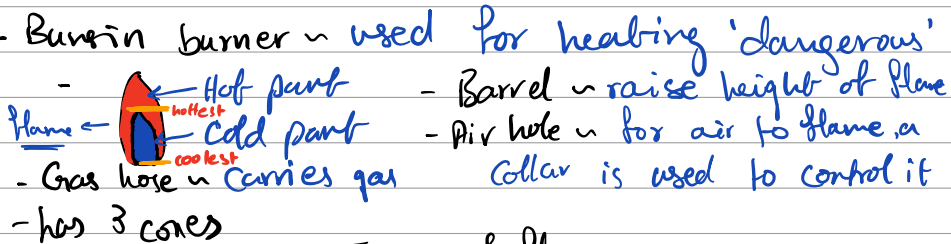


# Exp. 1 Basic laboratory operations

Q<sub>1</sub>) How to light-it-up? - Bunsin burner ~ used for heating 'dangerous' connect hose to gas, close air hole, hold lighted match to the side of the burner, turn on the gas, open the air hole.



## Types of flames

### Heating Flame

- 'Blue'
- Air holes open
- Hot
- Difficult to see
- Clean

### Safety Flame

- 'Yellow'
- Air holes closed
- cold
- Highly visible
- Dirty

Q<sub>2</sub>) How to close it? close air hole, turn off the gas

Q<sub>3</sub>) Types of balances?

- 1) Top loading
- 2) Triple-beam
- 3) Analytical

- complete combustion ~ blue flame, sufficient oxygen.  $CH_4 + O_2 \rightarrow CO_2 + H_2O$ , hot, non luminous

- incomplete combustion ~ yellow flame, insufficient oxygen.  $CH_4 + O_2 \rightarrow CO_2 + CO + C + H_2O$ , cold & luminous

Q<sub>4</sub>) What is density? specific property of matter mass ÷ volume.

$$D = \frac{m}{V}$$

- Top loading → rapid, nearest 0.1 - 0.001 g
- Triple beam → 3 beams, sliding masses, 610g capacity nearest 0.1g

Q<sub>5</sub>) How to measure?

- mass using triple beam
- V by l, w & h or graduated cylinder for irregular
- use density formula

- Analytical → V. Accurate, nearest 0.0001g, Delicate
- Difference in volume of graduated cylinder gives V of irregular object.
- measure m before V cuz some liquid could seep into the object measured.

## Exp. 2 Identification of a compound 'Physical'

Q<sub>1</sub>) name physical properties: <sup>intensive</sup> <sup>properties</sup>

- solubility, density, B.p, m.p, color, odor, state of matter, electric & magnetic

Physical properties can be determined or measured w/o changing composition.

Intensive properties independent on the amount of substance. (highlighted)

Extensive properties depend on the amount of substance such as mass & volume.

Q<sub>2</sub>) B.p of water at sea level  
- 100°C

Q<sub>3</sub>) B.p of water at 1905m  
- 93.4°C

① solubility - mass of substance that dissolves in a fixed amount of liquid at a given temperature

→ As solvent & solute have a similar structure it tends to dissolve more.

② Density - mass of substance contained in a given volume.

→ ↑ density  $\propto$  ↑ solubility

→ we can compare known density to unknown substance.

③ B.p - temp. at which vapor pressure of liquid equals pressure surrounding the liquid & it changes to vapor.

→ liquid  $\rightleftharpoons$  gaseous

→ constant temp.

→ magnitude of B.p depends on intermolecular forces

↑ forces  $\propto$  ↑ B.p

\* salt doesn't dissolve in benzene, cyclohexane & toluene: non polar

\* weakly polar solvents are slightly solubling. 'ethermet'.

\* liquids that boil at < 100°C are called volatile

↳ Their solubility is tested using gentle water bath not flames

# Exp 3: Identification of a compound 'Chemical'

Q<sub>1</sub>) Name chemical properties.

Color change, ppt,  
Flammability, Rusting,  
Creating gas bubbles,  
pH, reactivity with H<sub>2</sub>O

chemical properties & characteristics involved when substance interacts with another & change its chemical makeup based on its environment.

