9 PRACTICAL WORK

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.

(i) 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

$Mg + H_2SO_4 \rightarrow MgSO_4 + H_2\uparrow$

$Zn + 2HCl \rightarrow ZnCl_2 + H_2\uparrow$

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.

$$2H_2 + O_2 \rightarrow 2H_2O$$

(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

$2Pb_3O_4 \xrightarrow{\Delta} 6PbO + O_2\uparrow$

$2PbO_2 \xrightarrow{\Delta} 2PbO + O_2\uparrow$

$2HgO \xrightarrow{\Delta} 2Hg + O_2\uparrow$

Recognition and Identification of Gas

(a) The gas is colourless, odourless and neutral to litmus.

(b) It ***rekindles a glowing wooden splinter.***

(c) The gas is absorbed in colourless alkaline solution of pyrogallol and turns it dark brown.

3. Carbon dioxide

Preparation : *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

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

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

Metal carbonate/*hydrogen* carbonate + Acid (dil) → Salt + Water + Carbon dioxide

$CaCO_3 + 2HCl \rightarrow CaCl_2 + H_2O + CO_2\uparrow$

$NaHCO_3 + HCl \rightarrow NaCl + H_2O + CO_2\uparrow$

Recognition and Identification of Gas

(a) The gas is colourless and odourless.

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

(c) When the gas is passed through 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 when CO_2 is passed in excess.

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

ppt (Soluble)

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

4. Chlorine

Preparation : *Add conc. HCl to oxidizing agents like Pb_3O_4, PbO_2, MnO_2, etc.*

Oxidizing agent + Conc. HCl → Metal chloride + Water + Chlorine

$Pb_3O_4 + 8HCl \rightarrow 3PbCl_2 + 4H_2O + Cl_2\uparrow$

$MnO_2 + 4HCl \rightarrow MnCl_2 + 2H_2O + Cl_2\uparrow$

Recognition and Identification of Gas

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

(b) It turns ***moist blue litmus paper red*** and finally bleaches, *i.e.* ***decolourizes 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 precipitate*** (of silver chloride) is formed.

5. Hydrogen chloride

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

Metal chloride + Conc. sulphuric acid → Metal sulphate + Hydrogen chloride

$NaCl + H_2SO_4 \rightarrow NaHSO_4 + HCl\uparrow$

$KCl + H_2SO_4 \rightarrow KHSO_4 + HCl\uparrow$

Recognition and Identification of Gas

(a) The gas is colourless and has a pungent choking odour.

(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.***

$NH_3(aq) + HCl \rightarrow NH_4Cl$

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

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

The precipitate dissolves in excess NH_4OH.

6. Sulphur dioxide

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

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

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).

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

Milkiness disappears on passage of excess of sulphur dioxide.

$CaSO_3 + H_2O + SO_2 \rightarrow Ca(HSO_3)_2$ (soluble)

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

$2KMnO_4 + 2H_2O + 5SO_2 \rightarrow K_2SO_4 + 2MnSO_4 + 2H_2SO_4$

(pink) (colourless)

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

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

(orange) (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.*

Metal sulphide	+	dil. Acid	→	Salt	+	Hydrogen sulphide
FeS	+	H_2SO_4	→	$FeSO_4$	+	$H_2S\uparrow$
ZnS	+	2HCl	→	$ZnCl_2$	+	$H_2S\uparrow$

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.***

$(CH_3COO)_2Pb + H_2S \rightarrow PbS\downarrow + 2CH_3COOH$

(colourless) (black)

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

$Pb(NO_3)_2 + H_2S \rightarrow PbS\downarrow + 2HNO_3$

(colourless) (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.

8. Ammonia

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

Ammonium salt	+	Alkali	→	Salt	+	Water	+	Ammonia
$2NH_4Cl$	+	$Ca(OH)_2$	→	$CaCl_2$	+	$2H_2O$	+	$2NH_3\uparrow$
NH_4Cl	+	NaOH	→	NaCl	+	H_2O	+	$NH_3\uparrow$

Recognition and Identification of Gas

(a) The gas is colourless with a ***characteristic*** sharp, ***pungent smell.***

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

(c) If a 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.

