# CHEM PRACTICAL

## *01-Acid*

An acid is a substance which produces $H^+$ ions in aqueous Solution. Strong Acids completely ionise in water to give high concentration of $H^+$ ions in aqueous solution. Weak acids partially ionise in water to give low concentration of $H^+$ ions in aqueous solution

**Common Acids**

| **Name** | **Formula** | **Strength** |
|---|---|---|
| Hydrochloric Acid | $HCl$ | Strong |
| Sulfuric Acid | $H_2SO_4$ | Strong |
| Nitric Acid | $HNO_3$ | Strong |
| Ethanoic Acid | $CH_3COOH$ | Weak |

**Properties**

- Sour Taste
- pH less than 7
- Turns blue litmus paper red

**Chemical Reactions**

- Acid + base → salt + water (neutralisation)
- Acid + metal → salt + $H_2$ gas
- Acid + carbonate → salt + water + $CO_2$ gas

**Test For Gases**

| **Gas** | **Test** | **Result** |
|---|---|---|
| Hydrogen | Lighted splint | Extinguish with ‘pop’ sound |
| Carbon Dioxide | Limewater | White ppt |

# ***Base***

A base is a substance which reacts with acid to produce salt and water only.

- Bases include metal oxides, metal hydroxides and aqueous ammonia
- Bases can be soluble or insoluble in water
- Alkalis are soluble bases

**Alkali**

An alkali is a substance which produces $OH^{-}$ ions in aqueous solution. Strong alkalis completely ionise in water to give high concentrations of $OH^{-}$ in an aqueous solution. Weak alkalis partially ionise to give low concentrations of $OH^{-}$ in aqueous solutions.

**Common Alkalis**

| **Name** | **Formula** | **Strength** |
|---|---|---|
| Sodium hydroxide | $NaOH$ | Strong |
| Potassium hydroxide | $KOH$ | Strong |
| Calcium hydroxide | $Ca(OH)_2$ | Weak |
| Aqueous ammonia | $NH_3$ | Weak |

**Properties**

- Bitter taste
- pH more than 7
- Turns red litmus paper blue

**Chemical reactions**

- Base/ Alkali + acid → salt + water (neutralisation)
- Alkali + ammonium salt → salt + water + $NH_3$ gas

**Test for gas**

| **Gas** | **Test** | **Result** |
|---|---|---|
| Ammonia | Damp red litmus paper | Turns blue |

# ***Salt***

## Solubility

**Solubility of Common Salts**

| **Soluble Salts** | **Insoluble Salts** |
|---|---|
| All Sodium<br>All Potassium<br>All Ammonium<br>All Nitrates<br>S.P.A.N | |
| All Chlorides<br>( as well as other Halides - Bromides & Iodides) | Lead (II) Chloride<br>Silver Chloride |
| All Sulphates | Barium Sulphate<br>Calcium Sulphate (sparingly soluble)<br>Lead (II) Sulphate |
| Sodium Carbonate<br>Potassium Carbonate<br>Ammonium Carbonate<br>S.P.A | All Carbonates |
| Group I Metal Phosphates e.g. $Na_3PO_4$<br>Ammonium Phosphate $(NH_4)_3PO_4$ | All Phosphates |
| Sodium Hydroxide<br>Potassium Hydroxide<br>Calcium Hydroxide (sparingly soluble)<br>Magnesium Hydroxide (very sparingly soluble)<br>S.P.C.M | All Hydroxides |

## Salt Preparation

| **Solubility of Salt** | **Method** | **Separation technique** |
|---|---|---|
| Soluble | Titration | Crystallisation |
| | Acid + excess insoluble solid (base, metal, carbonate) | Filtration, then crystallisation |
| Insoluble | Precipitation | Filtration |

*Sample Planning Qns:*

1. *Plan an experiment to prepare clean dry crystals of sodium chloride*
2. *Describe a suitable method to prepare a clean dry sample of barium sulfate*
3. *Outline the steps to determine the water of crystallisation in a sample of hydrated copper (II) sulfate*

***SAMPLE:***

*X can be used to make lead (II) sulfate.*

*Starting from X, describe a method that can be used to make a pure, dry sample of lead (II) sulfate.*

*You are given a solution of lead (II) nitrate. You can assume that all the apparatus and reagents normally found in a school laboratory are available. [5]*