→ Gas evolving may be rapid or fizzing

g → gas w/o odor → CO<sub>2</sub>

g<sub>o</sub> → gas with odor → NH<sub>3</sub> 'has a strong & shocking'

Q<sub>2</sub>) State name & properties of each one

ppt - gr: granules, at the bottom, ↑ than powder

ppt - M: Milky, suspended, ↑ intense than cloudy

ppt - p: powder, at bottom

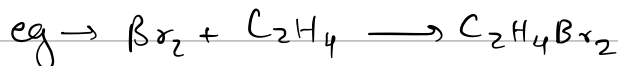
ppt - c: cloudy, suspended.

→ ppt precipitation → Crystalline, color or cloud appears → AgCl(s) 'white'; disappears → CO<sub>2</sub>

→ exothermic (evolved), warms

→ endothermic (absorbed), cools

→ Bromine + Alkene or Alkyne → Redox rxn.  
(Brown) (colorless)



Q<sub>3</sub>) which reagent

distinguishes btw soluble & insoluble?

eg - CaCO<sub>3</sub> → bubbles  
- HCl · CaCl<sub>2</sub> → no rxn.  
          KOH → ΔT

Q<sub>4</sub>) reagent soluble cl-salt

from soluble SO<sub>4</sub><sup>2-</sup> - salt?  
no rxn.

- AgNO<sub>3</sub> · eg Cl<sup>-</sup> → ppt

- NaOH · eg MgCl → ppt

\* never smell the rxn mixture directly. 'Fan it'

\* precipitation can be suspended too

\* most common rxns are acid-base ones 'usually colorless'

## Exp. 4 Limiting Reactant

Q1) what factors affect the yield?

amount of reactants & percent yield.

Stoichiometry - quantitative relationship between reactants & products in a balanced eqn.

$$\% \text{ yield} = \frac{\text{Actual}}{\text{Theoretical}} \times 100$$

Q2) how to determine limiting?

- calc. amt of product

- identify it

- the other is excess  
or

- no. of moles

- divide by coefficient

limiting reactant - completely consumed & limits the amount of product produced.

excess reactant - ↑ quantity than needed to complete rxn.

precipitate → ionic compound

Q3) Testing for limiting

add phosphate reagent

to barium; if ppt then

excess barium. same with  $\text{PO}_4^{3-}$

Spectator ion → ion that exists as reactant & product in a chemical eqn. [unchanged in both sides]

→ Analyzing the supernatant determines the limiting.

→ Digesting the ppt to obtain larger particles of ppt to minimize loss in supernatant through filter paper

\* left over reactants is excess reactant.

\* supernatant → liquid left after solid is removed

# Exp. 5 Acids & Bases

Q<sub>1</sub>) Name strong acids. 100% ionized

H<sub>2</sub>SO<sub>4</sub>, HCl, HNO<sub>3</sub>, HBr, HI, HClO<sub>4</sub> 'per chloric acid'

Acid → proton donor, sour, blue → red, < 7 pH, electrolyte  
- with active metals → salt + H<sub>2</sub>  
- neutralize bases → salt + H<sub>2</sub>O

Q<sub>2</sub>) Name weak acids. 5% ionized

H<sub>3</sub>PO<sub>4</sub>, HC<sub>2</sub>H<sub>3</sub>O<sub>2</sub>, C<sub>6</sub>H<sub>8</sub>O<sub>7</sub> citric acid

Uses: H<sub>3</sub>PO<sub>4</sub>: soft drinks, fertilizer & detergents  
H<sub>2</sub>SO<sub>4</sub>: fertilizer, car batteries  
HCl: gastric juice & stomach  
HC<sub>2</sub>H<sub>3</sub>O<sub>2</sub>: vinegar  
'Acetic acid'

Q<sub>3</sub>) What is pH?  
measure of conc. of H<sub>3</sub>O<sup>+</sup> ions in sol.

Base → proton acceptor, ↑ OH<sup>-</sup>, bitter, red → blue, > 7 pH  
electrolyte (has a slippery soapy feel)

Q<sub>4</sub>) Does HCl react with Cu(s)? No rxn.

Uses: NaOH: lye, drain & oven cleaner  
Mg(OH)<sub>2</sub>: laxative & antacid  
NH<sub>3</sub>: cleaners, fertilizer.