(e) 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.*

Hydrated salt	$\xrightarrow{\Delta}$	Anhydrous salt	+	Water vapour
$Na_2CO_3\cdot10H_2O$	$\xrightarrow{\Delta}$	Na_2CO_3	+	$10H_2O$
$CuSO_4\cdot5H_2O$ (blue)	$\xrightarrow{\Delta}$	$CuSO_4$ (white)	+	$5H_2O$

Recognition and Identification of Gas

(a) Colourless and odourless vapours condense to form a clear liquid on the cooler part of the test-tube.

(b) The liquid is neutral to litmus.

(c) This liquid ***turns anhydrous copper sulphate from white to blue.***

$$CuSO_4 \text{ (white)} + 5H_2O \rightarrow CuSO_4\cdot5H_2O \text{ (blue)}$$

(d) It turns blue cobalt chloride paper pink.

$$CoCl_2 \text{ (blue)} + 2H_2O \rightarrow CoCl_2\cdot2H_2O \text{ (pink)}$$

10. Nitrogen dioxide

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

Metal nitrate	$\xrightarrow{\Delta}$	Metal oxide	+	Oxygen	+	Nitrogen dioxide
$2Cu(NO_3)_2$	$\xrightarrow{\Delta}$	$2CuO$	+	O_2	+	$4NO_2\uparrow$
$2Pb(NO_3)_2$	$\xrightarrow{\Delta}$	$2PbO$	+	O_2	+	$4NO_2\uparrow$

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

Recognition and Identification of Gas

(a) The gas is *brown* in colour, has an irritating (pungent) odour and is non-combustible.

(b) It turns moist blue litmus paper red.

(c) It liberates iodine (violet vapours) from potassium iodie (Kl) solution or turns potassium iodide paper brown.

$$2KI + 2NO_2 \rightarrow 2KNO_2 + I_2\uparrow$$

(d) 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

EXCERCISE 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 sublimate. Careful observation of changes and identification of gases evolved give information that helps to identify the salt.

Observation	Identification of substance
A1. i) *Light green amorphous powder* turns to *black*, 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 *pale yellow.* ii) Gives off a colourless and odourless gas that turns *lime water milky.* 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 *cooling,* changes to a *white colour.* *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) *White crystalline* solid, on strong heating, swells and then melts, giving steamy vapours. ii) Steamy vapours *condense* on the cooler parts of the test tube to form tiny droplets of a colourless liquid. iii) Colourless liquid, when added to white *anhydrous copper sulphate,* turns it *blue* . iv) Colourless liquid turns blue coloured cobalt chloride paper pink. v) On cooling, a *white amorphous residue* is left.	$Na_2CO_3 . 10H_2O \xrightarrow{\Delta} Na_2CO_3 + 10H_2O$ (steam) Residue is **sodium carbonate.** Gas evolved is **water vapour.** Substance is **washing soda crystals.**
2. i) *Blue* crystalline solid, on heating, crumbles to form a *white amorphous powder.* ii) Gives off steamy vapours, which, on condensing on the cooler parts of the test tube, form a *colourless liquid* (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.	$CuSO_4 . 5H_2O \xrightarrow{\Delta} CuSO_4 + 5H_2O$ 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) White crystalline deliquescent solid. ii) On heating, it melts to form a white sticky mass and gives off *steamy vapours.* iii) On heating strongly, the white residue gives off *reddish brown fumes* that turn moist blue litmus paper red. iv) A glowing wooden splint held in the *reddish brown* gas (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.	$Zn(NO_3)_2 . 6H_2O \xrightarrow{\Delta} Zn(NO_3)_2 + 6H_2O$ $2Zn(NO_3)_2 \xrightarrow{\Delta} 2ZnO + 4NO_2\uparrow + O_2\uparrow$ The residue is **zinc oxide.** Gases evolved are **water vapour, nitrogen dioxide and oxygen.** Substance is **zinc nitrate hexahydrate.**

