21

Purification and Characterisation of Organic Compounds

TOPIC 1
Methods of Purification

01 Given below are two statements. One is labelled as Assertion (A) and the other is labelled as Reason (R).

Assertion (A) A simple distillation can be used to separate a mixture of propanol and propanone.

Reason (R) Two liquids with a difference of more than 20°C in their boiling points can be separated by simple distillations.

In the light of the above statements, choose the most appropriate answer from the options given below.

[2021, 31 Aug Shift-I]

(a) (A) is false but (R) is true.
(b) Both (A) and (R) are correct but (R) is not the correct explanation of (A).
(c) (A) is true but (R) is false
(d) Both (A) and (R) are correct and (R) is the correct explanation of (A).

Ans. ***(d)***

Propanol and propanone can be separated by simple distillation technique as difference in boiling point of propanol and propanone is more than 20°C.

Boiling point of propanol = 97°C.

Boiling point of propanone = 56°C

Difference in boiling points = 41° C > 20° C

Hence, option (d) is correct.

02 Which purification technique is used for high boiling organic liquid compound (decomposes near its boiling point)?

[2021, 22 July Shift-II]

(a) Simple distillation
(b) Steam distillation
(c) Fractional distillation
(d) Reduced pressure distillation

Ans. ***(d)***

Distillation under reduced pressure is used to purify liquids having very high boiling points and those, which decompose at or below their boiling points.

Because the boiling point of liquids are decreased at reduced pressure. Organic compounds can be distilled at lower temperatures.

Such liquids are made to boil at a temperature lower than their normal boiling points by reducing the pressure on their surface.

By reducing pressure, it can be distilled at low boiling point to avoid their decomposition.

03 Given below are two statements.

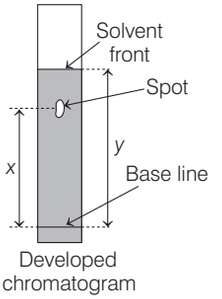
Statement I Retardation factor (R_f) can be measured in metre/centimetre.

Statement II R_f value of a compound remains constant in all solvents.

Choose the most appropriate answer from the options given below **[2021, 17 March Shift-I]**

(a) Statement I is true but statement II is false.
(b) Both statement I and statement II are true.
(c) Both statement I and statement II are false.
(d) Statement I is false but statement II is true.

Ans. ***(c)***



Developed chromatogram

$$R_f = \frac{\text{Distance moved by the substance from base line } (x)}{\text{Distance moved by the solvent from base line } (y)}$$

R_f (Retardation factor is dimensionless)

Different compounds are differently adsorbed in various.

So, R_f value of a compound varies with solvent and it is not constant.

Both statements I and II are false.

04 In chromatography technique, the purification of compound is independent of **[2021, 16 March Shift-I]**

(a) mobility or flow of solvent system
(b) solubility of the compound
(c) length of the column or TLC plate
(d) physical state of the pure compound

Ans. ***(d)***

In chromatography technique, the purification of compound is independent of physical state of the pure compound (stationary phase). Chromatography is based on the principle of adsorbtion. Different substances are differently adsorbed.

The technique of chromatography uses the difference in the rates at which the components of a mixture move through a porous medium (stationary phase) under the influence of some solvent or gas (moving phase).

05 Given below are two statements :
Statement I A mixture of chloroform and aniline can be separated by simple distillation.
Statement II When separating aniline from a mixture of aniline and water by steam distillation aniline boils below its boiling point.
In the light of the above statements, choose the most appropriate answer from the options given below. **[2021, 26 Feb Shift-I]**

(a) Statement I is false but statement II is true
(b) Both statement I and statement II are false
(c) Statement I is true but statement II is false
(d) Both statement I and statement II are true

Ans. ***(d)***

Statement I is true, i.e. a mixture of chloroform and aniline can be separated by simple distillation. Boiling points of chloroform (334 K) and aniline (457 K) differ largely. So, on boiling the mixture, vapours of $CHCl_3$ are formed first which is then condensed to pure liquid $CHCl_3$. Whereas, the vapours of aniline will form later and liquid aniline can be collected separately.

Statement II is also true, i.e. aniline and water can be separated by steam distillation technique. Aniline is steam volatile but immiscible with water. So, a mixture of aniline and water will boil close to but below 373 K. After distillation, the mixture of aniline (bottom layer) and water (top layer) can be separated by separating funnel.