Q<sub>5</sub>) Stable reactivity series

very rapid series

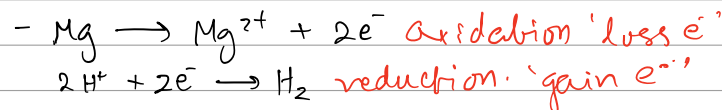
K	Zn	Cu
Na	Fe <small>slow rxn</small>	Ag <small>no rxn</small>
Ca	Sn	Au
Mg	Pb	Pt
Al	H	
C		

rapid

Brosted-Lowry → has both acids & bases

$$[H^+] = [OH^-] = 1 \times 10^{-7} M \rightarrow K_w = [H^+] \times [OH^-] = 1 \times 10^{-14}$$

$$* pH + pOH = 14$$



$$* pH = -\log [H^+]$$

$$* pOH = -\log [OH^-]$$

# Exp 6: Antacid Analysis.

<p>Q1) Name the most common antacids:</p>	<p>Antacid buffers <math>\rightarrow</math> Basic, neutralize excess <math>H^+</math>.          (causing an Acid-Base rxn)          some have buffers <math>\rightarrow</math> carbonate bicarbonate <math>CaCO_3</math> &amp; <math>NaHCO_3</math></p>
<p><math>Al(OH)_3, CaCO_3, MgCO_3,</math>  <math>Mg(OH)_2, NaHCO_3,</math>  <math>KHCO_3</math></p>	<p>Milk of magnesia <math>\rightarrow</math> suspension of <math>Mg(OH)_2 + NaHCO_3</math>          'Baking soda'</p>
<p>Q2) what is Indicator?  <math>Mg(OH)_2 + CaCO_3</math>          1 : 5</p>	<p>Indicators <math>\rightarrow</math> if its conjugate acid or base has a diff. colour. (to detect end point of titration)          - marks a certain pH level.</p>
<p>Q3) why use Back titration for antacids?          Its a buffer, thus <math>\uparrow</math> acid to find moles of antacid then sol. is titrated with base to find unneutralized acid</p>	<p>Cyanidin: acidic <math>\rightarrow</math> red Basic <math>\rightarrow</math> blue  <math>\hookrightarrow</math> Also known as cabbage juice indicator.  <math>\hookrightarrow</math> pH of <math>3 &gt; x &gt; 11</math></p> <p>Bromophenol: Yellow <math>\rightarrow</math> Blue pH <math>3.5 &gt; x &gt; 4.6</math>  <math>\downarrow</math> structure related to phenolphthalein          pH <math>\rightarrow</math> colourless (0-8.3); pink (8.3-10)</p>
<p>Q4) why is titration carried out?</p>	<p style="text-align: center;">Titration</p> <div style="display: flex; justify-content: space-around;"> <div style="text-align: center;"> <p>Forward Direct</p> </div> <div style="text-align: center;"> <p>Back / Indirect</p> </div> </div>
<p>To determine conc. of unknown</p>	<div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <p>- <math>M_{acid} V_{acid} = M_{base} V_{base}</math>              - mole HCl = Mole of Antacid</p> </div> <div style="width: 45%;"> <p>- <math>N_{acid}</math> - moles of HCl  <math>N_{antacid}</math> - moles of HCl neutralized by Antacid  <math>N_{Base}</math> - NaOH used to neutralize excess HCl              - <math>N_{acid} = N_{antacid} + N_{Base}</math></p> </div> </div>

- \* we can break the buffer capacity by  $\uparrow$  conc. or excess of acid
- \* Grad cylinder isn't accurate enough to measure HCl.

# Exp. 7 Recrystallization.

Q<sub>1</sub>) List 2 factors recrystallization depends on.

Temp of solvents & impurities & their solubility.

Q<sub>2</sub>) How to recover a decent amnt.?

- use ↓ amnt. of hot solvent

- good recovery  
- prevents saturation

- use absorbant like charcoal to remove coloring matter.

↑ selective

- scratch the walls of vessel to get crystals of supersaturated sol.

Q<sub>3</sub>) Recrystallization near B.P of solvent?

less solute is needed as solubility of solute ↑.

