of decomposition of hydrogen peroxide?

OR Aim of the experiment: To study the effect of different mass of manganese(IV) oxide powder as catalyst on the rate of decomposition of hydrogen peroxide

(b) Hypothesis : When the mass of manganese(IV) oxide powder increases, the rate of decomposition of hydrogen peroxide increases

(c) Variable : Manipulated: Different mass of manganese(IV) oxide
Responding: Rate of reaction
Constant: Volume and concentration of hydrogen peroxide // Temperature

(d) Materials : 2-volume hydrogen peroxide solution, manganese(IV) oxide powder

Apparatus : Conical flask, basin, rubber stopper with delivery tube, spatula, weighing bottle, measuring cylinder, burette, electronic balance, stopwatch and retort stand and clamp

(e) Procedure :

1. Fill a basin with water.
2. A burette is filled with water and invert the burette over water in a basin.
3. Clamp the burette using retort stand and record its initial burette reading.
4. Measure 50 cm^3 of 2-volume hydrogen peroxide and pour it into a conical flask.
5. Weigh 0.5 g of manganese(IV) oxide powder and add it into the conical flask.
6. Close the conical flask immediately with a stopper which is joined with delivery tube and start the stopwatch.
7. Swirl the conical flask throughout the experiment.
8. Record the burette readings at intervals of 30 seconds until the reaction stops.
9. Repeat steps 1 to 8 using 1 g of manganese(IV) oxide powder to replace 0.5 g of manganese(IV) oxide powder.

(f) Tabulation of data

Experiment I : Decomposition of H_2O_2 with 0.5 g of manganese(IV) oxide powder

Time/s	0	30	60	90	120	150	180	210	240
Burette readings / cm^3									
Volume of gas/cm^3									

Experiment II : Decomposition of H_2O_2 with 1.0 g of manganese(IV) oxide powder

Time/s	0	30	60	90	120	150	180	210	240
Burette readings / cm^3									
Volume of gas/cm^3									

QUESTION 5

"The rate of decomposition of hydrogen peroxide which is catalysed by manganese(IV) oxide depends on its concentration".
You are required to plan a laboratory experiment to investigate the effect of concentration of hydrogen peroxide on its rate of decomposition.

(a) Problem statement : How does the concentration of hydrogen peroxide affect on its rate of decomposition?

(b) Hypothesis : When the concentration of hydrogen peroxide solution increases, the rate of decomposition of hydrogen peroxide increases.

(c) Variable : Manipulated: Concentration of hydrogen peroxide
Responding: Rate of reaction
Constant: Manganese(IV) Oxide // Temperature // Mass of manganese(IV) oxide

(d) Materials : 2-volume hydrogen peroxide solution, 4-volume hydrogen peroxide solution and manganese(IV) oxide powder
Apparatus : Conical flask, basin, rubber stopper with delivery tube, spatula, weighing bottle, measuring cylinder, burette, electronic balance, stopwatch and retort stand and clamp

(e) Procedure :

1. Fill a basin with water.
2. A burette is filled with water and invert the burette over water in a basin.
3. Clamp the burette using retort stand and record its initial burette reading.
4. Measure 50 cm^3 of 2-volume hydrogen peroxide and pour it into a conical flask.
5. Weigh 0.5 g of manganese(IV) oxide powder and add it into the conical flask.
6. Close the conical flask immediately with a stopper which is joined with delivery tube and start the stopwatch.
7. Swirl the conical flask throughout the experiment.
8. Record the burette readings at intervals of 30 seconds until the reaction stops.
9. Repeat steps 1 to 8 using 4-volume of hydrogen peroxide solution to replace 2-volume of hydrogen peroxide solution.

(f) Tabulation of data

Experiment I : Using 2-volume of hydrogen peroxide

Time/s	0	30	60	90	120	150	180	210	240
Burette readings / cm^3									
Volume of gas/cm^3									

Experiment II : Using 4-volumer of hydrogen peroxide

Time/s	0	30	60	90	120	150	180	210	240
Burette readings / cm^3									
Volume of gas/cm^3									

QUESTION 6

TO INVESTIGATE THE COAGULATION OF LATEX

(a) Problem statement : How does presence of acid and alkali affect the coagulation of latex?

OR Aim of the experiment : To study the coagulation of latex by action of acid and the prevention of the coagulation of latex by alkali.

