

SYLLABUS

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 listed below.

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

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

Simple experiments on:

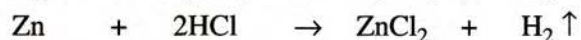
- (i) Action of heat on the following compounds:
 - (a) copper carbonate, zinc carbonate
 - (b) washing soda, copper sulphate crystals
 - (c) zinc nitrate, copper nitrate, lead nitrate
 - (d) ammonium chloride, iodine, ammonium dichromate
 Make observations, identify the products and make deductions where possible.
- (ii) Action of dilute sulphuric acid on the following substances. (warm if necessary)
 - (a) a metal
 - (b) a carbonate
 - (c) a sulphide
 - (d) a sulphite
 Make observations, identify the gas evolved and make deductions.
- (iii) Apply the flame test to identify the metal in the unknown substance.
 - (a) a sodium salt
 - (b) a potassium salt
 - (c) a calcium compound
- (iv) Simple experiments based on hard water and soft water – identification of hardness – simple softening – by heating the temporary hard water, using washing soda and advantage of using detergents over soap in hard water.
- (v) Find out the sources of pollution of water bodies in the locality. Suggest preventive steps to control it.

I. RECOGNITION AND IDENTIFICATION OF GASES

1. Hydrogen

Preparation : Add dilute HCl or dilute H_2SO_4 to reactive metals (metals above hydrogen in the activity series) like magnesium, zinc, iron, etc.

Active metal + dil Acid $\rightarrow$ Salt + Hydrogen



Recognition and Identification of Gas

- (a) The evolved gas is colourless, odourless
- (b) Neutral to litmus.
- (c) Pure hydrogen burns with a **pale blue flame** when a burning splint is brought near it.

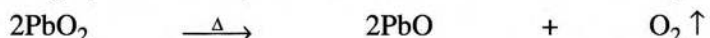
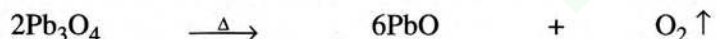


- (d) Hydrogen mixed with air burns with a **pop sound** when a burning taper is brought near it.

2. Oxygen

Preparation : Heat heavy metallic oxides

Heavy metal oxide $\xrightarrow{\Delta}$ Metal oxide/Metal + Oxygen



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

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



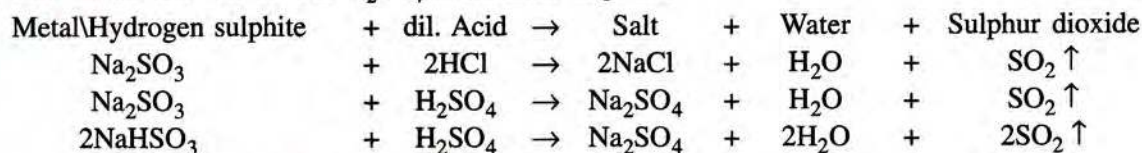
(d) When the gas is passed through silver nitrate solution, a white precipitate of silver chloride is formed.



The precipitate dissolves in excess NH_4OH .

6. Sulphur dioxide

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



Recognition and Identification of Gas

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

(b) Burning wooden splinter is extinguished in sulphur dioxide.

(c) It turns moist blue litmus red and finally bleaches it. This bleaching is temporary.

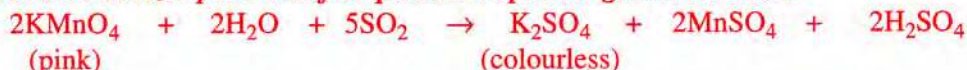
(d) The gas turns lime water turbid (milky). (Similar to carbon dioxide).



Milkiness disappears on passage of excess of sulphur dioxide.



(d) It *decolourizes pink acidified potassium permanganate solution*.



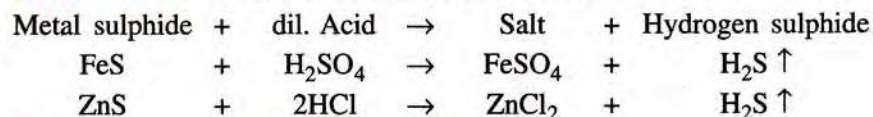
(e) It changes *orange/yellow solution of acidified potassium dichromate green*.



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

7. Hydrogen sulphide

Preparation : Add dil. HCl or dil. H_2SO_4 to metallic sulphides like ZnS , FeS , etc.



Recognition and Identification of Gas

(a) The gas is colourless with a *foul smell as of rotten eggs*.

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

(c) It turns *lead acetate paper black*.

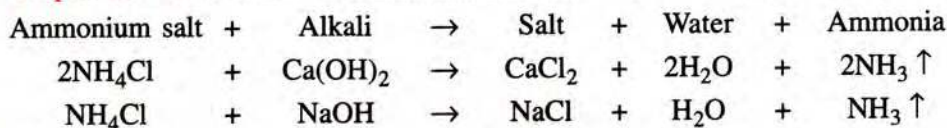


(d) It also turns *lead nitrate solution black*.



Note : H_2S also turns acidified potassium permanganate from pink to colourless and acidified potassium dichromate from orange to green but as yellow sulphur is also present the solution is not clear.

Preparation : Add alkali to ammonium salt like ammonium chloride or ammonium sulphate.