2. i) *Bluish green crystalline* solid, on heating, melts to form a bluish green mass and gives off *steamy vapours* that condense on the cooler parts of the test tube to form droplets of liquid (water). ii) On further heating, the *bluish* green mass changes to a black residue, *i.e.* copper (II) oxide. iii) It gives off a *reddish brown* gas. iv) It also gives a gas that rekindles a glowing splinter, *i.e.* oxygen.	$Cu(NO_3)_2.6H_2O \xrightarrow{\Delta} Cu(NO_3)_2 + 6H_2O$ $2Cu(NO_3)_2 \xrightarrow{\Delta} 2CuO + 4NO_2\uparrow + O_2\uparrow$ 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, *crumbles* 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 *reddish brown when hot.* On cooling, it changes to yellow, partly fuses in glass, and stains it yellow.	$2Pb(NO_3)_2 \xrightarrow{\Delta} 2PbO + 4NO_2 + O_2$ Residue is **lead (II) oxide.** Gases evolved are **nitrogen dioxide and oxygen.** Substance is **lead (II) nitrate.**
D1. i) *White crystalline solid,* 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.	$NH_4Cl \underset{\text{cool}}{\overset{\text{heat}}{\rightleftharpoons}} NH_3\uparrow + HCl\uparrow$ Substance is **ammonium chloride.**
2. i) *Violet crystalline solid,* on strong heating, sublimates to form violet vapours. These vapours settles 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.	$I_2 \xrightarrow{\Delta} 2I\uparrow$ (violet) (vapour) Substance is **iodine.**
3. i) *Orange red crystalline solid,* on strong heating, swells up and decomposes violently with flashes of light leaving greenish residue. It also gives off *steamy fumes,* 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.	$(NH_4)_2Cr_2O_7 \xrightarrow{\Delta} Cr_2O_3 + N_2\uparrow + 4H_2O\uparrow$ (orange red) (greenish-grey) Gases evolved are **water vapour and nitrogen.** Substance is **ammonium dichromate.**

S. NO. SUBSTANCE AND ITS COLOUR	PRODUCTS AFTER HEATING		
	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 ($Na_2CO_3 \cdot 10H_2O$) White crystals	Anhydrous Na_2CO_3	White powder	Water vapour (H_2O)
4. Copper sulphate ($CuSO_4 \cdot 5H_2O$) Blue crystals	Anhydrous $CuSO_4$	Dirty white	Water vapour (H_2O)
5. Zinc nitrate ($Zn(NO_3)_2$) White solid	Zinc oxide ZnO	Yellow when hot, white when cold	Nitrogen dioxide and Oxygen ($NO_2 + O_2$)
6. Copper nitrate ($Cu(NO_3)_2$) Green solid	Copper (II) oxide CuO	Black solid	Nitrogen dioxide and Oxygen ($NO_2 + O_2$)
7. Lead nitrate ($Pb(NO_3)_2$) White solid	Lead oxide PbO	Yellow solid	Nitrogen dioxide and Oxygen ($NO_2 + O_2$)
8. Ammonium chloride (NH_4Cl) White solid	No residue	White sublimate	Hydrogen chloride and Ammonia ($HCl + NH_3$)
9. Iodine (I_2) Violet solid	No Residue	Violet sublimate	Iodine vapours
10. Ammonium dichromate ($(NH_4)_2Cr_2O_7$) Orange solid	Chromium (III) oxide Cr_2O_3	Green solid	Water vapour and Nitrogen ($H_2O + N_2$)

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. *e.g.* (i) $Mg + H_2SO_4 \rightarrow MgSO_4 + H_2$ (ii) $Zn + H_2SO_4 \rightarrow ZnSO_4 + H_2$ 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. *e.g.* (i) $Na_2CO_3 + H_2SO_4 \rightarrow Na_2SO_4 + H_2O + CO_2$ (ii) $2NaHCO_3 + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O + CO_2$ 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. *e.g.* (i) $FeS + H_2SO_4 \rightarrow FeSO_4 + H_2S$ (ii) $ZnS + H_2SO_4 \rightarrow ZnSO_4 + H_2S$	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. *e.g.* (i) $Na_2SO_3 + H_2SO_4 \rightarrow Na_2SO_4 + H_2O + CO_2$ (ii) $K_2SO_3 + H_2SO_4 \rightarrow K_2SO_4 + 2H_2O + CO_2$	Gas evolved is SO_2. Given substance is a sulphite.