(b) Hypothesis : Addition of acid can coagulates latex while addition of alkali can prevent latex from coagulating

(c) Variable :

Manipulated: Presence of ethanoic acid and ammonia solution

Responding: Coagulation of latex/ Formation of lump of solid

Constant: Volume of latex / Latex

(d) Materials : Latex, ethanoic acid, ammonia solution

Apparatus: Beaker, Measuring cylinder, glass rod and dropper

(e) Procedure :

1. Pour about 20 cm^3 of latex into three beakers.
2. Using a dropper, add about 5 cm^3 of ethanoic acid to the first beaker and stir with glass rod.
3. Observe and record any changes that occur.
4. Using a dropper, add about 5 cm^3 of ammonia solution to the second beaker and stir with glass rod. Leave it aside.
5. Leave the latex in the third beaker exposed to the air for one day.
6. Observe and record the changes in the second and third beakers after one day.

(f)

Type of chemical solution	Observation / Coagulation of latex
Latex + ethanoic acid	
Latex + ammonia solution	
Latex only	

QUESTION 7

TO INVESTIGATE OXIDATION AND REDUCTION IN THE DISPLACEMENT OF HALOGEN FROM ITS HALIDE SOLUTION

(a) Problem statement : Does more reactive halogen can displace less reactive halogen from its halide solution?

(b) Hypothesis : More reactive halogen can displaces a less reactive halogen from its halide solution

(c) Variable : Manipulated: Type of halogen and their halide solutions
Responding: The colour formed in 1,1,1-trichloroethane
Constant: 1,1,1-trichloroethane

(d) Materials : Chlorine water, bromine water, iodine solution,
0.5 mol dm^{-3} potassium chloride solution,
0.5 mol dm^{-3} potassium bromide solution,
0.5 mol dm^{-3} potassium iodide solution and
1,1,1-trichloroethane

Apparatus: Dropper, test tube, test tube rack

(e) Procedure :

1. Put three test tubes into test tube rack.
2. Pour 2 cm^3 of potassium chloride solution, 2 cm^3 of potassium bromide solution and 2 cm^3 of potassium iodide solution into three separate test tubes.
3. Using dropper, add few drops of chlorine water to each test tube and shake the mixture thoroughly.
4. Using another dropper, add few drops of 1,1,1-trichloroethane to each test tube.
5. Shake the mixture thoroughly. After a few seconds, observe the colour formed in the 1,1,1-trichloroethane layers and record it.
6. Repeat steps 1 to 5 using bromine water and iodine solution consecutively, in place of chlorine water.
7. Record all the observations in the table.

(f)

Type of halogen	Halide solutions	Colour of halogen in 1,1,1-trichloroethane
Chlorine	Potassium bromide	
Chlorine	Potassium iodide	
Bromine	Potassium chloride	
Bromine	Potassium iodide	
Iodine	Potassium chloride	
Iodine	Potassium bromide	

QUESTION 8

TO STUDY THE REACTIVITY OF METALS WITH OXYGEN GAS

(a) Problem statement : How do different metals in the reactivity series react with oxygen?

OR Aim of the experiment : To compare the reactivity of metals in the reactivity series with oxygen.

(b) Hypothesis : When more reactive metal burnt with oxygen gas, the brighter the flame produced.

(c) Variable :

Manipulated: Types of metal

Responding: Brightness of flame produced/Reactivity of metals

Constant: Size of metals / Mass of metal powder / Oxygen gas

(d) Materials : Magnesium powder, Copper powder, iron filings solid potassium manganate(VII), asbestos paper and glass wool

Apparatus: Boiling tube, retort stand and clamp, Bunsen burner, spatula, forceps

(e) Procedure :

1. Put one spatula of potassium manganate(VII) in a boiling tube.
2. Push in some glass wool into the tube and clamp it horizontally.
3. Place one spatula of magnesium powder on a piece of asbestos paper and put it into the boiling tube.
4. Heat the magnesium powder strongly and then heat the solid potassium manganate(VII).
5. Observe how vigorous magnesium reacts with oxygen.
6. Repeat steps 1 to 5 using copper powder and iron filings to replace magnesium powder.
7. Record all the observations

(f) Tabulation of data

Type of metals	Observation
Magnesium	
Copper	
Iron	

Question 9

To determine the position of carbon in the reactivity series of metals

(a) Problem statement : How to determine the position of carbon in the reactivity series by heating a mixture of a carbon powder and a metal oxide?

(b) Hypothesis : When carbon is less reactive than the metal, reaction does not occur between carbon with the metal oxide. When carbon is more reactive than the metal, reaction occur between carbon with the metal oxide.

