13 Practical Work

SYLLABUS

Internal Assessment of Practical Work

Candidates will be asked to observe the effect of reagents and/or of heat on substances supplied to them. The exercises will be simple and may include the recognition and identification of certain gases and ions listed below. The examiners will not, however, be restricted in their choice to substances containing the listed ions.

Gases : Hydrogen, Oxygen, Carbon dioxide, Chlorine, Hydrogen chloride, Sulphur dioxide, Hydrogen sulphide, Ammonia, Water vapour, Nitrogen dioxide.

Ions : Calcium, Copper, Iron, Lead, Zinc and Ammonium, Carbonate, Chloride, Nitrate, Sulphide, Sulphite and Sulphate.

Knowledge of a formal scheme of analysis is not required. Semi-micro techniques are acceptable but candidates using such techniques may need to adapt the instructions given to suit the size of the apparatus being used.

Candidates are expected to have completed the following minimum practical work.

1. Make a solution of the unknown substance : add sodium hydroxide solution or ammonium hydroxide solution, make observations and give your deduction. Warming the mixture may be needed. Choose from substances containing Ca^{2+}, Cu^{2+}, Fe^{2+}, Fe^{3+}, Pb^{2+}, Zn^{2+}, NH_4^+.
2. Supply a solution of a dilute acid and alkali. Determine which is acidic and which is basic, giving two tests for each.
3. Add concentrated hydrochloric acid to each of the given substances, warm, make observations, identify any product and make deductions :
   (a) copper oxide (b) manganese dioxide.
4. Use of *p*H in soil analysis, water analysis, medical field – simple identification with universal indicator.

13.1 RECOGNITION AND IDENTIFICATION OF GASES

Preparation of Gases	Recognition and Identification of Gas
1. Hydrogen *Add dilute HCl or dilute H_2SO_4 to the reactive metals* (metals above hydrogen in the activity series) *like magnesium, zinc, iron, etc.* Active metal + dil Acid → Salt + Hydrogen Mg + H_2SO_4 → $MgSO_4$ + H_2 Zn + 2HCl → $ZnCl_2$ + H_2	(a) The evolved gas is colourless, odourless and neutral to litmus. (b) Pure hydrogen burns with a **pale blue flame** when a burning splint is brought near it. (c) Hydrogen-air burns with a ***pop sound*** when a burning taper is brought near it.
2. Oxygen *Heat higher metallic oxides or metal nitrates* Heavy metal oxide $\xrightarrow{\Delta}$ Metal oxide/ Metal + oxygen $2Pb_3O_4 \xrightarrow{\Delta} 6PbO + O_2$ $2HgO \xrightarrow{\Delta} 2Hg + O_2$ Metal nitrates $\xrightarrow{\Delta}$ Metal oxide + Nitrogen dioxide + Oxygen $2Cu(NO_3)_2 \xrightarrow{\Delta} 2CuO + 4NO_2 + O_2$ $2Zn(NO_3)_2 \xrightarrow{\Delta} 2ZnO + 4NO_2 + O_2$	(a) The gas is colourless, odourless and neutral to litmus. (b) It ***rekindles a glowing splinter.*** (c) The gas is absorbed in colourless alkaline solution of pyrogallol and turns it dark brown.

Preparation of Gases	Recognition and Identification of Gas

3. Carbon dioxide

Heat metallic carbonate **(except sodium carbonate and potassium carbonate)** *or add dilute acid to any carbonate or hydrogen carbonate.*

Metallic carbonate $\xrightarrow{\Delta}$ Metal oxide + carbon dioxide

$ZnCO_3 \xrightarrow{\Delta} ZnO + CO_2$

$CuCO_3 \xrightarrow{\Delta} CuO + CO_2$

Metal carbonate/ *hydrogen* carbonate	+ Acid (dil)	→ Salt	+ Water	+ Carbon dioxide
$CaCO_3$	+ 2HCl	→ $CaCl_2$	+ H_2O	+ CO_2
$NaHCO_3$	+ HCl	→ NaCl	+ H_2O	+ CO_2

(a) The gas is colourless and odourless.

(b) It turns ***moist blue litmus faint red***.

(c) When the gas is passed through the lime water, it turns milky due to the formation of white precipitate of calcium carbonate.

$Ca(OH)_2 + CO_2 \rightarrow CaCO_3\downarrow + H_2O$

The milkiness disappears on passing excess of CO_2

$CaCO_3$ (ppt) $+ CO_2 + H_2O \rightarrow Ca(HCO_3)_2$ (Soluble)

(d) The gas has no effect on filter paper dipped in acidified $K_2Cr_2O_7$ or $KMnO_4$.

4. Chlorine

Add conc. HCl to oxidising agents like Pb_3O_4, PbO_2, MnO_2, etc.