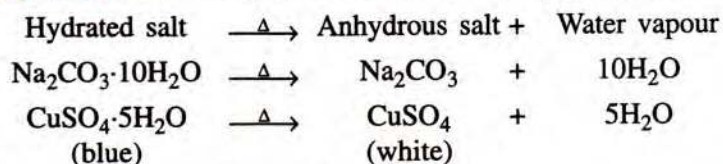


Recognition and Identification of Gas

- The gas is colourless with a **characteristic sharp, pungent smell**.
- It turns **moist red litmus blue**.
- If a rod dipped in conc. HCl is brought near the gas, **dense white fumes** of ammonium chloride are formed.
- The gas turns colourless **Nessler's reagent**, i.e. (K₂HgI₄) potassium mercuric iodide, brown.
- On passing the gas through a solution of copper sulphate, pale blue precipitate is formed, on passing excess ammonia this precipitate dissolves to form a dark blue solution.

9. Water vapour

Preparation : Heat a crystalline substance like hydrated sodium carbonate or hydrated copper sulphate.

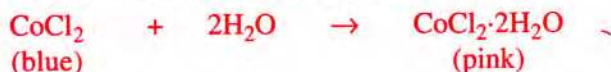


Recognition and Identification of Gas

- Colourless and odourless vapours condense to form a clear liquid on the cooler part of the test-tube.
- The liquid is neutral to litmus.
- This liquid **turns anhydrous copper sulphate from white to blue**.

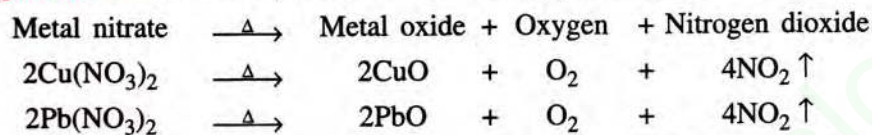


- It turns blue cobalt chloride paper pink.



10. Nitrogen dioxide

Preparation : Heat a heavy metal nitrate like copper nitrate or lead nitrate.



Note : Sodium nitrate and potassium nitrate do not produce nitrogen dioxide when they are heated.

Recognition and Identification of Gas

- The gas is **brown** in colour, has an irritating (pungent) odour and is non-combustible.
- It turns moist blue litmus paper red.
- It liberates iodine (violet vapours) from potassium iodide (KI) solution or turns potassium iodide paper brown.



- It turns green **acidified ferrous sulphate solution brown**.

S. NO.	GAS	COLOUR	ODOUR	NATURE
1.	Hydrogen (H_2)	Colourless	Odourless	Neutral
2.	Oxygen (O_2)	Colourless	Odourless	Neutral
3.	Carbon dioxide (CO_2)	Colourless	Odourless	Acidic
4.	Chlorine (Cl_2)	Greenish yellow	Pungent	Acidic
5.	Hydrogen chloride (HCl)	Colourless	Pungent	Acidic
6.	Sulphur dioxide (SO_2)	Colourless	Burning sulphur	Acidic
7.	Hydrogen sulphide (H_2S)	Colourless	Rotten eggs	Acidic
8.	Ammonia (NH_3)	Colourless	Sharp pungent	Basic
9.	Water vapour (H_2O)	Colourless	Odourless	Neutral
10.	Nitrogen dioxide (NO_2)	Brown	Irritating	Acidic

EXERCISE 9 (A)

1. (a) Give a 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 verified ?

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

- (d) State the gas responsible for the bleaching action.

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

2. What is observed on performing the following :

	Hydrogen	Oxygen	Carbon dioxide	Chlorine
Litmus test				
Apply burning splint to the gas				
Colour of gas	colourless	colourless	colourless	greenish yellow
Odour of gas				

3. Give a chemical test to distinguish between the following gases.

- (a) H_2 and CO_2 (b) H_2 and O_2
(c) CO_2 and SO_2 (d) HCl and H_2S

- (e) HCl and Cl_2 (f) NH_3 and HCl

- (g) SO_2 and Cl_2 (h) NH_3 and SO_2

4. Name the gas that

- (a) turns moist starch iodide paper blue black.

- (b) turns moist red litmus blue.

- (c) does not affect acidified $K_2Cr_2O_7$ paper but turns lime water milky.

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

5. What do you observe when

- (a) CO_2 is passed through lime water first and then a little in excess.

- (b) HCl is passed through silver nitrate solution.

- (c) H_2S is passed through lead nitrate solution.

- (d) Cl_2 is passed through potassium iodide (KI) solution.

- (e) Cobalt chloride paper is introduced in water vapour.

Write balanced equations for each of the above.

6. Name :

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

- (b) Two nitrates that do not produce nitrogen dioxide on heating.

- (c) A brown gas.

- (d) A greenish yellow gas.

- (e) A gas with rotten egg smell.

II. ACTION OF HEAT ON A GIVEN (UNKNOWN) SUBSTANCE

On heating, salts undergo characteristic changes. Some give off water of crystallization, while some decompose to give off gas/vapour. Some salts change their colour on heating, while some others sublime. Careful observation of changes and identification of gases evolved give information that helps to identify the salt.