(c) Variable : Manipulated: Types of metal oxide
Responding: Reaction occur or not
Constant: Carbon powder

(d) Materials : Carbon powder, copper(II) oxide, magnesium oxide, aluminium oxide and zinc oxide

Apparatus: Crucible, spatula, bunsen burner, pipe-clay triangle, tripod stand

(e) Procedure :

1. Put a spatula of carbon powder into a crucible.
2. Put a spatula of copper(II) oxide powder into a crucible containing carbon powder.
3. Heat the mixture strongly.
4. Observe and record the changes occur.
5. Steps 1 to 4 are repeated by using magnesium oxide powder, aluminium oxide powder and zinc oxide to replace copper(II) oxide powder.

(f)

Mixture	Observation
Carbon + copper(II) oxide	
Carbon + magnesium oxide	
Carbon + aluminium oxide	
Carbon + zinc oxide	

QUESTION 10

"Electrons flow from the reducing agent to the oxidizing agent during a redox reaction".
By choosing a suitable reaction, plan an experiment to determine the direction of the flow of electrons in a redox reaction.

(a) Problem statement : How to determine the direction of the flow of electrons when the reducing agent and oxidising agent are separated by an electrolyte in a U-tube?

(b) Hypothesis : When the reducing agent and oxidising agent are separated by an electrolyte in a U-tube, the transfer of electrons occurs and flow from reducing agent to oxidising agent.

(c) Variable :
Manipulated: Reducing agents and oxidising agents
Responding: Deflection of the needle of galvanometer
Constant: Carbon electrodes / Dilute sulphuric acid

(d) Materials **:** Bromine water, potassium iodide solution 0.5 mol dm^{-3} ; iron (II) sulphate solution, 0.5 mol dm^{-3} , acidified potassium manganate(VII) and dilute sulphuric acid.

Apparatus: U-tube, Galvanometer, Connecting wire with crocodile clips, carbon electrodes, retort stand and clamp

(e) Procedure :

1. Clamp a U-tube to a retort stand.
2. Pour dilute sulphuric acid into the U-tube.
3. Using a dropper, add iron(II) sulphate solution to one of the arms of the U-tube.
4. In the same manner as in step 3, add acidified potassium manganate(VII) solution to the other arm of the U-tube.
5. Immerse a carbon electrode in the iron(II) sulphate solution and another carbon electrode in the acidified potassium manganate(VII) solution.
6. Connect the electrodes to a galvanometer. Observe the deflection of galvanometer.
7. Leave the apparatus for 30 minutes and record any changes occur in the iron(II) sulphate solution and acidified potassium manganate(VII) solution.
8. Repeat steps 1 to 7 using bromine water and potassium iodide solution to replace iron(II) sulphate solution and acidified potassium manganate(VII) solution.

(f) Tabulation of data

Solution used		Direction of deflection of needle in the galvanometer	Colour change	
In the first arm of U-tube	In the second arm of U-tube		In the first arm of U-tube	In the second arm of U-tube
Bromine	Potassium iodide			
Iron(II) sulphate	Acidified potassium Manganate solution			

Question 11

HEAT OF DISPLACEMENT

(a) Problem statement : How do difference electropositivity of metal affect the heat of displacement of copper?

(b) Hypothesis : The higher the position of the more electropositive metal in the electrochemical series, the larger the value of heat of displacement of copper by the metal

(c) Variable : Manipulated: Metals that are more electropositive than copper
Responding: Heat of displacement
Constant: Volume and concentration of copper(II) sulphate solution/polystyrene cup/size of metals

(d) Materials : zinc powder, magnesium powder, 0.5 mol dm^{-3} copper(II) sulphate solution

Apparatus: Polystyrene cup, measuring cylinder, electronic balance, weighing bottle and thermometer

(e) Procedure :

1. Measure 50 cm^3 of 0.5 mol dm^{-3} copper(II) sulphate solution and pour it into a polystyrene cup.
2. Put the thermometer into the copper(II) sulphate solution. Measure and record the initial temperature of the solution.
3. Weigh 1 g of zinc powder.
4. Pour the zinc powder quickly and carefully into the copper(II) sulphate solution.
5. Stir the mixture with thermometer while observe the change in temperature.
6. Record the highest temperature achieved.
6. Repeat steps 1 to 5 using excess magnesium powder to replace excess zinc powder

(f)

Reactants	Zinc + copper(II) sulphate solution	Magnesium + copper(II) sulphate solution
Initial temperature of copper(II) sulphate solution (°C)		
Highest temperature of the reaction mixture (°C)		

QUESTION 12

HEAT OF NEUTRALISATION

(a) Problem statement : Does the heat of neutralization between a strong acid and a strong alkali is higher than the heat of neutralization between a weak acid and a strong alkali?