EXCERCISE 9 (B)

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	Column B
(a) $Pb(NO_3)_2$	(i) rotten egg smell
(b) CO_2	(ii) burns with pop sound
(c) $(NH_4)_2Cr_2O_7$	(iii) suffocating smell of sulphur
(d) HCl	(iv) lime water turns milky
(e) NO_2	(v) crackling sound
(f) O_2	(vi) residue swells up
(g) H_2	(vii) brown gas
(i) H_2S	(viii) supports combustion
(j) SO_2	(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

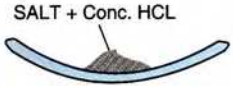
5. State the original colour of the following substance and colour of residue obtained after heating.
   (a) ammonium dichromate (b) copper carbonate
   (c) lead nitrate (d) zinc carbonate

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.



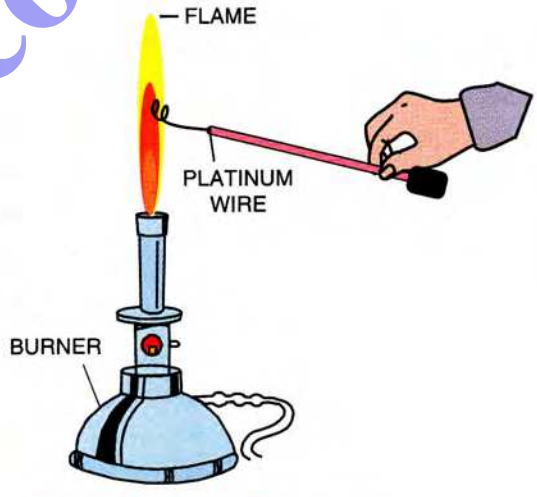


Fig. 9.1 Performing flame test

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+})

The colours imparted to the flame by various salts are given in Table-V

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 :

1. **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

   $(NH_4)_2\,Cr_2O_7 \xrightarrow{\Delta} Cr_2O_3 + N_2 + 4H_2O.$
   (orange) greenish grey
2. PbO_2, Pb_3O_4, HgO, KNO_3, $NaNO_3$ on heating produce oxygen gas
3. Carbonate and bicarbonate on heating evolve carbon dioxide (except K_2CO_3 and Na_2CO_3)
4. Hydrated salts on heating produce 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.
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 CuO.

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

Identification of solids by the action of heat

Compound	Result of the test
Ammonium salt	Ammonia gas is evolved
PbO_2, Pb_3O_4, HgO, KNO_3, $NaNO_3$	Oxygen gas is evolved
Carbonate and bicarbonate (except K_2CO_3 and Na_2CO_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.

Soft water does not contain dissolved calcium and magnesium salts. **This water forms lather with ordinary soap**. Examples : distilled water and rain water.

Types of Hardness

Temporary Hardness	**Permanent Hardness**
Contains Ca and Mg bicarbonates	Contains Ca and Mg chlorides and sulphates
Removal : by boiling followed by **filtration.**	**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.

$$\underset{\text{bicarbonate present is temporary}}{Ca(HCO_3)_2} \longrightarrow CaCO_3 + CO_2 + H_2O$$

Temparary hard water contains bicarbonate, which gives precipate 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.

Experiment III : Take samples of temporary 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.

$$\underset{\text{Bicarbonate present is temporary}}{Ca(HCO_3)_2} + \underset{\text{Washing Soda}}{Na_2CO_3} \longrightarrow CaCO_3 + 2NaHCO_3$$

(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.

$$\underset{\text{Sulphate present in hard water}}{CaSO_4} + Na_2CO_3 \longrightarrow \underset{\text{Precipitate}}{CaCO_3} + Na_2SO_4$$

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.

$$CaSO_4 + 2NaSt\ (soap) \longrightarrow \underset{\text{Scum}}{CaSt_2} + Na_2SO_4$$
(sodium sterate)

Detergents : They are the sodium salts of alkyl sulphonic acids. *Detergents contain a sulphonic acid group (SO_3H) 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.

EXCERCISE 9 (C)

1. What do you observe when dilute sulphuric acid is added to the following :
   (a) Sodium Sulphide (b) Sodium Carbonate
   (c) Zinc granules

2. 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

3. (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?