Observation	Identification of substance
A1. i) <i>Light green amorphous powder</i> turns to <i>black</i>, on strong heating. ii) Gives off a colourless, odourless gas that extinguishes a burning wooden splinter. iii) Turns lime water milky. iv) The gas has no effect on acidified $K_2Cr_2O_7$ or acidified $KMnO_4$.	$CuCO_3 \xrightarrow{\Delta} CuO + CO_2$ (Black) Residue is copper oxide. Gas evolved is carbon dioxide. Deduction : Light green powder is copper carbonate.
2. i) On strong heating, the light amorphous white solid, changes to <i>pale yellow</i>. ii) Gives off a colourless and odourless gas that turns <i>lime water milky</i>. The milkiness disappears on passing excess of gas. iii) The gas has no effect on acidified $K_2Cr_2O_7$ or acidified $KMnO_4$. iv) The residue, on <i>cooling</i>, changes to a <i>white colour</i>. i.e. residue is yellow when hot and white when cold.	$ZnCO_3 \xrightarrow{\Delta} ZnO + CO_2$ Residue is zinc oxide. Gas evolved is carbon dioxide. Deduction : White powder is zinc carbonate.
B1. i) <i>White crystalline solid</i>, on strong heating, swells and then melts, giving steamy vapours. ii) Steamy vapours <i>condense</i> on the cooler parts of the test tube to form tiny droplets of a colourless liquid. iii) Colourless liquid, when added to white <i>anhydrous copper sulphate</i>, turns it <i>blue</i>. iv) Colourless liquid turns blue coloured cobalt chloride paper pink. v) On cooling, a <i>white amorphous residue</i> is left.	$Na_2CO_3 \cdot 10H_2O \xrightarrow{\Delta} Na_2CO_3 + 10H_2O$ (steam) Residue is sodium carbonate. Gas evolved is water vapour. Substance is washing soda crystals.
2. i) <i>Blue crystalline solid</i>, on heating, crumbles to form a <i>white amorphous powder</i>. ii) Gives off steamy vapours, which, on condensing on the cooler parts of the test tube, form a <i>colourless liquid</i> (water). iii) The liquid turns blue-coloured cobalt chloride paper pink. iv) On strong heating, a black solid is formed and a gas is evolved. v) The evolved gas turns moist blue litmus red and changes colour of acidified $K_2Cr_2O_7$ solution from orange to green.	$CuSO_4 \cdot 5H_2O \xrightarrow{\Delta} CuSO_4 + 5H_2O$ Residue is copper sulphate. Gas evolved is water vapour. $2CuSO_4 \xrightarrow{\Delta} 2CuO + 2SO_2 + O_2$ On strong heating residue is black copper oxide Gases evolved are sulphur dioxide and oxygen. Substance is blue vitriol.
C1. i) <i>White crystalline deliquescent solid</i>. ii) On heating, it melts to form a white sticky mass and gives off <i>steamy vapours</i>. iii) On heating strongly, the white residue gives off <i>reddish brown fumes</i> that turn moist blue litmus paper red. iv) A glowing wooden splint held in the <i>reddish brown gas</i> (NO_2) bursts into flame. This reddish brown gas is mixed with oxygen. v) The residue is pale yellow, when it is hot, but on cooling, it changes to a white colour.	$Zn(NO_3)_2 \cdot 6H_2O \xrightarrow{\Delta} Zn(NO_3)_2 + 6H_2O$ $2Zn(NO_3)_2 \xrightarrow{\Delta} 2ZnO + 4NO_2\uparrow + O_2\uparrow$ The residue is zinc oxide. Gases evolved are water vapour, nitrogen dioxide and oxygen. Substance is zinc nitrate hexahydrate.

2. i) <i>Bluish green crystalline solid</i>, on heating, melts to form a bluish green mass and gives off <i>steamy vapours</i> that condense on the cooler parts of the test tube to form droplets of liquid (water). ii) On further heating, the <i>bluish green</i> mass changes to a black residue, <i>i.e.</i> copper (II) oxide. iii) It gives off a <i>reddish brown</i> gas. iv) It also gives a gas that rekindles a glowing splinter, <i>i.e.</i> oxygen.	$\text{Cu}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O} \xrightarrow{\Delta} \text{Cu}(\text{NO}_3)_2 + 6\text{H}_2\text{O}$ $2\text{Cu}(\text{NO}_3)_2 \xrightarrow{\Delta} 2\text{CuO} + 4\text{NO}_2\uparrow + \text{O}_2\uparrow$ Residue is copper oxide. Gases evolved are water vapour, nitrogen dioxide and oxygen. Substance is copper (II) nitrate hexahydrate.
3. i) Heavy white crystalline solid, on strong heating, <i>crumbles</i> with a crackling noise. ii) It gives off a reddish brown gas, which turns moist blue litmus paper red. iii) When a glowing wooden splinter is held in the reddish brown gas, it relights showing the presence of oxygen. iv) The residue is <i>reddish brown when hot</i>. On cooling, it changes to yellow, partly fuses in glass, and stains it yellow.	$2\text{Pb}(\text{NO}_3)_2 \xrightarrow{\Delta} 2\text{PbO} + 4\text{NO}_2 + \text{O}_2$ Residue is lead (II) oxide. Gases evolved are nitrogen dioxide and oxygen. Substance is lead (II) nitrate.
D1. i) <i>White crystalline solid</i>, on strong heating, sublimates to form a basic gas (NH_3) and an acidic gas (HCl). ii) The dense white fumes are noticed which form a white mass on the cooler parts of the test tube. iii) No residue is left behind.	$\text{NH}_4\text{Cl} \xrightleftharpoons[\text{cool}]{\text{heat}} \text{NH}_3\uparrow + \text{HCl}\uparrow$ Substance is ammonium chloride.
2. i) <i>Violet crystalline solid</i>, on strong heating, sublimates to form violet vapours. These vapours settle down on cooler part of the test tube to form violet crystals. ii) No residue is left at the bottom of the test tube. iii) A filter paper dipped in starch solution turns blue when it is brought in contact with the vapour. iv) These vapours (fumes) turn paper dipped in silver nitrate solution yellow.	$\text{I}_2 \xrightarrow{\Delta} 2\text{I}\uparrow$ (violet) (vapour) Substance is iodine.
3. i) <i>Orange red crystalline solid</i>, on strong heating, swells up and decomposes violently with flashes of light leaving greenish residue. It also gives off <i>steamy fumes</i>, which condense on the cooler parts of the test tube to form tiny droplets of water. ii) The colourless liquid turns cobalt chloride paper pink. iii) Greenish grey mass of chromium oxide is left behind. iv) A colourless, odourless gas is given out, which is neither combustible nor supports combustion. It does not turn lime water milky. The gas is nitrogen.	$(\text{NH}_4)_2\text{Cr}_2\text{O}_7 \xrightarrow{\Delta} \text{Cr}_2\text{O}_3 + \text{N}_2\uparrow + 4\text{H}_2\text{O}\uparrow$ (orange red) (greenish-grey) Gases evolved are water vapour and nitrogen. Substance is ammonium dichromate.