Q<sub>4</sub>) what is 100% recovery considered?

Failed recrystallization

Recrystallization → is a selective technique  
→ to remove impurities from solid o. compound (purification)  
→ suitable for small & large scale work.

Procedure: - Dissolving in boiling solvent  
- Filtering (hot sol.)

\* sudden cooling can trap liquid inside crystals  
- cool slowly (allows crystals to form)  
- Filtering crystals in cold solvent  
- Drying crystals

- larger & pure.

A good Recrystallization solvent:-

- Dissolve a good amnt. at ↑ temp.

- NO rxn - non toxic - volatile

- Dissolve impurities at ↓ temp.

- easily removed at ↓ B.P (like acetone)

- non-flammable - in expensive.

Use Hot filtration & vacuum apparatus: → faster &

- Filter & use charcoal or vacuum filtration (95% dry)

↑ use fluted filter paper for rapid process

- vacuum pump has side suction & uses Buchner / Hirsch funnel & can remove soluble impurities

Acetanilide (N-phenylacetamide)

- recrystallizes as white leaflets from water

- Determine m.p before & after to find efficiency.

\* hot solvents can fully dissolve solid become saturated at ↓ temp forming crystals.

\* soluble impurities will be left out in solvent.

\* use water Bath

\* % recovery →  $\frac{\text{crude}}{\text{pure}} \times 100$

# Exp. 8 Aspirin synthesis & Analysis

Q<sub>1</sub>) Who synthesized Aspirin first?  
 Felix Hoffmann 1897.  
 in pure & stable form

Aspirin → pain reliever (Acetyl salicylic acid)  
 white crystalline powder.  
 Salicylic acid → O=C(O)c1ccccc1O  
 Acetyl group → CC(=O)-  
 ↓  
 has an ester grp.

Q<sub>2</sub>) Is it displayed in WHO?  
 Yes, it's the safest & most effective, in list of essential medicines

∴ organic ester & acid  
 \* used as pain killer due to salicylate ion basic

Q<sub>3</sub>) uses of Aspirin:  
 Analgesic, fever-reducing, antipyretic, inflammation

Preparation:- By reacting salicylic acid with acetic anhydride gives Aspirin + Acetic acid → vinegar odour  
 - H<sup>+</sup> is used as a catalyst & prevents equilibrium  
 - nucleophilic subs. rxn.  
 - Ratio is 1:1:1:1

Q<sub>4</sub>) what is mp of pure Aspirin?  
135°C used as purity test

→ impurities ↓ mp  
 → if is imp. to use conc. H<sub>2</sub>SO<sub>4</sub> as it acts as a catalyst & prevents equilibrium.

Q<sub>5</sub>) what is an ideal solvent?  
 water as it removes some or all impurities.

- \* Analgesic → pain killer
- \* Aspirin → salicylate + acetate ions [Both basic]
- \* Aspirin → weak monoprotic acid. [gives one acidic hydrogen]



# Exp. 9 Rxn of functional grp. (1)

Q1) Name the aliphatic hydrocarbons:

Alkanes, Alkenes, Alkynes & Alicyclic (cyclohexane)

Q2) What does Aliphatic mean?

linear non cyclic

Q3) What reacts with  $\text{KMnO}_4$  in Toluene?

only the branch ( $\text{CH}_3$ ) not the ring.

Q4) How & what compound undergoes electrophilic sub?

- Aromatic: 'catalyst'
- using Lewis acid ( $\text{AlCl}_3$ )
- either Alkylation or Acylation

Q5) arrange compounds that produce more energy when burned.