Oxidising agent	+ Conc. HCl	→ Metal chloride	+ Water	+ Chlorine
Pb_3O_4	+ 8HCl	→ $3PbCl_2$	+ $4H_2O$	+ Cl_2
MnO_2	+ 4HCl	→ $MnCl_2$	+ $2H_2O$	+ Cl_2

(a) The gas is *greenish yellow* having a ***sharp pungent choking odour***.

(b) It turns a ***moist blue litmus paper red*** and finally bleaches *i.e.*, ***decolourises it***.

$Cl_2 + H_2O \rightarrow HCl + HClO$

$HClO \rightarrow HCl + [O]$

Colouring matter $+ [O] \rightarrow$ Colourless or bleached product

(c) It turns ***moist starch iodide paper (KI + Starch solution) blue black.***

$Cl_2 + 2KI \rightarrow 2KCl + I_2$

Starch $+ I_2 \rightarrow$ Blue black colour

(d) Pass the gas through ***silver nitrate solution***, a ***white ppt.*** is formed.

5. Hydrogen chloride

Add conc. H_2SO_4 to metal chlorides like NaCl, KCl, etc.

Metal chloride	+ Conc. sulphuric acid	→ Metal sulphate	+ Hydrogen chloride
NaCl	+ H_2SO_4	→ $NaHSO_4$	+ HCl
KCl	+ H_2SO_4	→ $KHSO_4$	+ HCl

(a) The gas is colourless with a pungent choking odour.

(b) The gas turns moist *blue litmus paper red.*

(c) If a glass rod dipped in ammonia solution is brought near the gas ***dense white fumes of ammonium chloride are formed.***

$NH_3(aq) + HCl \rightarrow NH_4Cl$

(d) Gas when passed through silver nitrate solution white precipitate is formed.

$AgNO_3(aq) + HCl \rightarrow AgCl\downarrow + HNO_3$

The ppt dissolves in excess of NH_4OH.

$AgCl + 2NH_4OH \rightarrow$ soluble compound $Ag(NH_3)_2Cl + 2H_2O$

6. Sulphur dioxide

Add dil. HCl or dil. H_2SO_4 to metallic sulphites.

Metal sulphite\ hydrogen sulphite	+ dil Acid	→ Salt	+ Water	+ Sulphur dioxide
Na_2SO_3	+ 2HCl	→ 2NaCl	+ H_2O	+ SO_2
Na_2SO_3	+ H_2SO_4	→ Na_2SO_4	+ H_2O	+ SO_2
$2NaHSO_3$	+ H_2SO_4	→ Na_2SO_4	+ $2H_2O$	+ $2SO_2$

(a) The gas is colourless with a smell of burning sulphur *i.e.*, suffocating odour.

(b) It turns moist blue litmus red and finally bleaches it.

(c) The gas turns lime water turbid (milky). (Similar to carbon dioxide).

$Ca(OH)_2 + SO_2 \rightarrow CaSO_3\downarrow + H_2O$

(d) It ***decolourises pink potassium permanganate solution.***

$2KMnO_4$ (pink) $+ 2H_2O + 5SO_2 \rightarrow K_2SO_4 + 2MnSO_4 + 2H_2SO_4$ (colourless)

(e) It changes ***orange/yellow solution of acidified potassium dichromate green.***

$K_2Cr_2O_7$ (orange) $+ H_2SO_4 + 3SO_2 \rightarrow Cr_2(SO_4)_3$ (green) $+ K_2SO_4 + H_2O$

(f) It has no effect on lead acetate paper.