	Residue left	Colour of residue	Gas produced
1. Copper carbonate (CuCO_3) Green solid	Copper (II) oxide CuO	Black solid	Carbon dioxide (CO_2)
2. Zinc carbonate (ZnCO_3) White solid	Zinc oxide ZnO	Yellow when hot, white when cold	Carbon dioxide (CO_2)
3. Washing soda ($\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$) White crystals	Anhydrous Na_2CO_3	White powder	Water vapour (H_2O)
4. Copper sulphate ($\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$) Blue crystals	Anhydrous CuSO_4	Dirty white	Water vapour (H_2O)
5. Zinc nitrate ($\text{Zn}(\text{NO}_3)_2$) White solid	Zinc oxide ZnO	Yellow when hot, white when cold	Nitrogen dioxide and Oxygen ($\text{NO}_2 + \text{O}_2$)
6. Copper nitrate ($\text{Cu}(\text{NO}_3)_2$) Green solid	Copper (II) oxide CuO	Black solid	Nitrogen dioxide and Oxygen ($\text{NO}_2 + \text{O}_2$)
7. Lead nitrate ($\text{Pb}(\text{NO}_3)_2$) White solid	Lead oxide PbO	Yellow solid	Nitrogen dioxide and Oxygen ($\text{NO}_2 + \text{O}_2$)
8. Ammonium chloride (NH_4Cl) White solid	No residue	White sublimate	Hydrogen chloride and Ammonia ($\text{HCl} + \text{NH}_3$)
9. Iodine (I_2) Violet solid	No Residue	Violet sublimate	Iodine vapours
10. Ammonium dichromate ($(\text{NH}_4)_2\text{Cr}_2\text{O}_7$) Orange solid	Chromium (III) oxide Cr_2O_3	Green solid	Water vapour and Nitrogen ($\text{H}_2\text{O} + \text{N}_2$)

III. Action of dilute sulphuric acid on a given substance.

Observation	Inference
a. Add dilute sulphuric acid to the given (unknown) substance and warm it. There is vigorous effervescence, and a colourless, odourless gas evolves. <i>e.g.</i> (i) $\text{Mg} + \text{H}_2\text{SO}_4 \rightarrow \text{MgSO}_4 + \text{H}_2$ (ii) $\text{Zn} + \text{H}_2\text{SO}_4 \rightarrow \text{ZnSO}_4 + \text{H}_2$ The gas burns with a pop sound when a burning splint is brought near it.	Gas evolved is hydrogen. Given substance may be a reactive metal like zinc, iron, magnesium, etc.
b. Add dilute sulphuric acid to the given (unknown) substance and warm it. A colourless gas is evolved with brisk effervescence, and the gas on passing through lime water turns lime water milky. <i>e.g.</i> (i) $\text{Na}_2\text{CO}_3 + \text{H}_2\text{SO}_4 \rightarrow \text{Na}_2\text{SO}_4 + \text{H}_2\text{O} + \text{CO}_2$ (ii) $2\text{NaHCO}_3 + \text{H}_2\text{SO}_4 \rightarrow \text{Na}_2\text{SO}_4 + 2\text{H}_2\text{O} + \text{CO}_2$ The gas has no effect on acidified potassium dichromate paper.	Gas evolved is carbon dioxide. Substance may be a carbonate or hydrogen carbonate.
c. Add dilute sulphuric acid to the given (unknown) substance and warm it. A colourless gas with a foul smell, as of rotten eggs, is evolved. <i>e.g.</i> (i) $\text{FeS} + \text{H}_2\text{SO}_4 \rightarrow \text{FeSO}_4 + \text{H}_2\text{S}$ (ii) $\text{ZnS} + \text{H}_2\text{SO}_4 \rightarrow \text{ZnSO}_4 + \text{H}_2\text{S}$	Gas evolved is hydrogen sulphide. Substance may be a sulphide.
d. Add dilute sulphuric acid to the given (unknown) substance and warm it. A colourless gas with suffocating smell of burning sulphur is evolved. Gas turns lime water milky and turns acidified potassium dichromate paper green. The gas turns lead acetate paper black. <i>e.g.</i> (i) $\text{Na}_2\text{SO}_3 + \text{H}_2\text{SO}_4 \rightarrow \text{Na}_2\text{SO}_4 + \text{H}_2\text{O} + \text{CO}_2$ (ii) $\text{K}_2\text{SO}_3 + \text{H}_2\text{SO}_4 \rightarrow \text{K}_2\text{SO}_4 + 2\text{H}_2\text{O} + \text{CO}_2$	Gas evolved is SO_2. Given substance is a sulphite.