So, both statements I and II are true (option-d).

06 Glycerol is separated in soap industries by **[2020, 3 Sep Shift-I]**

(a) fractional distillation
(b) differential extraction
(c) steam distillation
(d) distillation under reduced pressure

Ans. ***(d)***

In soap industries, glycerol is separated from spent lye using distillation under reduced pressure.

So, option (d) is correct.

(a) Fractional distillation is used to separate two liquids when difference in their boiling points is not much.
e.g. Separation of different fractions of crude oil in petroleum refinery.
(b) Differential extraction is based on different solubilities of an organic compound in different solvents. In this process same solvent is repeatedly used (continuous extraction) for extraction of the compound.
(c) Steam distillation method is used to separation substances which are steam volatile and are immiscible with water.
e.g. Separation of aniline water mixture.

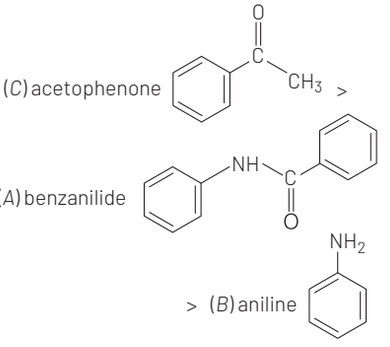
07 A chromatography column, packed with silica gel as stationary phase, was used to separate a mixture of compounds consisting of (*A*) benzanilide (*B*) aniline and (*C*) acetophenone. When the column is eluted with a mixture of solvents, hexane : ethyl acetate (20 : 80), the sequence of obtained compounds is **[2020, 7 Jan Shift-II]**

(a) (*C*), (*A*) and (*B*) (b) (*A*), (*B*) and (*C*)
(c) (*B*), (*C*) and (*A*) (d) (*B*), (*A*) and (*C*)

Ans. ***(a)***

In column chromatography, individual components of a mixture are separated by elution (washing with solvents). The component with relatively stronger rate of adsorption attached with mobile phase (solvents) move faster down the column (greater R_f value), and gets eluted first, followed by other components in the decreasing order of R_f values.

In the given separation, the solvent used has greater polarity due to greater composition of polar solvent ethyl acetate (80%), and therefore, more polar component (having greater dipole moment) of mixture will have more R_f value and will get eluted faster. Dipole moment of components in mixture is in the order :



∴ The sequence of obtained compounds is (*C*) > (*A*) > (*B*)

08 A flask contains a mixture of isohexane and 3-methylpentane. One of the liquids boils at 63°C while the other boils at 60°C. What is the best way to separate the two liquids and which one will be distilled out first? **[2020, 8 Jan Shift-I]**

(a) Fractional distillation 3-methylpentane
(b) Fractional distillation, isohexane
(c) Simple distillation, 3-methylpentane
(d) Simple distillation, isohexane

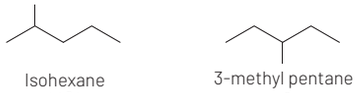
Ans. ***(b)***

The boiling points of the given compounds are very close.

∴ Simple distillation can't be used.

Fractional distillation is only suitable to separate the two liquids.

Further, the liquid with lower boiling point distills out first. Since, 3-methyl pentane has a more symmetrical structure as compared to isohexane. Therefore, it has a greater area of contact and better interaction between molecules. This accounts for the greater boiling point of 3-methyl pentane as compared to isohexane.



Isohexane 60°C | 3-methyl pentane 63°C

09 The principle of column chromatography is

[2019, 10 April Shift-I]

(a) differential absorption of the substances on the solid phase
(b) differential adsorption of the substances on the solid phase
(c) gravitational force
(d) capillary action

Ans. ***(b)***

In column chromatography, separation of mixture of compounds (adsorbate) takes place over a column of solid adsorbent (silica gel and Al_2O_3) packed in a glass tube.

When an appropriate eluant (liquid) is allowed to flow down the column, the compounds present in the mixture get adsorbed to different extent on the adsorbent column and thus complete separation takes place.

Thus, column chromatography is based on the differential adsorption of the substance on the solid phase.