4. (a) What do you understand by :
   (i) temporary hardness ? (ii) soft water ?
   (iii) permanent hardness ?
   (b) How are temporary and permanent hardness removed ?

5. (a) What are soaps and detergents ?
   (b) Why do they differ in their actions ?
   (c) Explain their cleansing actions.

6. Compare the effect of soaps and detergents on hard water.

7. 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	

8. 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.

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				

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

Fig. 9.2 Sources of water pollution

Polluted water can be identified by the following:

(i) Foul smell from water
(ii) Bad taste of drinking water
(iii) Oil and grease floating on the surface of water
(iv) 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.

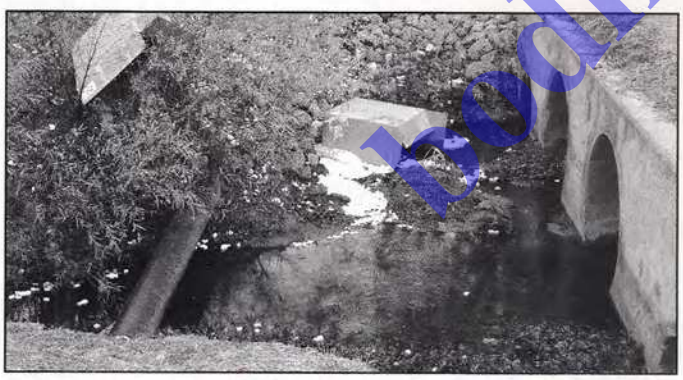


Fig. 9.3 Polluted water

- 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.

*p*H 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.

*p*H value is obtained with the help of a universal indicator that changes colour at different *p*H 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 *p*H 7 is neutral (water)
- a solution of *p*H less than 7 is acidic
- a solution of *p*H more than 7 is basic

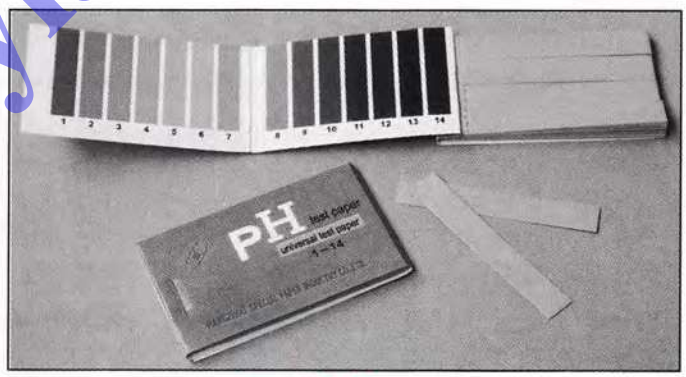


Fig. 9.4 pH papers

- the higher the *p*H above 7, the stronger the base, and the lower the *p*H below 7, the stronger the acid.

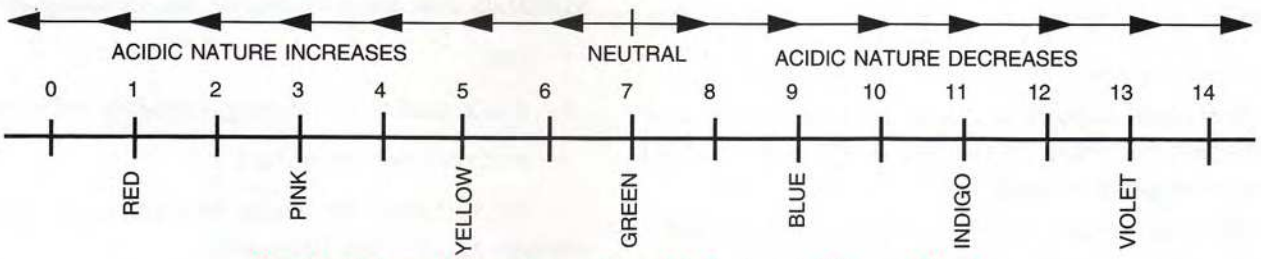


Fig. 9.5 Colour changes in a universal indicator at different pH values

Pollution can change the pH of water, which 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	*p*H 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 dissolved oxygen, but stagnant water contains little 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.

WAY 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 cm^3 of water is taken in a beaker for finding its pH value
- 500 cm^3 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.