FORM 4 PLANNING EXPERIMENTS

QUESTION 1

Plan a laboratory experiment to show the rate of diffusion depends on temperature.

(a) Problem statement : How does the temperature affect the rate of diffusion of bromine gas?

OR Aim of the experiment : To study the effect of temperature on the rate of diffusion of bromine gas.

(b) Hypothesis : The higher the temperature, the higher the rate of diffusion of bromine gas.

(c) Variable :
Manipulated: Temperature
Responding: Rate of diffusion of bromine gas / Time taken for gas to spread fully into second gas jar
Constant: Size of gas jar / Liquid bromine

(d) Materials : Liquid bromine
Apparatus : Gas jars, gas jar cover, Droppers, Bunsen burner, Stopwatch

(e) Procedure :

1. Place 5 drops of liquid bromine into a gas jar.
2. Cover the gas jar immediately and left aside for a few minutes.
3. Invert a gas jar full of air on the top of the gas jar full of bromine vapour.
4. Remove the cover.
5. The time taken for brown gas to spread fully into second gas jar is recorded.
6. Repeat steps 1 to 5 by heating the gas jar.

(f) Tabulation of data

Temperature of bromine vapour	Time taken (s)
Room temperature	
High temperature	

QUESTION 2

PLAN AN EXPERIMENT TO COMPARE THE REACTIVITY OF GROUP 1 METALS WITH CHLORINE GAS / OXYGEN GAS (SAME EXPERIMENT)

(a) Problem statement : How does the reactivity of group 1 metals change when reacts with chlorine gas/oxygen gas?

OR Aim of the experiment : To compare/study the reactivity of group 1 elements with chlorine gas/oxygen gas

(b) Hypothesis : The lower the position of group 1 elements, the higher the reactivity of group 1 element in their reaction with chlorine gas/oxygen gas

(c) Variable :
Manipulated: Different types of alkali metals
Responding: Reactivity of metals / The brightness of the flame
Constant: Temperature / Size of alkali metals

(d) Materials : Lithium, sodium, potassium, chlorine gas/oxygen gas, filter paper

Apparatus: Gas jars, gas jar spoons, gas jar covers, small knife,

(e) Procedure :

1. Cut a small piece of lithium using a knife and forceps.
2. Wipe the oil on the surface of the lithium with filter paper.
3. Put the lithium in a gas jar spoon.
4. Heat the lithium strongly until it burns.
5. Transfer the gas jar spoon quickly into a gas jar filled with chlorine gas/oxygen gas.
6. Record all the observations in the table.

(f) Tabulation of data

Alkali metals	Observation
Lithium	
Sodium	
Potassium	

QUESTION 3

PLAN AN EXPERIMENT TO COMPARE THE REACTIVITY OF GROUP 17 ELEMENTS WITH WATER//SODIUM HYDROXIDE SOLUTION

(a) Problem statement : How does the reactivity of halogens(chlorine, bromine And iodine) change when reacts with water//sodium hydroxide solution?

OR Aim of the experiment : To compare/study the reactivity of halogens with water//sodium hydroxide solution

(b) Hypothesis : The higher the position of the group 17 element, the higher the reactivity of the halogen with water.

(c) Variable : Manipulated: Type of halogens
Responding: Reactivity of the halogens
Constant: Water//sodium hydroxide solution

(d) Materials : Chlorine gas, liquid bromine, solid iodine, water//sodium hydroxide solution, blue litmus paper.
(for NaOH solution – no need blue litmus paper)

Apparatus: Test tubes,dropper, test tube holder, stopper

(e) Procedure :

1. Pass the chlorine gas into 5 cm^3 of distilled water//sodium hydroxide solution in a test tube.
2. Close the test tube with stopper and shake the solution formed.
3. Observe the rate of dissolving of the halogens in water//changes in colour.
4. Put a piece of blue litmus paper into the solution formed.(only reaction with water)
5. Record the observation in the table.
6. Repeat the experiment by adding two drops of liquid bromine and a small piece of solid iodine into distilled water//sodium hydroxide solution.

(f) Tabulation of data

Halogens	Observation
Chlorine	
Bromine	
Iodine	

QUESTION 4

TO STUDY THE PROPERTIES OF THE OXIDES OF ELEMENTS IN PERIOD 3

(a) Problem statement : How do the acid-base properties of the oxides of elements change across Period 3?

OR Aim of the experiment : To sudy the acid-base properties of the oxides of elements across Period 3.