10 In chromatography, which of the following statements is incorrect for R_f?

[2019, 10 April Shift-II]

(a) R_f value depends on the type of chromatography
(b) Higher R_f value means higher adsorption
(c) R_f value is dependent on the mobile phase
(d) The value of R_f can not be more than one

Ans. ***(b)***

In chromatography, the expression of retention factor (R_f) is

$$R_f = \frac{\text{Distance travelled by the compound from origin}}{\text{Distance travelled by the solvent from origin}} < 1$$

The value of R_f signifies the relative ratio of migration of each component of the mixture with respect to the developing solvent used. R_f value depends on the type of adsorption chromatography like TLC (Thin-Layer Chromatography), paper chromatography etc. The R_f value is also the characteristic of a compound (sample) for a given developing solvent at a given temperature.

When the compound in the sample (usually less polar) is weakly adsorbed the spot will travel a shorter distance from the origin and hence the R_f value will be decreased.

11 If dichloromethane (DCM) and water (H_2O) are used for differential extraction, which one of the following statements is correct?

(a) DCM and H_2O would stay as lower and upper layer respectively in the S.F.
(b) DCM and H_2O would stay as upper and lower layer respectively in the separating funnel (SF)
(c) DCM and H_2O will be miscible clearly
(d) DCM and H_2O will make turbid/colloidal mixture

[2019, 10 Jan Shift-I]

Ans. ***(a)***

Dichloromethane, DCM (CH_2Cl_2) is heavier (density = 1.3266 g cm^{-3}) than water (density = 1g cm^{-3}). So, DCM and H_2O will stay as lower and upper layer respectively in the separating funnel (SF).

12 The correct match between items I and II is

[2019, 11 Jan Shift-I]

	Item I (Mixture)		**Item II** (Separation method)
A.	H_2O : Sugar	P.	Sublimation
B.	H_2O : Aniline	Q.	Recrystallisation
C.	H_2O : Toluene	R.	Steam distillation
		S.	Differential extraction

(a) (A)→(Q); (B)→(R); (C)→(S)
(b) (A)→(Q); (B)→(R); (C)→(P)
(c) (A)→(S); (B)→(R); (C)→(P)
(d) (A)→(R); (B)→(P); (C)→(S)

Ans. ***(a)***

The correct option is :
(A)→(Q); (B)→(R); (C)→(S)

(A) H_2O and sugar mixture They do not react chemically. On heating, solubility of sugar in H_2O increases and on rapid cooling of saturated solution, sugar recrystallises (*Q*).

(B) H_2O and aniline mixture Aniline is steam volatile but insoluble in H_2O. So, steam distillation (*R*) is employed for their separation.

(C) H_2O and toluene mixture Toluene is steam non-volatile and also insoluble in H_2O. So, differential extraction method (S) can be used to separate them.

13 The distillation technique most suited for separating glycerol from spent lye in the soap industry is

[JEE Main 2016]

(a) fractional distillation
(b) steam distillation
(c) distillation under reduced pressure
(d) simple distillation

Ans. ***(c)***

Glycerol with high boiling point (290°C) can be separated from spent lye by distillation under reduced pressure. This process is used to purify liquids having very high boiling points. By this process, liquid is made to boil at lower temperature than its boiling point by lowering the pressure on its surface.

TOPIC 2
Qualitative Analysis

14 The metal that can be purified economically by fractional distillation method is

[2021, 20 July Shift-I]

(a) Fe (b) Zn (c) Cu (d) Ni

Ans. ***(b)***

Zinc can be purified economically by fractional distillation.

Fractional distillation process utilises the boiling point difference between metal and that of impurity. Using this process, crude zinc containing Cd, Fe and Pb as impurities can be refined.

15 In the sulphur estimation, 0.471 g of an organic compound gave 1.44 g of barium sulphate. The percentage of sulphur in the compound is ..... %.
(Nearest integer)
(Atomic mass of Ba = 137 u)

[2021, 26 Aug Shift-II]

Ans. ***(42)***

Atomic mass of sulphur is 32 g.

Molecular weight of $BaSO_4$ is 233 g.