1. Distinguish by heating the following in dry test tube.
 - (a) zinc carbonate, copper carbonate and lead carbonate
 - (b) zinc nitrate and copper nitrate
 - (c) copper and copper carbonate
 - (d) ammonium chloride and iodine

2. Match the following :

Column A

- (a) $\text{Pb}(\text{NO}_3)_2$
- (b) CO_2
- (c) $(\text{NH}_4)_2\text{Cr}_2\text{O}_7$
- (d) HCl
- (e) NO_2
- (f) O_2
- (g) H_2
- (i) H_2S
- (j) SO_2

Column B

- (i) rotten egg smell
- (ii) burns with pop sound
- (iii) suffocating smell of sulphur
- (iv) lime water turns milky
- (v) crackling sound
- (vi) residue swells up
- (vii) brown gas
- (viii) supports combustion
- (ix) fumes in moisture

3. Distinguish by dilute sulphuric acid.
 - (a) Sodium sulphite and sodium carbonate ?
 - (b) Copper and magnesium ?
 - (c) Sodium sulphide and sodium sulphite ?
4. Write your observation and a balanced equation in the case of the following substances being heated.
 - (a) Ammonium dichromate
 - (b) Copper nitrate
 - (c) Copper carbonate
 - (d) Zinc carbonate
 - (e) Ammonium chloride
5. State the original colour of the following substance and colour of residue obtained after heating.

(a) ammonium dichromate	(b) copper carbonate
(c) lead nitrate	(d) zinc carbonate

IV. FLAME TEST

Compounds of certain metals impart a characteristic colour to a flame. The procedure to detect the colour imparted is as follows.

A thin platinum wire is first thoroughly cleaned by dipping it in concentrated hydrochloric acid. It is then heated in the non-luminous flame of the burner. The process is repeated. When the wire imparts no colour to the flame, it is ready for use.

Now, the wire is first dipped in concentrated hydrochloric acid and then into a small amount of the substance being investigated, so that a little of the substance may stick to it. It is then introduced into the non-luminous part of the flame, and the colour imparted to the flame is observed.

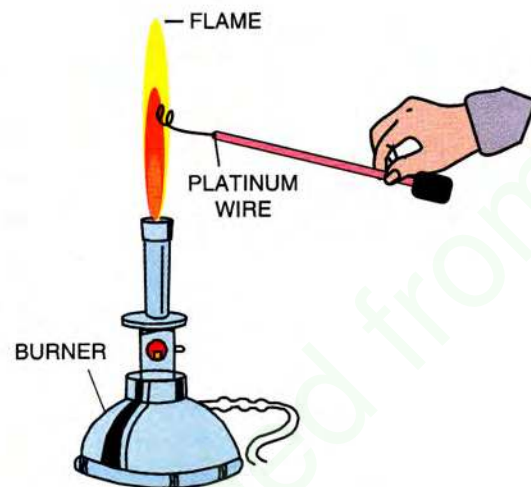


Fig. 9.1 Performing flame test

Table V — Colour imparted to a flame by salts of different metals

Colour imparted to the flame (Colour observed with naked eyes)	Colour seen through a blue glass	Name of metal.
(a) Golden yellow (persistent)	Yellow colour vanishes	Sodium (Na^+)
(b) Violet (Lilac)	Violet or Pink	Potassium (K^+)
(c) Brick red (fugitive, i.e. comes and goes).	Light green	Calcium (Ca^{2+})
(d) Peacock bluish green (Wire slowly gets corroded)	Bluish green	Copper (Cu^{2+})

FLAME TESTS — COLOURS



SODIUM SALT
Golden Yellow Flame



POTASSIUM SALT
Lilac Flame



CALCIUM SALT
Brick Red Flame



COPPER SALT
Peacock Bluish Green Flame

Fig. 9.2 Colour imparted to the flame by salts

REGONITION 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 :

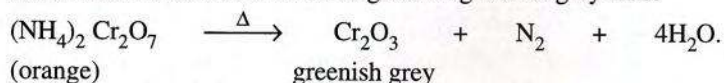
1. Smell of ammonia gas.	NH_4^+
2. Smell of hydrogen sulphide gas.	S^{2-}
3. Smell of sulphur dioxide gas.	SO_3^{2-}

C. State :

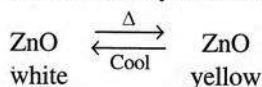
1. Amorphous salt.	CO_3^{2-}
2. Hygroscopic or deliquescent nature.	Cl^- or NO_3^-

D. Action of Heat :

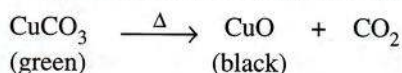
- Ammonium salt** when heated with alkali (except ammonium hydroxide) produces Ammonia gas. Ammonium nitrate and Ammonium chloride (explosive) leaves no residue behind on heating. Ammonium dichromate on heating leaves greenish grey mass.