Preparation of Gases	Recognition and Identification of Gas
7. Hydrogen sulphide *Add dil HCl or dil H_2SO_4 to metallic sulphides like ZnS, FeS.* Metal sulphide + dil Acid → Salt + Hydrogen sulphide $FeS + H_2SO_4 \rightarrow FeSO_4 + H_2S$ $ZnS + 2HCl \rightarrow ZnCl_2 + H_2S$	(a) The gas is colourless having a *foul smell of rotten eggs.* (b) It turns ***moist blue litmus red.*** (c) It turns ***lead acetate paper black.*** $(CH_3COO)_2Pb + H_2S \rightarrow PbS\downarrow + 2CH_3COOH$ (black) (d) It also turns ***lead nitrate solution black.*** $Pb(NO_3)_2 + H_2S \rightarrow PbS\downarrow + 2HNO_3$
8. Ammonia ***Add alkali to ammonium salt like ammonium chloride, ammonium sulphate.*** Ammonium salt + Alkali → Salt + Water + Ammonia $2NH_4Cl + Ca(OH)_2 \rightarrow CaCl_2 + 2H_2O + 2NH_3$ $NH_4Cl + NaOH \rightarrow NaCl + H_2O + NH_3$	(a) The gas is colourless with a sharp ***pungent characteristic smell.*** (b) It turns ***moist red litmus blue.*** (c) If a glass rod dipped in conc. HCl is brought near the gas, ***dense white fumes*** of ammonium chloride are formed. (d) The gas turns colourless ***Nesslers reagent*** *i.e.* (K_2HgI_4) potassium mercuric iodide brown.
9. Water vapour *Heat a crystalline substance like hydrated sodium carbonate or hydrated copper sulphate.* Hydrated salt $\xrightarrow{\Delta}$ Anhydrous salt + Water vapour $Na_2CO_3 \cdot 10H_2O \xrightarrow{\Delta} Na_2CO_3 + 10H_2O$ $CuSO_4 \cdot 5H_2O \xrightarrow{\Delta} CuSO_4 + 5H_2O$ (blue) (white)	(a) Colourless, odourless forms a clear liquid on the cooler parts of the test-tube. (b) The liquid is neutral to litmus. (c) This liquid ***turns anhydrous copper sulphate from white to blue.*** $CuSO_4 + 5H_2O \rightarrow CuSO_4 \cdot 5H_2O$ (white) (blue) (d) It turns blue cobalt chloride paper pink. $CoCl_2 + 6H_2O \rightarrow CoCl_2 \cdot 6H_2O$ (blue) (pink)
10. Nitrogen dioxide *Heat heavy metal nitrate like copper nitrate, lead nitrate.* Metal nitrate $\xrightarrow{\Delta}$ Metal oxide + Oxygen + Nitrogen dioxide $2Cu(NO_3)_2 \xrightarrow{\Delta} 2CuO + O_2 + 4NO_2$ $2Pb(NO_3)_2 \xrightarrow{\Delta} 2PbO + O_2 + 4NO_2$ **Note :** Sodium nitrate and potassium nitrate do not produce nitrogen dioxide on heating	(a) The gas is *brown* in colour having an irritating (pungent) odour and non-combustible. (b) It turns moist blue litmus paper red. (c) It turns starch Iodide paper from colourless to blue black. $2KI + 2NO_2 \rightarrow 2KNO_2 + I_2$ Turns potassium iodide paper brown. (d) It turns green ***acidified ferrous sulphate solution brown.***

13.2 RECOGNITION OF SUBSTANCES BY COLOUR, ODOUR, PHYSICAL STATE AND ACTION OF HEAT

A. Colour :

	Suspected ion
1. Blue or bluish green colour.	Cu^{2+}
2. Light green colour.	Fe^{2+}
3. Yellow or yellowish brown.	Fe^{3+}
4. White colour (or colourless).	Pb^{2+}, Zn^{2+}, Ca^{2+} Na^+, K^+, or NH_4^+

B. Odour :

1. Smell of ammonia gas.	NH_4^+
2. Smell of hydrogen sulphide gas.	S^{2-}
3. Smell of sulphur dioxide gas.	SO_3^{2-}

C. State :

1. Amorphous salt.	CO_3^{2-}
2. Hygroscopic or deliquescent nature.	Cl^- or NO_3^-

D. Action of Heat :

1. **Ammonium salt** when heated with alkali (except ammonium hydroxide) produces Ammonia gas. Ammonium nitrate (explosive) and Ammonium chloride leaves no residue behind on heating. Ammonium dichromate on heating leaves greenish grey mass.

   $(NH_4)_2Cr_2O_7 \xrightarrow{\Delta} Cr_2O_3 + N_2 + 4H_2O.$
   (orange) greenish grey

2. PbO_2, Pb_3O_4, HgO, KNO_3, $NaNO_3$ on heating produces oxygen gas.
3. Carbonate and bicarbonate on heating evolves carbon dioxide (except K_2CO_3 and Na_2CO_3).
4. Hydrated salts on heating produces water vapour.
5. Sulphites and some sulphates when heated produce sulphur dioxide gas.
6. Lead compounds decompose to give **lead monoxide PbO (litharge).**
   PbO is brown when hot, yellow when cold and sticks to the glass test tube.
7. Zinc compounds decompose on heating to give zinc oxide. $ZnCO_3 \rightarrow ZnO + CO_2$

   Zinc oxide is yellow when hot, white when cold. $ZnO \underset{\text{Cool}}{\overset{\Delta}{\rightleftharpoons}} ZnO$
   white yellow
8. Copper compounds decompose to give black copper oxide. $CuCO_3 \xrightarrow{\Delta} CuO + CO_2$
   (green) (black)

Note : **Dry test** involves – colour, density, physical state, dry heating and flame test.
Wet test involves adding reagents to identify the substance.