(b) Hypothesis : Magnesium oxide dissolve in an acid, aluminium oxide dissolve in both acid and alkali and phosphorus pentoxide dissolve in an alkali

(c) Variable :
Manipulated: Types of oxide of elements in Period 3.
Responding: Solubility of the oxides in acid or alkali
Constant: Nitric acid and sodium hydroxide solution
Volume and concentration of nitric acid and sodium hydroxide solution

(d) Materials : Magnesium oxide, Aluminium oxide and Phosphorus pentoxide

Apparatus: Test tubes, spatula, glass rod, Bunsen burner, Test tube holder, test tube rack

(e) Procedure :

1. 5 cm^3 of 2 mol dm^{-3} nitric acid and 5 cm^3 of 2 mol dm^{-3} sodium hydroxide solution are placed in two separate test tubes.
2. Using a spatula, magnesium oxide is added into each of the test tubes.
3. The test tubes are warmed and stirred with a glass rod until no further change.
4. Observe and record the solubility of the metal oxide in nitric acid and sodium hydroxide.
5. Repeat steps 1 to 5 using aluminium oxide and phosphorus pentoxide respectively to replace magnesium oxide.

(f) Tabulation of data

Oxide of elements	**Solubility**	
	in nitric acid	**in sodium hydroxide solution**
Magnesium oxide		
Aluminium oxide		
Phosphorus pentoxide		

QUESTION 5

Acetamide is a covalent compound
Lead(II) bromide is an ionic compound
PLAN AN EXPERIMENT TO COMPARE THE ELECTRICAL CONDUCTIVITY OF THE TWO SUBSTANCES

(a) Problem statement : Which of the compounds, acetamide or lead(II) bromide conducts electricity in the molten state?

OR Aim of the experiment : To compare/study the electrical conductivity of acetamide compound and lead(II) bromide compound in their molten state

(b) Hypothesis : Lead(II) bromide conducts electricity in the molten state while acetamide cannot conduct electricity in the molten state.

(c) Variable :
Manipulated: Acetamide and lead(II) bromide
Responding: Electrical conductivity of the compounds in the molten state
Constant: Types of electrode

(d) Materials : Acetamide, lead(II) bromide
Apparatus: Crucible, carbon electrodes, batteries, connecting wires, bunsen burner, pipe-clay triangle, bulb

(e) Procedure :

1. A crucible is filled with acetamide powder until it is half full.
2. The crucible is placed on a pipe-clay triangle on the tripod stand.
3. The acetamide powder is heated until it is completely melted.
4. Two carbon electrodes are dipped into the molten acetamide and electrodes are connected to the batteries and bulb using connecting wires.
5. The observation on whether the bulb glows is recorded.
6. Steps 1 to 5 are repeated by using lead(II) bromide to replace acetamide.

(f) Tabulation of data

Substances	**Observation**
Acetamide	
Lead(II) bromide	

QUESTION 6

Electrolysis of copper(II) sulphate by using copper electrodes and carbon electrodes

Problem statement : How do the types of electrodes affect the products of electrolysis of copper (II) sulphate solution?

Hypothesis : When copper electrodes are used instead of carbon electrodes, types of products formed at the anode and the cathode are different.

Manipulated variable: Different types of electrodes.

Responding variable : Products of electrolysis // Thickness of electrode

Fixed variable : Concentration of aqueous copper(II) suphate solution//Type of electrolyte

Apparatus : Electrolytic cells, carbon electrodes, copper electrodes, ammeter, connecting wires with crocodile clips, test tubes, and batteries

Materials : Aqueous copper(II) sulphate 1 mol dm^{-3}

Procedure :

1. The cell is filled up with aqueous solution of copper(II) sulphate until its level is above the carbon 1electrode .
2. Fill two test tubes with copper(II) sulphate solution until full and invert it over the each carbon electrodes
3. The electrodes are connected to the batteries and ammeter using connecting wires.
4. Turn on the switch and allow current flow for about 20 minutes.
5. Changes at both the electrodes are observed and recorded.
6. The experiment is repeated with copper electrodes to replace the carbon electrodes.

Observation :

Cathode	Anode	Observation	
		Cathode	Anode
Carbon	Carbon		
Copper	Copper		

QUESTION 7

Investigate the factor of concentration of ions on the selective discharge of ions at the electrodes

Problem statement : How does the concentration of ions in hydrochloric acid affect the discharge of ions at the anode?

Hypothesis : When the concentration of chloride ion is higher, the chloride ion will be selectively discharged at the anode.

Manipulated variable: Concentration of chloride ion

Responding variable : Products of electrolysis at the anode//Types of Ions discharged at the anode.