- PbO_2 , Pb_3O_4 , HgO , KNO_3 , NaNO_3 on heating produce oxygen gas.
- Carbonate and bicarbonate on heating evolve carbon dioxide (except K_2CO_3 and Na_2CO_3).
- Hydrated salts on heating produce water vapour.
- Sulphites and some sulphates when heated produce sulphur dioxide gas.
- Lead compounds decompose to give **lead monoxide PbO (litharge)**. PbO is brown when hot, yellow when cold and sticks to the glass.
- Zinc compounds decompose on heating to give zinc oxide. $\text{ZnCO}_3 \rightarrow \text{ZnO} + \text{CO}_2$. **Zinc oxide** is yellow when hot white when cold.



- Copper compounds decompose to give black copper oxide CuO.



Note : Dry test involves – colour, density, physical state, dry heating and flame test.

Wet test involves adding reagents to identify the substance.

Cation→ Anion ↓	K	Na	Ba	Ca	Mg	Al	Zn	Fe	Fe	Mn	Pb	Cu	Ag	Hg
	(I)	(I)	(II)	(II)	(II)	(III)	(II)	(II)	(III)	(II)	(II)	(II)	(I)	(II)
NO ₃ (I)	S	S	S	S	S	S	S	S	S	S	S	S	S	S
CH ₃ COO(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

Identification of solids by the action of heat

Compound	Result of the test
Ammonium salt	Ammonia gas is evolved
PbO ₂ , Pb ₃ O ₄ , HgO, KNO ₃ , NaNO ₃	Oxygen gas is evolved
Carbonate and bicarbonate (except K ₂ CO ₃ and Na ₂ CO ₃)	Carbon dioxide is evolved
Hydrated salt	Water vapour evolved
Sulphite or sulphate	Sulphur dioxide gas is evolved
Lead compounds decompose to give lead monoxide; PbO	Brown when hot, yellow when cold
Zinc compounds decompose on heating to give zinc oxide	Yellow when hot white when cold
Copper compound decomposes to give black copper oxide CuO	Black residue

Some naturally occurring acids

Acid	Natural source
Acetic acid	Vinegar
Citric acid	Citrus fruits (oranges; lemons)
Butyric acid	Rancid butter
Hydrochloric acid	Gastric juice
Formic acid	Sting of bees and ants

Acid	Natural source
Lactic acid	Sour milk
Malic acid	Apples
Oleic acid	Olive oil
Stearic acid	Fats
Tartaric acid	Grapes; tamarind; apples
Uric acid	Urine

V. SIMPLE EXPERIMENTS BASED ON HARD WATER AND SOFT WATER.

Hard Water : Water that contains dissolved bicarbonates, sulphates and chlorides of calcium and

magnesium is called hard water. **This water does not form lather with ordinary soap.** Examples : sea water, river water, lake water, etc.

and magnesium salts. **This water forms lather with ordinary soap.** Examples : distilled water and rain water.

Types of Hardness

Temporary Hardness

Contains Ca and Mg bicarbonates

Removal : by boiling followed by **filtration**.

Permanent Hardness

Contains Ca and Mg chlorides and sulphates

Removal : by addition of
(i) washing soda
(ii) caustic soda.

Differentiating hard water from soft water.

Experiment I : Two unknown samples A and B, one containing hard water and the other containing soft water, are taken separately in beakers. Ordinary soap is rubbed by the hands into the two samples.

Observation : One sample forms lather easily, while the other sample does not lather.

Conclusion : The sample that lathers easily with ordinary soap is soft water.

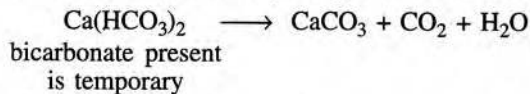
Differentiating between temporary and permanent hard water

Experiment II : Provide two unknown samples to the students, one containing temporary and the other containing permanent hard water, in separate beakers.

The given samples of water are boiled slowly, and then filtered. Ordinary soap is rubbed by the hands into each filtered sample.

Observation : One sample lathers with soap, but the other one does not.

Conclusion : The boiled and filtered sample that lathers with soap is temporary hard water.



Temporary hard water contains bicarbonate, which gives precipitate of insoluble carbonate on boiling. This precipitate is removed by filtration and water becomes soft.

The other sample is permanent hard water.

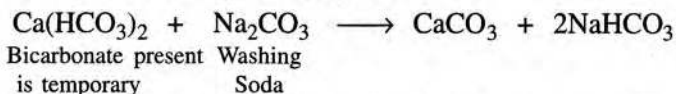
Object : Softening temporary and permanent hard water by addition of washing soda.

and permanent hard water in separate beakers and add washing soda to both samples. The two solutions are filtered to remove any precipitate formed.

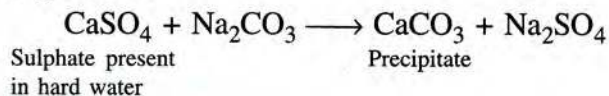
Ordinary soap is rubbed into the filtered solutions.

Observation : Both samples lather easily with ordinary soap.

Conclusion : (i) Temporary hard water is softened by using washing soda.

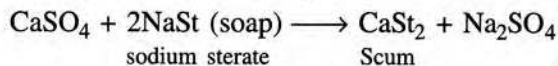


(ii) Permanent hard water is softened by using washing soda since permanent hardness is due to the presence of sulphate and chlorides of calcium and magnesium.



Soap and detergents

Soap : It is the sodium or potassium salt of an organic fatty acid. It reacts with hard water forming scum, which is why ordinary soap is wasted.