Table of solubility of salts and bases in water (Roman numerals indicate the valency of the radical or metal)

Cation→ Anion ↓	K (I)	Na (I)	Ba (II)	Ca (II)	Mg (II)	Al (III)	Zn (II)	Fe (II)	Fe (III)	Mn (II)	Pb (II)	Cu (II)	Ag (I)	Hg (II)
NO_3(I)	S	S	S	S	S	S	S	S	S	S	S	S	S	S
CH_3COO(I)	S	S	S	S	S	Sp	S	S	S	S	S	S	S	S
Cl(I)	S	S	S	S	S	S	S	S	S	S	N	S	N	N
SO_4(II)	S	S	N	Sp	S	S	S	S	S	S	N	S	Sp	S
OH(I)	S	S	S	Sp	Sp	N	N	N	N	N	N	N	—	—
S(II)	S	S	S	Sp	S	—	N	N	—	N	N	N	N	N
SO_3(II)	S	S	N	N	N	—	N	—	N	N	N	N	N	N
PO_4(III)	S	S	N	N	N	N	N	N	N	N	N	N	N	N
CO_3(II)	S	S	N	N	N	—	N	N	N	N	N	N	N	N

Note : S : Soluble; N : Insoluble; — : Does not exist; Sp : Sparingly soluble

13.3 IDENTIFICATION OF IONS

Identification of ions is usually done in solution state.

Salt is dissolved in water to make solution. If the salts do not dissolve in water then Nitric acid is added to form nitrate. All nitrates are soluble in water.

Cations are tested by the action of alkalies as they give characteristic coloured metallic hydroxide precipitates (see chapter 4). When adding the alkali, add it slowly at first (one drop at a time). If it is added too quickly, it is easy to miss a precipitate that redissolves in excess.

Anions are tested by the reaction of acids or by specific reagents.

IDENTIFICATION OF CATIONS BY ACTION OF ALKALIES (SEE CHAPTER 4 ALSO)

Sodium hydroxide solution			Ammonia solution		
Metal	***Colour of precipitate***	***With excess sodium hydroxide solution***	***Metal***	***Colour of precipitate***	***With excess ammonium hydroxide solution***
Calcium	White curdy	Insoluble	Calcium	No ppt.	No change
Lead	White chalky	Soluble	Lead	White chalky	Insoluble
Zinc	White gelatinous	Soluble	Zinc	White gelatinous	Soluble
Copper	Pale blue	Insoluble	Copper	Pale blue	Soluble - deep blue solution
Iron (II)	Pale green turning brown	Insoluble	Iron (II)	Pale green turning brown	Insoluble
Iron (III)	Reddish brown	Insoluble	Iron (III)	Rust (brown)	Insoluble

Test for NH_4^+ salt

(i) When caustic alkali (NaOH or KOH) is added to any ammonium salt, ammonia gas is evolved.

(ii) If Nessler's reagent is added to any ammonium salt solution, it turns brown.

IDENTIFICATION OF ANIONS

(A) By adding dilute sulphuric acid

	Experiment	Observation	Inference
1. (a)	Take a small quantity of salt in a test tube and add dilute H_2SO_4. Warm, if no action in cold.	Brisk effervescence and a *colourless* and *odourless* gas evolved. It *does not support* combustion *i.e.*, burning splinter get extinguished. It turns *moist blue litmus faint red.*	The gas evolved is carbon dioxide. The salt contains **Carbonate** ion (CO_3^{2-}).
(b)	Pass the gas through lime water.	Lime water turns milky.	
(c)	To the above precipitate, pass the gas in excess or add dilute nitric acid in excess.	The white precipitate dissolves to form colourless solution.	
2. (a)	Take a small quantity of salt in a test-tube and add dil. H_2SO_4 acid.	**Rotten egg smelling** gas evolved. It turns moist blue litmus paper red.	The gas evolved is hydrogen Sulphide.
(b)	Bring a moist lead acetate paper near the gas.	Moist lead acetate paper **turns black.**	The salt contains **Sulphide** ion (S^{2-}).
3. (a)	Take a small quantity of salt in a test-tube and add dilute H_2SO_4 acid (warm if necessary).	Gas evolved has **suffocating odour of burning sulphur.**	The gas evolved is Sulphur dioxide.
(b)	Bring a filter paper moistened with acidified $K_2Cr_2O_7$ (Potassium dichromate) near the gas.	**Golden yellow or orange** colour paper turns **green.**	The salt contains **Sulphite** ion (SO_3^{2-}).

(B) By adding concentrated sulphuric acid

	Experiment	Observation	Inference
1. (a)	Take a small amount of salt in a test-tube and add conc. H_2SO_4. Warm it gently.	Colourless gas (HCl) evolves with *pungent* odour.	***Chloride** ion (Cl^-)* may be present.
(b)	Bring a glass rod carrying a drop of ammonia solution near the gas evolved in (a).	*Dense white fumes* are produced.	***Chloride** ion (Cl^-)* confirmed.
(c)	Add a pinch of manganese dioxide to the salt followed by conc. H_2SO_4 and heat.	Greenish yellow gas evolves with a pungent odour, and turns moist starch iodide paper blue black.	***Chloride** ion (Cl^-)* confirmed.
(d)	Add silver nitrate ($AgNO_3$) solution	White precipitate of AgCl is formed which dissolves in excess of NH_4OH.	***Chloride** ion (Cl^-)* confirmed.
2. (a)	Take a small amount of salt in a test-tube and add conc. H_2SO_4 and warm gently.	*Reddish brown fumes* evolve. The fumes becomes thick on adding copper turnings.	The gas evolved is nitrogen dioxide and salt contains. ***Nitrate** (NO_3^-)*
(b)	To the salt solution, add freshly prepared ferrous sulphate solution, then cautiously pour a few drops of conc. H_2SO_4 along the side of the test tube. **This test is known as *brown ring-test.***	A *brown ring appears* at the junction of the two liquid layers. The brown ring disappears on shaking.	***Nitrate** ion (NO_3^-)* confirmed.