So, weight of sulphur in $BaSO_4$

$$= \frac{\text{Atomic mass of sulphur}}{\text{Molecular weight of } BaSO_4} \times \text{Weight of } BaSO_4$$

$$= \frac{32}{233} \times 1.44$$

Percentage of sulphur

$$= \frac{\text{Weight of sulphur}}{\text{Weight of organic compound}} \times 100$$

$$= \frac{32}{233} \times \frac{1.44}{0.471} \times 100 = 41.98 \simeq 42\%$$

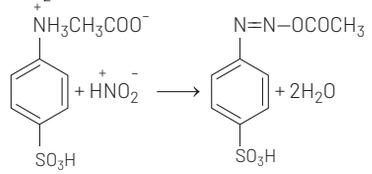
16 Reagent, 1-naphthylamine and sulphanilic acid in acetic acid is used for the detection of

[2021, 18 March Shift-I]

(a) N_2O (b) NO_3^- (c) NO (d) NO_2^-

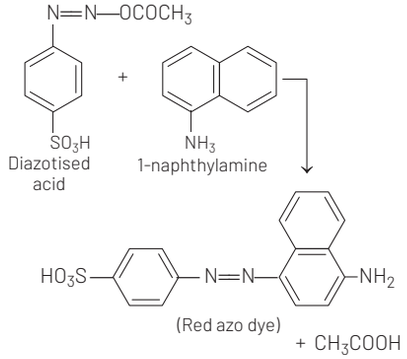
Ans. ***(d)***

When a solution is acidified with acetic acid, sulphanilic acid and then 1-naphthylamine is added, the red coloured precipitate obtain indicates presence of NO_2^- anions. For detection of NO_2^- following test is used.



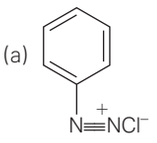
Sulphanilic acid solution

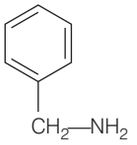
Above reagent is used to detect NO_2^- ion.



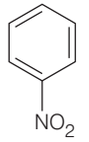
17 Nitrogen can be estimated by Kjeldahl's method for which of the following compound ?

[2021, 17 March Shift-II]

(a) 

(b) 

(c) 

(d) 

Ans. ***(b)***

Nitrogen can be estimated by Kjeldahl's method for the benzyl amine as in this compound nitrogen is not the part of ring and is free to react.

Because this method can be readily applied to the compound in which nitrogen is free to react with the reagent. The compounds which have nitrogen in the ring (like pyridine), an azo compound, or in nitro compounds are not readily converted into the ammonium sulphate by the action of sulphuric acid.

18 Match the following :

	Test / Method		Reagent
I.	Lucas test	(A)	$C_6H_5SO_2Cl$/ KOH
II.	Dumas method	(B)	HNO_3 / $AgNO_3$
III.	Kjeldahl's method	(C)	CuO /CO_2
IV.	Hinsberg test	(D)	Conc. HCl and $ZnCl_2$
		(E)	H_2SO_4

[2020, 6 Sep Shift-II]

(a) (I)-(D), (II)-(C), (III)-(B), (IV)-(E)
(b) (I)-(B), (II)-(D), (III)-(E), (IV)-(A)
(c) (I)-(D), (II)-(C), (III)-(E), (IV)-(A)
(d) (I)-(B), (II)-(A), (III)-(C), (IV)-(D)

Ans. ***(c)***

Correct match is
I → (D), II → (C), III → (E), IV → (A)

(I) Lucas test → Conc.HCl + $ZnCl_2$
It is a solution of anhydrous zinc chloride in concentrated hydrochloric acid. This solution is used to classify alcohols of low molecular weight. Primary, secondary and tertiary alcohols are classified based on their reactivity with the Lucas reagent.

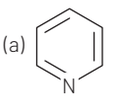
(II) Duma's method → CuO / CO_2
This method is based upon the fact that nitrogenous compound when heated with cupric oxide in an atmosphere of CO_2, yield free nitrogen. Traces of oxide of nitrogen, which may be formed in some cases, are reduced to elemental nitrogen by passing over heated copper spiral.

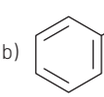
(III) Kjeldahl's method → H_2SO_4
This method is used for the quantitative determination of nitrogen containing organic substances. In this method, consists of heating a sample at 360-410°C with concentrated sulphuric acid (H_2SO_4), which decomposes the organic sample by oxidation to liberate the reduced nitrogen as ammonium sulphate.

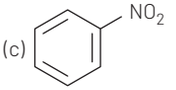
(IV) Hinsberg test →
$C_6H_5SO_2Cl$ / *aq*. KOH
Hinsberg reagent is an alternative name for benzene sulphonyl chloride.
This name is given for its use in the Hinsberg test for the detection and distinction of primary, secondary and tertiary amine in a given sample.
So, correct match is option (c).

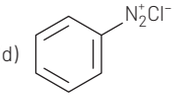
19 Which of the following compounds will be suitable for Kjeldahl's method for nitrogen estimation?