Detergents : They are the sodium salts of alkyl sulphonic acids. *Detergents contain a sulphonic acid group (SO₃H) instead of a carboxylic group (–COOH).*

They can lather even with hard water, since due to the solubility of their calcium and magnesium salts in water they do not form scum.

Comparing the effects of soaps and detergents on hard water

Experiment IV : Take two beakers containing samples of hard water. In one beaker, ordinary soap is rubbed into the water, while in the other beaker, a detergent is rubbed into the water.

Observation : Lather is formed in the beaker in which detergent is used, but lather does not form when ordinary soap is rubbed.

Conclusion : Detergents form lather even with hard water, while ordinary soap is wasted due to formation of scum.

- What do you observe when dilute sulphuric acid is added to the following :
(a) Sodium Sulphide (b) Sodium Carbonate
(c) Zinc granules
- Match column A with column B.

Column A	Column B
(a) Blue salt changes to white and then black	(i) Ammonium dichromate
(b) Orange-coloured compound changes to green.	(ii) Iodine
(c) Red compound changes to brown and then yellow.	(iii) Zinc Nitrate
(d) White to yellow when hot and white when cold.	(iv) Copper Sulphate
(e) Violet solid changes to violet vapours.	(v) Red Lead
- (a) How is a flame test performed ?
(b) How will you distinguish :
 (i) sodium chloride, potassium chloride and calcium chloride ?
 (ii) between soft water and hard water.
 (iii) temporary hard water and permanent hard water?

9. 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				

- (a) What do you understand by :
 (i) temporary hardness ? (ii) soft water ?
 (iii) permanent hardness ?
 (b) How are temporary and permanent hardness removed ?
- (a) What are soaps and detergents ?
 (b) Why do they differ in their actions ?
 (c) Explain their cleansing actions.
- Compare the effect of soaps and detergents on hard water.
- Copy and complete the following table that refers to the action of heat on some carbonates :

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

- Identify the following substances :
 (a) An alkaline gas A which gives dense white fumes with hydrogen chloride.
 (b) Gas C that has an offensive smell as of rotten eggs.
 (c) Gas D that is colourless and can be used as a bleaching agent.

VI. WATER POLLUTION

Water pollution is the introduction of substances of such character and in such quantity that alter the natural quality of water and impair its usefulness.

It affects the health of living organisms and may offend the sense of sight, taste or smell. It refers to



Fig. 9.2 Sources of water pollution

any type of aquatic contamination which renders the water unusable for living organisms.

Polluted water can be identified by the following:

- Foul smell from water
- Bad taste of drinking water
- Oil and grease floating on the surface of water
- Excessive growth of algae and weeds in water.

All over the world, freshwater resources are threatened not only by over-exploitation and poor management but also by ecological degradation.

The main reasons for fresh water pollution are:

- Discharge of untreated waste
- Dumping of industrial effluents
- Run-off from agricultural fields
- Industrial growth, urbanization
- Increasing use of synthetic organic substances.

It is generally accepted that developed countries suffer from problems of chemical discharge into water sources and developing countries face problems of agricultural run-off into water sources. Polluted water causes water-borne diseases and leads to other health-related problems.

SOURCES OF WATER POLLUTION

The main sources of water pollution are :

- (i) **Household detergents** that are used for washing purposes.
- (ii) **Sewage and domestic wastes.**
- (iii) **Industrial wastes** contain heavy metals, their salts and organic compounds. All these get accumulated in marine food chains.
- (iv) **Oil spills** poison sea life.
- (v) **Thermal pollution** raises the temperature of water and depletes the oxygen present in it, killing fishes and other aquatic organisms.

WATER QUALITY

Determination of water quality may be done in two ways :

1. Select a water body and survey its specific parameters throughout the year.
2. Select a specific parameter from the list given below and measure it in different types of water bodies.



Fig. 9.3 Polluted water

- pH value
- Bacteria present
- Hardness of water
- Dissolved oxygen
- Biological Oxygen Demand (BOD)
- Turbidity

These parameters and their effects on water bodies are described below.

pH VALUE

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

Concentration of H^+ ions present in solution decides whether it is acidic or alkaline or neutral.

pH value is obtained with the help of a universal indicator that changes colour at different pH values, as shown below.

pH can be studied with the help of a pH meter. pH value can also be read by matching a wet paper with a standard printed colour scale.

- a solution of pH 7 is neutral (water)
- a solution of pH less than 7 is acidic
- a solution of pH more than 7 is basic

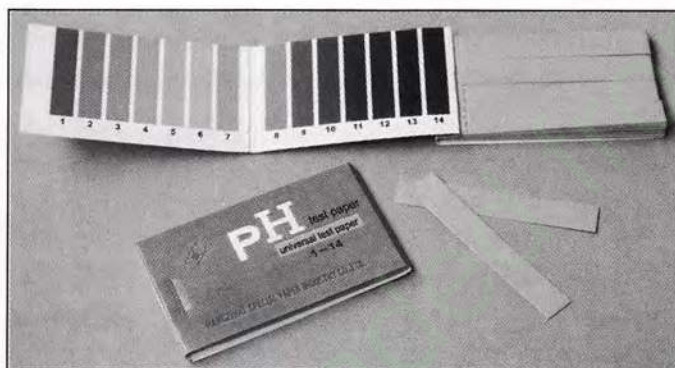


Fig. 9.4 pH papers

- the higher the pH above 7, the stronger the base, and the lower the pH below 7, the stronger the acid.