(C) Test for sulphate ion

	Experiment	Observation	Inference
1.	To the salt solution, add little nitric acid and then add barium chloride solution.	White precipitate is obtained, which is insoluble in mineral acid.	***Sulphate** ion (SO_4^{2-})* is confirmed.
2.	To the solution, add acetic acid and lead acetate solution.	White precipitate is obtained, which is soluble in excess of ammonium acetate solution.	***Sulphate** ion (SO_4^{2-})* confirmed.

General Identification of Anions

	Add to the salt or salt solution	Observation	Anion Present
1.	dil HCl or dil H_2SO_4 and heat	(i) Carbon dioxide gas is evolved. (ii) Sulphur dioxide gas is evolved. (iii) Hydrogen Sulphide gas is evolved.	CO_3^{2-} SO_3^{2-} S^{2-}
2.	Conc. H_2SO_4 and heat	(i) Hydrogen chloride gas is evolved. (ii) Nitrogen dioxide gas is evolved.	Cl^- NO_3^-
3.	Silver Nitrate solution	Curdy white ppt., is insoluble in dil. HNO_3 but dissolves in NH_4OH	Cl^-
4.	Lead acetate solution	White ppt insoluble in dil. HCl, dil. HNO_3	SO_4^{2-}
5.	Barium nitrate solution or Barium chloride solution	(i) White precipitate soluble in dil. HCl or dil. HNO_3. (ii) White precipitate insoluble in dil. HCl or dil. HNO_3.	CO_3^{2-} or SO_3^{2-} SO_4^{2-}

13.4 DISTINCTION BETWEEN COLOURLESS SOLUTIONS OF DILUTE ACIDS AND ALKALIS.

	TEST	ACID SOLUTION	ALKALIS
1. (a)	Moist litmus paper	*Blue turns red*	*Red turns blue*
(b)	Methyl orange	Orange turns *pink*	Orange turns *yellow*
(c)	Phenolphthalein	Colourless remains *colourless*	Colourless turns *pink*
2.	**Chemical tests**		
(a)	On adding sodium carbonate	Carbon dioxide is evolved [test with lime water]	Carbon dioxide is not evolved
(b)	On adding ammonium carbonate	No ammonia gas evolved	Ammonia gas evolved [test with red litmus and bring glass rod dipped in HCl in contact with the gas]

13.5 DISTINGUISH BETWEEN BLACK COPPER OXIDE AND BLACK MANGANESE DIOXIDE

	Experiment	Manganese dioxide	Copper oxide
(a)	Add conc. HCl to black powder and heat.	Greenish yellow gas *chlorine* is evolved.	Chlorine gas is not evolved.
(b)	Filter the above solution.	*Filtrate* is brownish in colour.	*Filtrate* is bluish in colour.
(c)	On adding ammonium hydroxide to the above *filtrate*.	No precipitate is formed.	The pale blue precipitate is formed, which is soluble in excess of ammonium hydroxide, giving an azure blue colour (deep blue) to the solution.

13.6 FLAME TEST

Procedure : Concentrated HCl is added to the salt to form a paste and to convert the salt into its chloride, since chlorides of metals generally volatize and ionize when heated giving a characteristic colour in the non luminous flame of a bunsen burner.

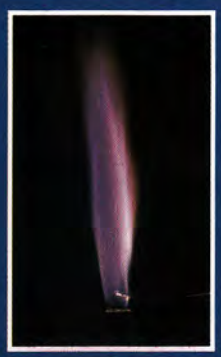
A thin platinum wire is first cleaned thoroughly by **dipping** it into the **concentrated hydrochloric acid**. It is then heated in the non-luminous flame of the burner. *When the wire imparts no colour to the flame, it is ready for use.* Now, a little paste of the substance is taken on the wire. It is then introduced into the non-luminous part of the flame and colour imparted to the flame is observed.