**Precipitation of lead (II) nitrate**

1. Add an excess of aqueous silver nitrate to X.

*Thought Process: Excess silver nitrate needed to precipitate as much chloride as possible. Silver chloride will be formed. Silver chloride is insoluble. Aqueous barium nitrate should not be used as insoluble barium sulfate will be formed.*

2. Filter the mixture.

*Thought Process: Residue is silver chloride, filtrate contains silver ions, sulfate ions and nitrate ions.*

3. Keep the filtrate.
4. Add an excess of aqueous lead (II) nitrate to the filtrate.

*Thought Process Insoluble lead (II) sulfate will be formed. The remaining solution contains silver ions, lead (II) ions and nitrate ions.*

5. Filter the mixture.
6. Keep the residue.

*Thought Process Residue is lead (II) sulfate, filtrate contains lead (II) ions, silver ions and nitrate ions.*

**Purification of lead (II) nitrate**

1. Rinse the residue with a small volume of cold distilled water.
2. Dry the residue between pieces of clean dry filter papers.

# ***02- Qualitative Analysis***

**Test for cations**

- Alkalis are used to test for cations
- A few drops of alkali are added, then in excess
- Hydroxides are formed
- The hydroxides formed may be soluble or insoluble in excess alkali
- If the hydroxide reacts and dissolves in excess alkali, the colour of the final solution must be described. If the hydroxide is insoluble, it forms a precipitate (ppt)
- Lead (II) ios not tested in practical but may be tested in planning

| **Cation** | **Aq Sodium Hydroxide** | **Aq Ammonia** | **Eqn** |
|---|---|---|---|
| Aluminium ($Al^{3+}$) | White ppt, soluble in excess giving colourless sol$^n$ | White ppt, insoluble in excess | $Al^{3+} + 3OH \rightarrow Al(OH)_3$ |
| Ammonium ($NH_4^+$) | Ammonia produced on warming | - | - |
| Calcium ($Ca^{2+}$) | White ppt, insoluble in excess | No ppt | $Ca^{2+} + OH \rightarrow Ca(OH)_2$ |
| Copper (II) ($Cu^{2+}$) | Light blue ppt, insoluble in excess | Light blue ppt, soluble in excess giving dark blue sol$^n$ | $Cu^{2+} + OH \rightarrow Cu(OH)_2$ |
| Iron (II) ($Fe^{2+}$) | Red-Brown ppt, insoluble in excess | Green ppt, insoluble in excess | $Fe^{2+} + OH \rightarrow Fe(OH)_2$ |
| Iron (III) ($Fe^{3+}$) | Red-brown ppt, insoluble in excess | Red-Brown ppt, insoluble in excess | $Fe^{3+} + OH \rightarrow Fe(OH)_3$ |
| Lead (II) ($Pb^{2+}$) | White ppt, insoluble in excess giving colourless sol$^n$ | White ppt, insoluble in excess | $Pb^{2+} + OH \rightarrow Pb(OH)_2$ |
| Zinc ($Zn^{2+}$) | White ppt, insoluble in excess giving colourless sol$^n$ | White ppt, insoluble in excess giving colourless sol$^n$ | $Zn^{2+} + OH \rightarrow Zn(OH)_2$ |

# ***03-Redox***

| **Reduction** | **Oxidation** |
|---|---|
| Gain of electrons | Loss of electrons |
| Gain of hydrogen | Loss of hydrogen |
| Loss of oxygen | Gain of oxygen |
| Decrease in oxidation state | Increase in Oxidation state |

| **Redox Agent** | **Itself** | **Other Substance** | **Example** |
|---|---|---|---|
| Oxidising Agent | Reduced | Oxidised | Potassium manganate (VII) ($KMnO_4$)<br>Potassium manganate (VI) |
| Reducing Agent | Oxidised | Reduced | Potassium Iodide ($KI$) |

**Common Redox Reagents**

| **Test For** | **Redox Reagent** | **Type of agent** | **Start Colour** | **Colour Change** |
|---|---|---|---|---|
| Reducing Agent | $KMnO_4$ | Oxidising Agent | Purple | Colourless |
| Reducing Agent | $K_2Cr_2O_7$<br>Potassium Dichromate (VI) | Oxidising Agent | Orange | Green |
| Oxidising Agent | $KI$ | Reducing Agent | Colourless | Brown |