cyclohexane > cyclohexene > alkene

Hydrocarbons - Carbon & Hydrogen

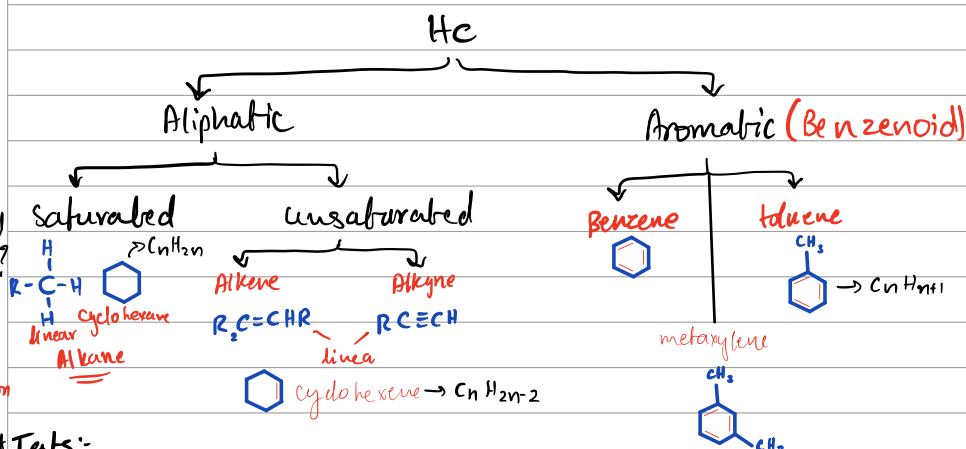
Alkanes - Saturated & unreactive Cyclo  $\rightarrow$  single bond

Alkenes - unsaturated (=) bonds & reactive cyclo  $\rightarrow$  double bond somewhere

Alkynes - unsaturated ( $\equiv$ ) bonds & reactive.

Aromatic - related to benzene 6C; Alternating (=) bond

$\rightarrow$  eg. meta xylene (dimethylbenzene)



Tests:-

1) Baeyers  $\sim$  using  $\text{KMnO}_4$  reacts with unsaturated aliphatic  $\rightarrow$  Brown ppt

$\rightarrow$  oxidizing agent deep purple.  $\bullet$  To detect presence of multiple bonds.  $\bullet$  dilute & cold.

2) Bromine  $\sim$  adding  $\text{Br}_2$  with heat & sunlight  $\rightarrow$  for Alkanes (substitution)

$\bullet$  only on Alkenes  $\rightarrow$  in dark.  $\bullet$  From yellow/orange  $\rightarrow$  colourless

3) Chloroform  $\sim$  Aromatic compounds [ $\text{CHCl}_3$  with  $\text{AlCl}_3$ ] Lewis acid

$\bullet$  Color depends on no. of rings.

$\bullet$  orange/red for Benzene  $\bullet$  Blue/purple for naphthalene

4) Rxn with  $\text{H}_2\text{SO}_4$   $\sim$  in aromatic  $\rightarrow$  undergoes sulfonation ' $\text{SO}_3\text{H}$ '

$\bullet$  In Benzene with conc.  $\text{H}_2\text{SO}_4 \rightarrow \text{SO}_3\text{H} \rightarrow$  sulfol group.

\* cyclic forms a ring of carbon atoms.

\* diene  $\rightarrow$  has 2 (=) bonds

\*  $\text{I}_2$  is also used like  $\text{Br}_2$  & used for determining degree of unsaturation

\* saturated  $\rightarrow$  clean burn; unsaturated  $\rightarrow$  produce soot.

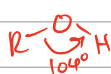
# Exp 10 Reaction of Functional group (II)

Q1) What are oxygen containing compounds?  
Aldehydes, ketones & Alcohols

Functional groups:-  
ketone ~ Carbonyl  $\begin{matrix} O \\ || \\ R-C-R \end{matrix}$   
Aldehyde ~ Carbonyl  $\begin{matrix} O \\ || \\ R-C-H \end{matrix}$   
Alcohol ~ hydroxyl  $\begin{matrix} OH \\ | \\ R \end{matrix}$

Q2) is C=O polar?  
Yes,  $\delta^+ \text{C} = \delta^- \text{O} \rightarrow sp^2$   
↳ electrophile  
Can react with nucleophile

→ in Alcohol ~ Oxygen is nucleophile, base &  $sp^3$



- primary → 1 R grp
- secondary → 2 R grps
- tertiary → 3 R grps

Q3) Determine  $H_3C-OH$   
methyl alcohol (methanol)

→ in ketones ~ ending them with -one eg. propanone

→ in Aldehydes ~ ending them with -al eg. propanal  
↳ longest chain containing C=O

Q4) is iodoform oxidizing?  
Yes, for methyl carbonyl or methyl carbinol

Reactions:- 1) 2, 4-DNP test orange/red to yellow/deep red  
- for aldehydes, ketones & their derivatives.