Table 13.1 : Colour imparted to the flame by salts of different metals

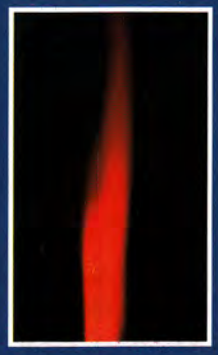
	Colour imparted to the flame (Colour observed with naked eye)	Colour seen through the blue glass.	Name of metal
(a)	Golden yellow (persistent)	Yellow colour vanishes.	***Sodium ion*** (Na^+)
(b)	Violet (Lilac)	Violet or pink.	***Potassium ion*** (K^+)
(c)	Brick red	Light green.	***Calcium ion*** (Ca^{2+})
(d)	Peacock bluish green	Bluish green.	***Copper ion*** (Cu^{2+})

FLAME TESTS — COLOURS

SODIUM SALT
Golden Yellow Flame



POTASSIUM SALT
Lilac Flame



CALCIUM SALT
Brick Red Flame

COPPER SALT
Peackock Bluish Green Flame

13.7 HYDROGEN ION SCALE OR THE *PH* SCALE (Refer Chapter 3)

The acidic and basic strengths of solutions are compared on the hydrogen ion scale or the pH scale, and gives a value called pH value.

A solution of *p*H 7 is neutral (water), less than 7 is acidic and more than 7 is basic.

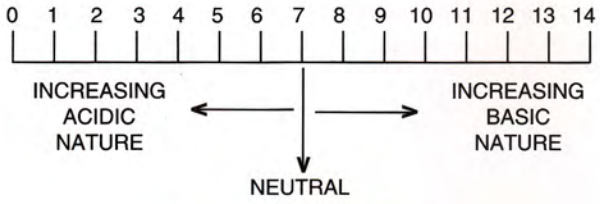


Fig. 13.1 The pH scale.

13.8 INDICATORS

Indicator	Colour in neutral solution	Colour in acidic solution	Colour in alkaline solution
Litmus	Purple	Red	Blue
Methyl orange	Orange	Pink	Yellow
Phenolphthalein	Colourless	Colourless	Pink
Alkaline phenolphthalein	Pink	Colourless	Pink

Universal indicator

It gives different colours with solutions of different *p*H values. Thus, *one universal indicator produces a green colour in neutral solution, p*H = 7. *It changes in basic solution from blue to indigo and to violet when p*H *increases from 7 to 14.* The colour change in acidic solution is from yellow to pink and then to red as *p*H decreases from 7 to 1 (Fig. 13.2).

Experiment : *How to find the pH of different substances ?*

Make solution of the substance to be tested and put a drop of it on *p*H paper. *For example* take hydrochloric acid, distilled water, sodium hydroxide solution, and ammonium hydroxide on different strips of *p*H paper. You will observe different shades on different strips. By comparing the colours given by the manufacturer, you can find the *p*H of different solutions.

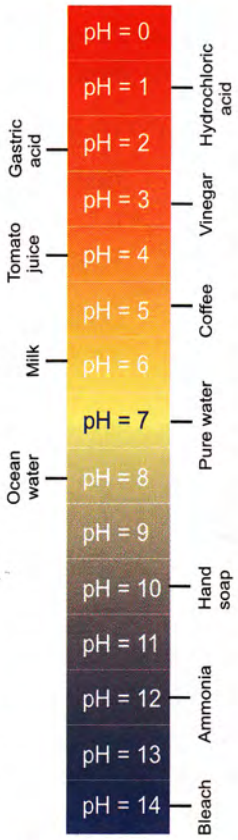


Fig. 13.2. Colour changes of universal indicator at different pH values

EXERCISE

1. (a) Give only one suitable chemical test to identify the following gases.
   (i) Ammonia (ii) Sulphur dioxide
   (iii) Hydrogen chloride (iv) Chlorine
   (v) Carbon dioxide (vi) Oxygen
   (vii) Hydrogen

   (b) Select a basic gas mentioned in Q.1 (a). How is the basic nature suspected ?

   (c) Select acidic gases from the gases mentioned in Q.1(a). How is the acidic nature suspected?

   (d) The two gases A and B are bleaching agents. A is greenish yellow and bleaches due to its oxidising

property while B a colourless gas bleaches due to reduction. Identify A and B.

(e) Which gas turns blue cobalt chloride paper light pink ?

Give one similarity in test between (i) Cl_2 and HCl (ii) SO_2 and CO_2.

2. Name the gases which

(a) extinguishes burning wooden splinter.

Ans. : NH_3, HCl, SO_2, H_2S, CO_2, NO_2, Cl_2.

(b) turns moist red litmus blue.

(c) do no effect moist litmus.

(d) affects the acidified $K_2Cr_2O_7$ paper and also turns lime water dirty milky.

3. Name :

(a) Two carbonates which do not produce carbon dioxide on heating.

(b) A colourless gas which bleaches

(c) Gases which have sour taste

(d) Greenish yellow gas which also bleaches

(e) Gas with rotten egg smell.

4. From the following list of substances *choose* those which meet the description given in part (a) below. Ammonium chloride, ammonium nitrate, chlorine, dilute hydrochloric acid, iron, lead nitrate, manganese (IV) oxide, silver nitrate, sodium nitrate, sodium nitrite and sulphur.

Two compounds whose aqueous solutions give white precipitates with dilute hydrochloric acid.

5. Name the *anion* present in each of the following compounds :

(a) Compound A when warmed with concentrated sulphuric acid gives a gas which fumes in moist air and which gives dense white fumes with ammonia.