[JEE Main 2018]

(a) 

(b) 

(c) 

(d) 

Ans. ***(b)***

Estimation of nitrogen through Kjeldahl's method is not suitable for organic compounds containing nitrogen in ring or nitrogen in nitro or azo groups. It is because of the fact that nitrogen of these compounds does not show conversion to Ammonium sulphate ($(NH_4)_2SO_4$) during the process. Hence, among the given compounds only aniline can be used suitably for estimation of nitrogen by Kjeldahl's method.

TOPIC 3
Quantitative Analysis

20 The transformation occurring in Duma's method is given below

$$C_2H_7N + \left(2x + \frac{y}{2}\right)CuO \longrightarrow x\,CO_2 + \frac{y}{2}H_2O + \frac{z}{2}N_2 + \left(2x + \frac{y}{2}\right)Cu$$

The value of *y* is ..... . (Integer answer) **[2021, 31 Aug Shift-II]**

Ans. ***(7)***

For the reaction

$$C_2H_7N + \left(2x + \frac{y}{2}\right)CuO \longrightarrow x\,CO_2 + \frac{y}{2}H_2O + \frac{z}{2}N_2 + \left(2x + \frac{y}{2}\right)Cu$$

On reactant side number of H-atom = 7

On product side number of H-atom

$$= \frac{y}{2} \times 2$$

$$7 = \frac{y}{2} \times 2$$

$$\therefore \quad y = 7$$

21 The number of moles of CuO, that will be utilised in Dumas method for estimation nitrogen in a sample of 57.5 g of N, N-dimethylaminopentane is ..... $\times 10^{-2}$. (Nearest integer) **[2021, 27 Aug Shift-I]**

Ans. ***(1125)***

In Dumas method,

$$C_xH_yN_z + \left(2x + \frac{y}{2}\right)CuO \longrightarrow xCO_2 + \frac{y}{2}H_2O + \frac{z}{2} + \left(2x + \frac{y}{2}\right)Cu$$

N,N-dimethylaminopentane has formula $C_7H_{17}N$.

So, relating with $C_xH_yN_z$

$$x = 7;\ y = 17;\ z = 1$$

Molar mass of $C_7H_{17}N = 115$ g

1 mole $C_7H_{17}N$ requires $= \left(2x + \frac{y}{2}\right)CuO$

$= 22.5$ moles of CuO

57.5 g i.e. $\left(\frac{57.5}{115}\right)C_7H_{17}N$ will utilise

$$= \frac{22.5}{115} \times 57.5 \text{ moles of CuO}$$

$= 11.25$ g mol

$\approx 1125 \times 10^{-2}$ mol.

22 In carius method for estimation of halogens, 0.2 g of an organic compound gave 0.188 g of AgBr. The percentage of bromine in the compound is ..... (Nearest integer)

[Atomic mass; Ag = 108, Br = 80] **[2021, 27 Aug Shift-I]**

Ans. ***(40)***

Mass of bromine = 80 u

Mass of silver = 108 u

Mass of AgBr = 108 + 80 = 188 u

Weight of organic compound = 0.2 g

$$\% \text{ of Br} = \frac{\text{Molar mass of Br}}{\text{Molar mass of AgBr}} \times \frac{\text{Weight of AgBr}}{\text{Weight of organic compound}} \times 100$$

$$= \frac{80}{188} \times \frac{0.188}{0.2} \times 100 = 40\%.$$

23 0.8 g of an organic compound was analysed by Kjeldahl's method for the estimation of nitrogen. If the percentage of nitrogen in the compound was found to be 42%, then ..... mL of 1 M H_2SO_4 would have been neutralised by the ammonia evolved during the analysis. **[2021, 25 July Shift-II]**

Ans. ***(12)***

Organic compound analysed by Kjeldahl's method = 0.8 g

$$\text{Weight of nitrogen} = \left(\frac{42}{100} \times 0.8\right)\text{g}$$

$$\text{Mole of N} = \frac{\text{weight of N}}{\text{molar mass of N}}$$

$$\text{Mole of N} = \frac{42 \times 0.8}{100 \times 14} = \frac{2.4}{100} \text{ mol}$$

$$\text{Mole of } NH_3 = \frac{2.4}{100} \text{ mol}$$

Reaction,

$$2NH_3 + H_2SO_4 \longrightarrow (NH_4)_2SO_4$$

$$\frac{2.4}{100}\text{ mol} \quad \frac{1.2}{100}\text{ mol}$$

$\therefore$ 2 moles of NH_3 will neutralise 1 mole of H_2SO_4.