Fixed variable : Type of electrode//Type of electrolyte//duration of electrolysis

Apparatus : Electrolytic cells, carbon electrodes, ammeter, connecting wires with crocodile clips, batteries and wooden splinter

Materials : 1.0 mol dm^{-3} hydrochloric acid, 0.001 mol dm^{-3} hydrochloric acid, blue and red litmus paper

Procedure :

1. The cell is filled up with 1.0 mol dm^{-3} hydrochloric acid until its level is above the electrode .
2. Fill two test tubes with 1.0 mol dm^{-3} hydrochloric acid until full and invert it over the each carbon electrodes
3. The electrodes are connected to the batteries and ammeter using connecting wires.
4. Turn on the switch and allow current flow for about 20 minutes.
5. Collect the gas produced at the anode and test with moist blue and red litmus paper and a glowing splinter.
6. Repeat steps 1 to 5 by using 0.001 mol dm^{-3} hydrochloric acid.

Observation :

Electrolyte	Observation at the anode
1.0 mol dm^{-3} hydrochloric acid	
0.001 mol dm^{-3} hydrochloric acid	

Question 8

To construct the electrochemical series using the principle of displacement of metals

Problem statement How can the electrochemical series of metals be constructed based on the displacement of metals?

Hypothesis Less electropositive metal can be displaced from its salt solution by more electropositive metal. The greater the number of metals that can be displaced by a more electropositive metal from their solutions, the higher its position in the electrochemical series.

Variables

Manipulated : Pairs of metals and salt solution used
Responding : Deposition of metal//colour change of the solution
Fixed : concentration and volume of the solution

Materials 1.0 mol dm^{-3} magnesium nitrate solution, 1.0 mol dm^{-3} zinc nitrate solution, 1.0 mol dm^{-3} lead(II) nitrate solution, 1.0 mol dm^{-3} copper(II) nitrate solution, magnesium strips, zinc strip, lead strip and copper strip

Apparatus Test tube and sandpaper

Procedure

1. Pour 5 cm^3 of magnesium nitrate solution, zinc nitrate solution, lead(II) nitrate solution and copper(II) nitrate solution into four separate test tubes.
2. For each test tube, place a strip of magnesium into each solution.
3. Record all the observations in the table.
4. Repeat steps 1 to 3 using strips of zinc, lead and copper to replace magnesium strip. For each repetition, use a fresh salt solution.
6. Record all observations in the table.

Tabulation of data

Salt / solution / Metal strip	Magnesium nitrate	Zinc nitrate	Lead(II) nitrate	Copper(II) nitrate
Magnesium				
Zinc				
Lead				
Copper				

QUESTION 9

Aim To investigate the role of water in showing the properties of acids

Problem Statement Does the presence of water can show the acidic properties of an acid?

Hypothesis An acid will show its acidic properties when dissolved in water.

Variables
Manipulated : Types of solvents
Responding : Change in colour of blue litmus paper
Fixed : Type of acid and litmus paper

Materials Glacial ethanoic acid, aqueous solution of ethanoic acid, solution of ethanoic acid in dry propanone , blue litmus paper.

9Apparatus Test tube, dropper, glass rod

Procedure
1. A piece of dry blue litmus paper is placed into a test tube.
2. A dropper is used to draw up some dry glacial ethanoic acid.
3. A few drops of glacial ethanoic acid are placed onto the blue litmus paper into the test tube.
4. The change of the colour on the blue litmus paper is observed and recorded.
5. Steps 1 to 4 are repeated by using ethanoic acid in water , glacial ethanoic acid in dry propanone to replace glacial ethanoic acid.
6. The observations are tabulated.

Tabulation of data

Type of acid	Observation
Glacial ethanoic acid	
Ethanoic acid in water	
Glacial ethanoic acid in dry propanone	

QUESTION 10

Aim To compare the rate of rusting of iron, steel and stainless steel.

Problem Statement How does the rate of rusting of iron, steel and stainless steel differ?

Hypothesis Iron rust faster than steel, and steel rusts faster than stainless steel.

Variables
Manipulated : Different types of nails
Responding : Intensity of blue colour
Fixed : Size of nails, concentration of solution used

Materials Iron nail, steel nail, stainless steel nail, jelly solution, potassium hexacyanoferrate(III) solution, water, sandpaper

Apparatus Test tubes, test tube rack and dropper

Procedure
1. Clean the nails using sand paper.
2. Place the iron nail into test tube A, the steel nail into test tube B, and the stainless steel nail in test tube C.
3. Prepare hot jelly solution and add few drops of potassium hexacyanoferrate(III) solution to the jelly solution.
4. Pour the hot jelly solution into three test tubes until all the nails are fully immersed.
5. Put the test tubes in a test tube rack and left aside for three days.
6. Observe and record the intensity of blue colour.