(b) When barium chloride solution is added to a solution of compound B, a white precipitate insoluble in dilute hydrochloric acid is formed.

(c) The action of heat on the insoluble compound C produces a gas which turns lime water turbid.

(d) Compound D when warmed with dilute sulphuric acid gives a gas which turns acidified dichromate solution green.

6. A given white crystalline salt was tested as follows :

(a) It dissolved in water and the resulting solution of the salt turned blue litmus red.

(b) Addition of barium chloride solution into this solution gave a white precipitate.

(c) A flame test on the salt gave a persistent golden-yellow colourisation.

What conclusions can be drawn for each observation ?

7. (a) Sodium hydroxide solution is added to solution A. A white precipitate is formed which is insoluble in excess sodium hydroxide solution. Name the metal ion present in solution A.

(b) When ammonium hydroxide is added to solution B, a pale blue precipitate is formed. This pale blue precipitate dissolves in excess ammonium hydroxide giving an inky blue solution. Name the cation present in solution B.

(c) When an ammonium salt is warmed with sodium hydroxide solution, ammonia gas is evolved. State *three* ways in which you could identify this gas.

8. Complete the following table and write your observations.

	Hydrogen sulphide	Ammonia	Sulphur dioxide	Hydrogen chloride
Shake the gas with red litmus solution				
Shake the gas with blue litmus solution				
Apply a burning splint to the gas				

9. Use the information given in (a) to (h) to identify the substances P to W selecting your answers from the given list.

List :

Calcium	Oxygen	Copper (II) oxide
Carbon	Calcium hydroxide	Copper (II) nitrate
Lead (II) oxide	Hydrogen chloride	Chlorine
Lead (II) nitrate	Calcium oxide	Ammonium chloride

(a) P is a white solid. When heated produces white fumes (sublime).

(b) P and R on warming produce an alkaline gas.

(c) On adding water to T, heat is evolved and R is formed.

(d) Q burns brightly in air to form T.

(e) When S is heated, it gives off brown fumes and leaves a black residue of U.

(f) A solution of S is formed by warming U with dilute nitric acid.

(g) V is a gaseous non metallic element that reacts with hydrogen to form W.

(h) A solution of W will neutralise the solution of R.

10. Copy and complete the following table which refers to the action of heat on some carbonates :

Carbonate	Colour of residue on cooling
Zinc carbonate	
Lead carbonate	
Copper carbonate	

11. Distinguish by a chemical test,

(a) Sodium carbonate and sodium sulphite

(b) Sodium chloride and sodium sulphide

(c) Sodium hydroxide solution and ammonium hydroxide solution.

(d) Ammonium sulphate and sodium sulphate.

(e) Sulphuric acid from nitric acid and hydrochloric acid.

12. Sodium hydroxide solution is added first in a small quantity, then in excess to the *aqueous salt solutions* of copper (II) sulphate, zinc nitrate, lead nitrate, calcium chloride and iron (III) sulphate. Copy the following table and write the colour of the precipitate in (i) to (v) and the nature of the precipitate (soluble or insoluble) in (vi) to (x).

Aqueous salt solution	Colour of precipitate when NaOH is added in a small quantity	Nature of precipitate (soluble or insoluble) when NaOH is added in excess
Copper (II) sulphate	(i)	(vi)
Zinc nitrate	(ii)	(vii)
Lead nitrate	(iii)	(viii)
Calcium chloride	(iv)	(ix)
Iron (III) sulphate	(v)	(x)

13. State your observations when :

(a) lead nitrate solution and sodium chloride solution are mixed.

(b) zinc chloride solution, zinc nitrate solution and zinc sulphate solutions are added individually to

(i) barium chloride solution,

(ii) lead nitrate solution.

(c) Decomposition of bicarbonates by dil. H_2SO_4

$2NaHCO_3 + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O + 2CO_2$

$2KHCO_3 + H_2SO_4 \rightarrow K_2SO_4 + 2H_2O + 2CO_2$

14. The questions (i) to (v) refer to the following salt solutions listed A to F.

A. Copper nitrate B. Iron (II) sulphate

C. Iron (III) chloride D. Lead nitrate

E. Magnesium sulphate F. Zinc chloride

(i) Which two solutions will give a white precipitate when treated with dilute hydrochloric acid followed by barium chloride solution?

(ii) Which two solutions will give a white precipitate when treated with dilute nitric acid followed by silver nitrate solution?

(iii) Which solution will give a white precipitate, when either dilute hydrochloric acid or dilute sulphuric acid is added to it?

(iv) Which solution becomes a deep/inky blue colour when excess of ammonium hydroxide is added to it?

(v) Which solution gives a white precipitate with excess ammonium hydroxide solution?

15. Mention the colour changes observed when the following indicators are added :

Solution	Acids	Alkalies
(a) Alkaline phenolphthalein solution,		
(b) Methyl orange solution,		
(c) Neutral litmus solution.		