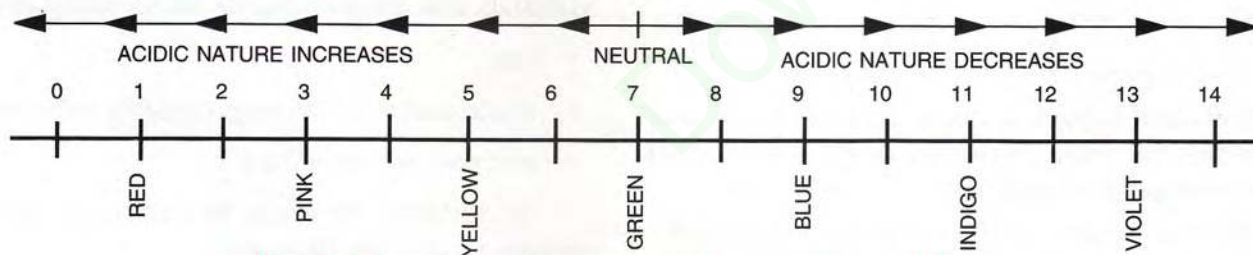


Fig. 9.5 Colour changes in a universal indicator at different pH values

in turn can harm animals and plants living in it. For instance, water coming out of an abandoned coal mine can have a pH value as low as 2, which means it is very acidic and would thus affect any creature surviving in or on it.

Non-polluted water is one that has pH value 7 or close to 7. Thus, if the pH value of water is much higher or lower than 7, that water is polluted and potentially harmful.

For general information

Substance	pH value
Hydrochloric acid	1.0
Sulphuric acid	1.2
Citric acid	2.3
Lime juice	2.4
Acetic acid	2.9
Carbonic acid	3.0
Pure water	7.0
Human blood	7.3
Sodium bicarbonate solution	8.4
Milk of magnesia	10.5
Sodium carbonate solution	11.6
Sodium hydroxide	13.0

Bacteria

Biological water quality assessment can also be done by measuring growth of bacteria in a water body.

Growth of bacteria can be measured by taking a sample of water in a petri dish and observing it under a microscope 3 or 4 times at regular intervals.

Water free of bacteria is non-polluted water, whereas water with bacterial growth is considered polluted.

Hardness

When water produces little or no lather with soap, it is considered hard water. Hard water is unsuitable for washing clothes, geysers as well as for drinking. *Hard water is regarded as polluted water.*

Dissolved oxygen

Dissolved oxygen is responsible for survival of aquatic life in water. Dissolved oxygen is breathed by fish and other aquatic life.

Moving water, such as we see in mountain streams and large rivers, tends to contain a lot of

of it.

If quantity of oxygen dissolved in stream or river water is less than quantity of dissolved oxygen in normal water, it is said to be polluted.

Quantity of dissolved oxygen can be measured with the help of an instrument called Oxygen Flow Meter.



Fig. 9.6 Instrument for measuring dissolved oxygen

Biological Oxygen Demand (BOD)

Biological oxygen demand is a measure of the oxygen utilized by micro-organisms during oxidation of organic substances. Micro-organisms present in a polluted water sample use oxygen to oxidize waste, and thus BOD increases in polluted water. Amount of oxygen present in pure water is measured first, and then in polluted water. Decrease in the amount of oxygen is the BOD value. *Biological oxygen demand increases in polluted water.*

Turbidity

Turbidity is the amount of particulate matter suspended in water.

Turbidity measures the scattering effect that suspended solids have on light; the higher the intensity of scattered light, the higher the turbidity. Materials that are responsible for turbidity include:

- clay
- waste matter containing insoluble substances
- microscopic organisms

As turbidity of water increases, its ability to support aquatic life decreases.

WAYS TO CONTROL WATER POLLUTION :

- Sewage should be treated fully before we release its into water bodies.
- Chemicals released from factories should be treated to neutralize their toxic contents.
- Heavier floating solids can be removed by gravity settlement and screening.
- Organic matter should be removed by oxidation or precipitation.
- Pathogens can be destroyed by ultraviolet radiation.

PROJECT / EXPERIMENT

OBJECT :

To find out the sources of pollution of water bodies in one's locality and determine the quality of water.

Procedure : In this project, survey of a locality is done where a DRAIN exists. The following datas are collected.

The major sources of water pollution were found and they are :

- (i) Household wastes.
- (ii) Detergents from clothes people wash.
- (iii) Wastes from shops.
- (iv) Animals excreta accumulated by the sweeper.
- (v) Wastes generated by a restaurant near the drain, including plastic packaging, bottles, cans, food stuff and clothing.
- (vi) Washes of nearby hospital.
- (vii) Wastes from factories.

In order to determine the quality of water,

- 100 cm³ of water is taken in a beaker for finding its pH value
- 500 cm³ of water is taken in another beaker for measuring the oxygen dissolved in it.

Data obtained is as follows :

Month	April	May	June	July	Aug.	Sept.
pH	6.0	5.9	6.6	7.8	7.0	6.8
DO (mg/l)	4.1	3.5	2.1	1.7	1.7	1.5

Conclusion :

1. If *pH* of water is less than 7, i.e. water is acidic, it would affect all living creatures present there. Acidity results mainly from discharge of industrial effluents.
2. When Dissolved Oxygen (DO) decreases in a water body, mainly due to the carbon-containing matter present in it, it becomes difficult for aquatic organisms that take dissolved oxygen to survive.

Thus, water quality is considered to be good when there is more dissolved oxygen, and it is considered bad when there is less dissolved oxygen.