(b) Hypothesis : Reaction between hydrochloric acid and sodium hydroxide has a higher heat of neutralization than ethanoic acid and sodium hydroxide

(c) Variable :

Manipulated: Hydrochloric acid and ethanoic acid

Responding: Heat of neutralisation

Constant: Volume and concentration of sodium hydroxide solution / Polystyrene cup / Size of polystyrene cup

(d) Materials : 2.0 mol dm^{-3} hydrochloric acid, 2.0 mol dm^{-3} ethanoic acid, 2.0 mol dm^{-3} sodium hydroxide solution

Apparatus: Polystyrene cup, measuring cylinder, and thermometer

(e) Procedure :

1. Measure 50 cm^3 of 2.0 mol dm^{-3} sodium hydroxide solution using a measuring cylinder and pour it into a polystyrene cup.
2. Put the thermometer into the sodium hydroxide solution. Measure and record the initial temperature of the solution.
3. Measure 50 cm^3 of 2.0 mol dm^{-3} hydrochloric acid using another measuring cylinder and pour it into another polystyrene cup.
4. Pour the hydrochloric acid quickly and carefully into the sodium hydroxide solution in the polystyrene cup.
5. Stir the mixture with thermometer while observe the change in temperature.
6. Record the highest temperature achieved.
7. Repeat steps 1 to 6 using 50 cm^3 of 2.0 mol dm^{-3} ethanoic acid to replace hydrochloric acid

(f)

Reactants	Hydrochloric acid + Sodium hydroxide solution	Ethanoic acid + Sodium hydroxide solution
Initial temperature of sodium hydroxide solution (°C)		
Initial temperature of acid (°C)		
Average of initial temperature of the solutions (°C)		
Highest temperature of the reaction mixture (°C)		

QUESTION 13
HEAT OF COMBUSTION

(a) Problem statement :
How does the number of carbon atoms per molecule of alcohol affect the heat of combustion? //
Does alcohol with higher number of carbon atoms per molecule have a higher heat of combustion?

(b) Hypothesis : The higher the number of carbon atoms per molecules of alcohol, the higher the heat of combustion.

(c) Variable : Manipulated: Different types of alcohols
Responding: Heat of combustion
Constant: Volume of water/copper can

(d) Materials : Methanol, ethanol, propan-1-ol, butan-1-ol, water
Apparatus: copper can, tripod stand, thermometer, measuring cylinder, spirit lamps, electronic balance, wooden block, windshield

(e) Procedure :
1. 200 cm^3 of water is measured using a measuring cylinder and poured into a copper can. Initial temperature of water is measured and recorded.
2. The copper can is placed on a tripod stand.
3. Spirit lamp is filled with methanol and the lamp and its content is weighed and the mass is recorded.
4. The lamp is put under copper can and the wick of the lamp is lighted immediately.
5. The apparatus is covered with windshield.
6. Stir the water continuously until the temperature of the water increases by 30°C.
7. The flame is put off and the highest temperature reached by water is recorded.
8. The mass of the lamp and its content is weighed immediately and is recorded.
9. Steps 1 to 7 are repeated by using ethanol, propan-1-ol and butan-1-ol to replace methanol.

(f)

Type of alcohol	Methanol	Ethanol	Propan-1-ol	Butan-1-ol
Initial temperature of water /°C				
Highest temperature of water /°C				
Increase in the temperature /°C				
Mass of lamp before burning /g				
Mass of lamp after burning /g				
Mass of alcohol burnt /g				

QUESTION 14

"In hard water, the cleansing action of a detergent is more effective than soap"
Design a laboratory experiment to prove the above statement.

(a) Problem statement : Is the cleansing action of a detergent more effective than that of soap in hard water?

OR Aim of the experiment : To compare the effectiveness of cleansing action of soap and detergent in hard water.

(b) Hypothesis : Detergent cleans stain more effectively than soap in hard water

(c) Variable :
Manipulated: Soap and detergent solutions
Responding: Cleansing effect on cloth//The ability to remove oily stains on cloth
Constant: Cloth with oily stains// volume of hard water

(d) Materials : Detergent solution, soap solution, cloths with oily stains, hard water(magnesium sulphate solution)

Apparatus: Beakers, measuring cylinder and glass rod

(e) Procedure :

1. Label two beakers as A and B respectively.
2. Fill beaker A with 50 cm^3 of soap solution while beaker B with 50 cm^3 of detergent solution
3. Pour 20 cm^3 of hard water / magnesium sulphate solution into each beaker.
4. Stir the solution in each beaker using a glass rod.
5. Dip a small cloth with oily stains into each beaker.
6. Wash each cloth in each beaker.
7. Observe and record whether the oily stain on piece of cloth disappears in each beaker.

(f)

Beaker	Observation
A (Soap solution +hard water)	
B (detergent solution + hard water)	