**Test For Anions**

- Each anion is tested using different reagents
- Insoluble ppt formed are insoluble salts
- Colour of ppt formed must be described
- Acid is added in some tests to remove insoluble carbonates which form ppt

| **Anion** | **Test** | **Result** | **Ppt** | **Eqn** |
|---|---|---|---|---|
| Carbonate ($CO_3^{2-}$) | Add Dilute Nitric Acid | Effervescence $CO_2\ produced$ | - | $acid + carbonate \rightarrow salt + H_2O + CO_2$ |
| Chloride ($Cl^-$) | Acidify with dilute nitric acid, add aq silver nitrate | White ppt | Silver Chloride ($AgCl$) | $Ag^+ + Cl^- \rightarrow AgCl$ |
| Iodide ($I^-$) | Acidify with dilute nitric acid, add aq silver nitrate | Yellow ppt | Silver Iodide ($AgI$) | $Ag^+ + I^- \rightarrow AgI$ |
| Nitrate ($NO_3^-$) | Add aq sodium hydroxide, add aluminium foil. Warm carefully | $NH_3\ produced$ | - | - |
| Sulfate ($SO_4^{2-}$) | Acidify with dilute nitric acid, add aw barium nitrate | White ppt | Barium Sulfate($BaSO_4$) | $Ba^{2+} + SO_4^{2-} \rightarrow BaSO_4$ |
| | Acidify with dilute $HCl$, add aq barium chloride | | | |

**Test for Gases**

- Each gas is tested using different reagents
- Sulfur Dioxide will not be tested as too dangerous

| Gas | Test | Result |
|---|---|---|
| Ammonia ($NH_4$) | Damp red litmus paper | Turns Blue |
| Carbon Dioxide ($CO_2$) | Limewater | Turns Red |
| Chlorine ($Cl_2$) | Damp Litmus paper | Bleaches |
| Hydrogen ($H_2$) | Lighted Splint | Extinguished with 'pop' sound |
| Oxygen ($O_2$) | Glowing Splint | Relights |
| Sulfur Dioxide ($SO_2$) | Aq acidified $KMnO_4$ | Turns from purple to colourless |
| | Aq acidified $K_2Cr_2O_7$ | Turns from orange to green |

**Experiments on qualitative analysis**

Qualitative analysis experiments may involve identification of unknown ionic compound(s). More than 1 chemical test will be required.

**Practical tips**

- Tests for ions and gases are given in the 'Notes for Qualitative Analysis' provided at the back of the practical exam paper.
- It is advisable to memorise as many of the tests as possible.
- Record all observations and conclusions, including negative results.
- For negative results, write no visible change/ reaction or no gas produced.
- For any unknown chemical tests, perform the chemical test following the instructions given and record your observations (for example, colour of ppt or solution, effervescence, smell of gas). You do not need to write conclusions.

**Tests for gases**

- When effervescence is observed, cover the test tube opening with your thumb to prevent gas from escaping.
- Test for the most likely gas based on your knowledge of the compound. If you are not sure what gas is produced, try all tests for gases.

Safety Notes

- Ammonia, chlorine and sulfur dioxide are toxic gases.
- Point the opening of the test tube away from yourself and others to reduce exposure to toxic gases.
- Do not smell directly at the opening of the test tube. Do not place the opening of the test tube directly below your nose.
- Place the opening of the test tube near your nose.
- Use one hand to gently fan the gas from the opening of the test tube towards your nose.

**Test for ammonia and chlorine**

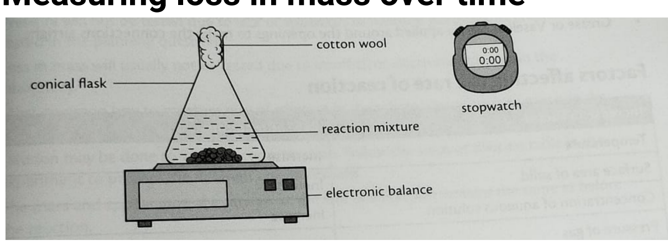
1. Put one drop of distilled water on one piece of litmus paper to moisten it before use.
2. You should smell the pungent smell of ammonia or chlorine gas.
3. Insert the damp litmus paper into the test tube or place it near the opening of the test tube
4. Make sure that the damp litmus paper does not touch the opening or sides of the test tube
5. If ammonia gas is present, the damp red litmus paper will turn blue.
6. If chlorine gas is present, the damp red or blue litmus paper will turn white.