Q5) What are the results of Lucas test for 1ry, 2ry & 3ry -ol?

- layers separate immediately (3ry)
- takes 1-5 minutes (2ry)
- no rxn (1ry)

2) Fehling's test → To differentiate between aldehydes & ketones

- Active ingredient is  $Cu^{2+}$ , oxidizing agent sol.
- in Aldehyde → Carboxylate +  $Cu_2O$  (cuprous oxide) Red ppt.
- Also works as test for glucose → Red precipitate.
- with ketone → no reaction

Q6) What does chromic Anhydride test?  $H_2CrO_4$

Alcohols, 1ry, 2ry & 3ry  
 $\begin{matrix} \downarrow & \downarrow & \downarrow \\ COOH & \text{ketone} & \text{no rxn} \end{matrix}$

- oxidizing agent
- Tests Aldehyde too → COOH

3) Tollen's reagent → To differentiate between aldehydes & ketones

- Active ion is silver ( $Ag^+$ ), in basic medium, oxidizing
- with Aldehyde → gives silver mirror
- with ketone → no reaction

4) Iodoform Test → To check the presence of carbonyl compounds

- Reagents must have a methyl ( $CH_3$ ) group to react
- Iodine  $\xrightarrow{\text{in presence of NaOH}}$  gives carboxylate & yellow ppt (Iodoform)  $\hookrightarrow$  or triiodo methane

5) sodium Bisulfite → ( $NaHSO_3$ ) → addition reaction

- with both Aldehyde & ketone → crystalline product.

6) Lucas test → To differentiate between primary, secondary & tertiary alcohols

- $ZnCl_2 + HCl$  ← Reagent
- Results in insoluble Alkyl halide  $R_3CCl$  this forms layers in water

\* c1ccc(O)cc1 → phenol not alcohol

\* Glucose → Aldohexose, reducing sugar

Compound Name	Structure of Compound and Functional Group (red)	Example		
		Formula		Name
alkene	$C=C$	$C_2H_4$		ethene
alkyne	$C\equiv C$	$C_2H_2$		ethyne
alcohol	$R-\ddot{O}-H$	$CH_3CH_2OH$		ethanol
ether	$R-\ddot{O}-R'$	$(C_2H_5)_2O$		diethyl ether
aldehyde	$\begin{array}{c} :O: \\    \\ R-C-H \end{array}$	$CH_3CHO$		ethanal
ketone	$\begin{array}{c} :O: \\    \\ R-C-R' \end{array}$	$CH_3COCH_2CH_3$		methyl ethyl ketone
carboxylic acid	$\begin{array}{c} :O: \\    \\ R-C-\ddot{O}-H \end{array}$	$CH_3COOH$		acetic acid
ester	$\begin{array}{c} :O: \\    \\ R-C-\ddot{O}-R' \end{array}$	$CH_3CO_2CH_2CH_3$		ethyl acetate
amine	$\begin{array}{c} \ddot{N}-H \\   \\ H \end{array} \quad \begin{array}{c} \ddot{N}-H \\   \\ R' \end{array} \quad \begin{array}{c} \ddot{N}-R'' \\   \\ R' \end{array}$	$C_2H_5NH_2$		ethylamine
amide	$\begin{array}{c} :O: \\    \\ R-C-\ddot{N}-R' \\   \\ H \end{array}$	$CH_3CONH_2$		acetamide

Test	NaCl	Na <sub>2</sub> CO <sub>3</sub>	Na <sub>2</sub> SO <sub>4</sub>	NH <sub>4</sub> Cl	BaCl <sub>2</sub>	ZnSO <sub>4</sub>	unknown
AgNO <sub>3</sub>	P	P	P	P	P	P	P
NaOH	nr	nr	nr	g odor	nr	nr	nr
H <sub>2</sub> SO <sub>4</sub>	nr	g odor	nr	nr	P	nr	g odor
Ba(NO <sub>3</sub> ) <sub>2</sub>	nr	P	P	nr	nr	P	P