Tabulation of data

Test tube	Intensity of blue colour
A (Iron nail)	
B (Steel nail)	
C (Stainless steel nail)	

EXAMPLE

1. Two students are discussing about the uses of electrolysis process to solve their problem.

Based on the above situation, plan a laboratory experiment to electroplate an iron spoon with silver metal and copper metal using the electrolysis process. You are given silver nitrate solution and copper (II) nitrate solution.

Your planning must include the following items:
(a) Problem statement
(b) All the variables
(c) Statement of the hypothesis
(d) List of materials and apparatus
(e) Procedure of the experiment
(f) Tabulation of data

[17 *marks*]

Question	Rubric	Score
1(a)	[Able to give the statement of the problem correctly] Example : How can an iron spoon be electroplated with silver and copper through electrolysis?	3
	[Able to give the statement of the problem incorrectly] Example : To study/ determine the electrolysis process to electroplate an iron spoon with silver and copper.	2
	[Able to give an idea of statement of the problem] Example : To study the process/ uses of electrolysis	1
	[No response or wrong response]	0

Question	Rubric	Score
1(b)	*[Able to state* All *variables correctly]* Example : Manipulated variable : Silver metal with silver nitrate solution and copper metal with copper(II) nitrate solution Responding variable : Deposition of metal on the iron spoon Constant variable : Iron spoon and concentration of electrolyte	3
	[Able to state any two *variables correctly]*	2
	[Able to state any one *variables correctly]*	1
	[No response or wrong response]	0

Question	Rubric	Score
1(c)	*[Able to state the relationship between the manipulated variable and the responding variable correctly]* Example : If copper metal is used at the anode, iron spoon will be electroplated with copper, If silver metal is used at the anode, iron spoon will be electroplated with silver.	3
	[Able to state the relationship between the manipulated variable and the responding variable incorrectly] Example : If copper/silver metal is used at the anode, iron spoon will be electroplated with copper/silver //The different of electroplating metal at cathode, the different metal of anode	2
	[Able to state an idea of hypothesis] Example : Electroplating is affected by the type of anode	1
	[No response or wrong response]	0

Question	Rubric	Score
1(d)	*[Able to give the list of the apparatus and materials correctly and completely]* Example : Materials : Silver nitrate solution, copper (II) nitrate solution, iron spoon, silver, copper, sand paper Apparatus : beaker, connecting wire with crocodile clip, ammeter,battery	3
	[Able to give at least two substances and at least two apparatus]	2
	[Able to give at least one substance and at least one apparatus	1
	[No response or wrong response]	0

<table>
<tr><th>Question</th><th>Rubric</th><th>Score</th></tr>
<tr><td rowspan="4">1(e)</td><td>[Able to state all procedures correctly]
Example :
1. Clean silver, copper and iron poon with sandpaper.
2. 50 cm^3 silver nitrate solution is measured and poured into a beaker.
3. Silver is connected to positive terminal of the battery while the iron spoon is connected to negative terminal of battery.
// Silver act as anode while the iron spoon act as cathode.
4. Pair of silver and iron spoon is immersed into silver nitrate solution.
5. The switch is turned on
6. Any changes at the electrode is observed.
7. Repeat steps 1 to 5 using copper(II)nitrate solution and copper metal.</td><td>3</td></tr>
<tr><td>[Able to state 5 steps of procedures correctly]
Steps 1,3, 5,6</td><td>2</td></tr>
<tr><td>[Able to state 3 steps of procedures correctly]
Steps 1,3</td><td>1</td></tr>
<tr><td>[No response or wrong response]</td><td>0</td></tr>
</table>

<table>
<tr><th>Question</th><th>Rubric</th><th>Score</th></tr>
<tr><td rowspan="3">1(f)</td><td>Able to exhibit the tabulation of data that includes the following information.
columns and rows
observation at the iron spoon and silver/copper metal
Example :
<table><tr><td>Type of metal at the anode</td><td>Observation at iron spoon</td></tr><tr><td>Copper</td><td></td></tr><tr><td>Silver</td><td></td></tr></table></td><td>2</td></tr>
<tr><td>Able to tabulate the data incompletely

Example :
<table><tr><td>Anode</td><td>Observation</td></tr><tr><td></td><td></td></tr><tr><td></td><td></td></tr></table></td><td>1</td></tr>
<tr><td>[No response or wrong respons]</td><td>0</td></tr>
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