# ***<u>04-Rate of Reaction</u>***

## Measuring Rate of Reaction

| **Method** | **Apparatus Required** | **Rate of Reaction** |
|---|---|---|
| Loss in mass over time | Stopwatch<br>Electronic Balance | $Rate = \frac{decrease\ in\ mass}{time}$ |
| Gas production over time | Stopwatch<br>Gas Syringe | $Rate = \frac{increase\ in\ gas\ volume}{time}$ |

**Measuring loss in mass over time**




*Cotton wool absorbs any aqueous reagent(s) which may spurt or splash upwards out of the conical flask.*
*This may happen if rate of reaction is very high and the effervescence is vigorous.*
*The cotton wool prevents loss of mass of reactants.*

*SAMPLE*

*Controlled variables: - mass of metal - surface area/length of metal*
*- Conc. of acid - type of acid - temp. Of acid*

1. Use a measuring cylinder to measure and pour 30cm³ of 2.0mol/dm³ HCl into a conical flask
2. Weigh 1.0g of magnesium powder *(any reasonable value that is constant)*
3. Pour all the magnesium powder into the conical flask. Immediately connect to empty gas syringe and start stopwatch. *(correctly drawn and labelled diagram)*
4. Record the volume of gas in the gas syringe every 10s for a total of 1 min. *(any reasonable alternatives between 5s to 30s. Use of datalogger to continuously record vol. of gas over time also accepted.)*

**Determining Rate of Reaction**

1. Plot a graph of volume of gas against time for each metal
2. Find the gradient of each graph at the start time (time = 0s)

   $The\ gradient\ gives\ rate\ of\ reaction.\ Gradient\ = \frac{volume\ of\ gas}{time}$

Or

1. Calculate the rate of reaction

   $Rate\ of\ Reaction = \frac{volume\ of\ gas}{time}$

**Experiments on rate of reaction**

Rate of reaction experiments usually involve 1 factor. Any factor, except pressure, may be tested in experiments.

The reaction in the question may be familiar or unfamiliar. Familiar reactions include reactions involving acid or alkali, redox reactions, displacement reactions. Displacement reactions are redox reactions.

The method to measure the rate of the reaction depends on the reaction. If the question involves an unfamiliar reaction, the method to measure the rate of reaction may be mentioned in the question.

All experiments on rate of reaction require a stopwatch to measure the time taken for the reaction to occur.

**Practical tips**

Pressure will not be tested due to lack of apparatus to measure gas pressure. Pressure may be tested in the planning question.

Loss in mass will usually not be tested due to insufficient electronic balances in the laboratory.

Most common way to measure the rate of reaction in the school laboratory is to measure the time taken for the reaction to finish or reach an end-point.

Dilution may be done to vary the concentration. Follow the steps or dilution table in the experiment to prepare the different concentrations.

The mass and appearance of a catalyst at the end of a reaction remains the same as before the reaction

OTHER TYPES OF PLANNING:

- A sample of 5 antacid tablets were accidentally left exposed to the air for a week. They absorbed water and became damp, forming solids with the formula $CaCO_3.xH_2O$.
  Outline a method to determine the value of $x$.
  Note any assumptions that you made.
  **Assumptions:**
  - Each antacid tablet contains the same mass of calcium carbonate.
  - Each antacid tablet contains the mass of calcium carbonate calculated
  - Increase in mass of tablets is due to water only
  - Each antacid tablet gained the same mass of water
  - All the water absorbed by the tablets combined with the calcium carbonate only

  **Finding the mass of water**

1. Measure the initial mass of 5 damp antacid tablets
2. Heat the 5 damp antacid tablets gently in a crucible or evaporating dish
3. Measure the final mass of 5 tablets
4. The different in mass is the mass of water

**Determining the value of $x$.**

1. Calculate the number of moles of water in 5 tablets
   $Number\ of\ moles\ =\ \frac{mass\ of\ water}{18}$.
2. Divide by 5 to get the number of moles of water by the number of moles of calcium carbonate to obtain $x$.