16. Salts A, B, C, D and E undergo reactions (i) to (v) respectively. Identify the anion present in these salts on the basis of these reactions.

(a) When silver nitrate solution is added to a solution of A, a white precipitate, insoluble in dilute nitric acid, is formed.

(b) Addition of dilute hydrochloric acid to B produces a gas which turns lead acetate paper black.

(c) When a freshly prepared solution of ferrous sulphate is added to a solution of C and concentrated sulphuric acid is gently poured from the side of the test-tube, a brown ring is formed.

(d) When dilute sulphuric acid is added to D, a gas is produced which turns acidified potassium dichromate solution from orange to green.

(e) Addition of dilute hydrochloric acid to E produces an effervescence. The gas produced turns limewater milky but does not affect acidified potassium dichromate solution.

2008

(a) The salt which in solution gives a pale green precipitate with sodium hydroxide solution and a white precipitate with barium chloride solution is :

(i) Iron (III) sulphate (ii) Iron (II) sulphate
(iii) Iron (II) chloride (iv) Iron (III) chloride

(b) Identify the following substances :
(i) An alkaline gas A which gives dense white fumes with hydrogen chloride.
(ii) A dilute acid B which does not normally give hydrogen when reacted with metals but does give a gas when it reacts with copper.
(iii) Gas C has an offensive smell like rotten eggs.
(iv) Gas D is a colourless gas which can be used as a bleaching agent.
(v) Liquid E can be dehydrated to produce ethene.

2009

(a) Carbon dioxide and sulphur dioxide gas can be distinguished by using.
(i) moist blue litmus paper
(ii) lime water
(iii) acidified potassium dichromate paper
(iv) none of the above.

(b) Identify the substance 'R' based on the information given below :

The pale green solid 'R' turns reddish brown on heating. Its aqueous solution gives a white precipitate with barium chloride solution. The precipitate is insoluble in mineral acids.

(c) Give one chemical test to distinguish between the following pairs of compounds.
(i) Zinc sulphate soln. and zinc chloride soln.
(ii) Iron (II) chloride soln. and iron (III) chlorde soln.
(iii) Calcium nitrate soln. and calcium chloride soln.

2010

(a) Select the correct answer from A, B, C, D and E.
A. Nitroso iron (II) sulphate B. Iron (III) chloride
C. Chromium sulphate D. Lead (II) chloride
E. Sodium chloride.

The compound which is responsible for the green colour formed when SO_2 is bubbled through acidified potassium dichromate solution.

(b) State your observation :
(i) a piece of moist blue litmus paper.
(ii) paper soaked in potassium permanganate solution – is introduced in each case into a jar of sulphur dioxide.

(c) Write the equation for the reaction of magnesium sulphate solution with barium chloride solution.

2011

(a) Choose from the list of substances – Acetylene gas, aqua fortis, coke, brass, barium chloride, bronze, platinum.

An aqueous salt solution used for testing sulphate radical.

2012

(a) Name – the gas which turns acidified potassium dichromate solution green.

(b) Identify the anion present in the following compounds :
(i) Compound X on heating with copper turnings and conc. sulphuric acid liberates a reddish brown gas.
(ii) When a solution of compound Y is treated with silver nitrate solution a white precipitate is obtained which is soluble in excess of ammonium hydroxide solution.
(iii) Compound Z which on reacting with dilute sulphuric acid liberates a gas which turns lime water milky, but the gas has no effect on acidified potassium dichromate solution.
(iv) Compound L on reacting with barium chloride solution gives a white precipitate insoluble in dilute hydrochloric acid or dilute nitric acid.

(c) State one chemical test between each of the following pairs :
(i) Sodium carbonate and sodium sulphite.
(ii) Ferrous nitrate and lead nitrate.
(iii) Manganese dioxide and copper (II) oxide.

(d) State your observation : A zinc granule is added to copper sulphate solution.

(e) Give balanced equation for the reaction : Silver nitrate solution and sodium chloride solution.

2013

(a) Give a chemical test to distinguish between :
(i) Sodium chloride soln. and sodium nitrate soln.
(ii) Hydrogen chloride gas and hydrogen sulphide gas.
(iii) Calcium nitrate soln. and zinc nitrate soln.
(iv) Carbon dioxide gas and sulphur dioxide gas.

(b) Which one of the following will not produce an acid when made to react with water.
(i) Carbon monoxide (ii) Carbon dioxide
(iii) Nitrogen dioxide (iv) Sulphur trioxide

2014

(a) Distinguish between : Sodium nitrate and sodium sulphite [using dilute sulphuric acid].

(b) State your observation : When moist starch iodide paper is introduced into chlorine gas.

(c) The flame test with a salt P gave a brick red flame. What is the cation in P.

(d) A gas Q turns moist lead acetate paper silvery black. Identify the gas Q.

(e) pH of liquid R is 10. What kind of substance is R ?