Given 1 M H_2SO_4 is neutralised by NH_3

$\therefore$ Molarity of

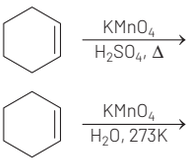
$$H_2SO_4 = \frac{\text{Moles of } H_2SO_4}{\text{Volume of solution (L)}}$$

$$1\text{M} = \frac{1.2}{100} \times \frac{1}{V_{H_2SO_4}(\text{L})}$$

$$\therefore \text{ Number of mole of } H_2SO_4 = \frac{1{\cdot}2}{100}$$

$$V_{H_2SO_4} = \frac{1.2}{100}\text{L} \quad \{1\text{L} = 1000\text{ mL}\}$$

$$V_{H_2SO_4} = 12\text{ mL}$$

24 

For above chemical reactions, identify the correct statement from the following **[2021, 20 July Shift-I]**

(a) Both compound '*A*' and compound '*B*' are dicarboxylic acids.

(b) Both compound '*A*' and compound '*B*' are diols.

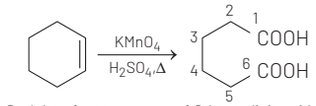
(c) Compound '*A*' is diol and compound '*B*' is dicarboxylic acid.

(d) Compound '*A*' is dicarboxylic acid and compound '*B*' is diol.

Ans. ***(d)***

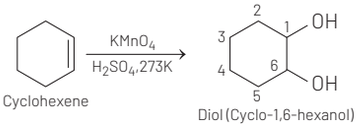
Compound '*A*' is dicarboxylic acid and compound '*B*' is 'diol'. Alkenes forms dicarboxylic acid on treating with hot acidic $KMnO_4$.

Chemical reactions are as follows



Cyclohex-1-ene — 1,6-hexa-dioic acid (Dicarboxylic acid) (*A*)

Alkenes on treating with $KMnO_4$ in water at room temperature gives diol.



Cyclohexene — Diol (Cyclo-1,6-hexanol) (*B*)

25 Methylation of 10 g of benzene gave 9.2 g of toluene. Calculate the percentage yield of toluene ..... . (Nearest integer) **[2021, 22 July Shift-II]**

Ans. ***(78)***

For the reaction,

$$C_6H_6(10\text{g}) + CH_3Cl + \text{Anhyd. } AlCl_3 \longrightarrow C_6H_5CH_3(9.2\text{ g})$$

1 mole of benzene produced 1 mole of toluene, if reaction yield is 100%.

78 g of benzene produced 92 g of toluene, if reaction yield is 100%.

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

$$\% \text{ yield} = \frac{9.2}{\frac{92}{78} \times 10} \times 100 = 78\%$$

Hence, % yield of toluene is 78.

26 When 0.15 g of an organic compound was analysed using Carius method for estimation of bromine, 0.2397 g of AgBr was obtained. The percentage of bromine in the organic compound is ..... . (Nearest integer)

[Atomic mass : Silver = 108, bromine = 80] **[2021, 20 July Shift-II]**

Ans. ***(68)***

Carius halogen method is generally used to determine the quantity of halogens in a chemical compound. In this method, heat known mass of an organic compound with fuming HNO_3 in presence of $AgNO_3$ in a hard glass tube.

Moles of Br = Moles of AgBr obtained

$$\text{Mass of Br} = \frac{\text{Mass of AgBr}}{\text{Molecular weight of AgBr}} \times \text{Molecular weight of Br}$$

$$= \frac{0.2397}{188} \times 80 \text{ g}$$

$$\% \text{ of Br} = \frac{W_{Br}}{W_{Total}} \times 100$$

$$= \frac{0.2397 \times 80}{188 \times 0.15} \times 100 = 0.85 \times 80 = 68$$

27 In Carius method, halogen containing organic compound is heated with fuming nitric acid in the presence of **[2021, 20 July Shift-II**

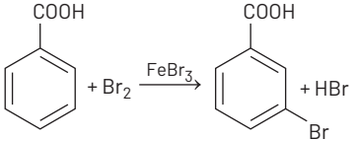
(a) HNO_3 (b) $AgNO_3$
(c) $CuSO_4$ (d) $BaSO_4$

Ans. ***(b)***

Organic compound is heated with fuming nitric acid in the presence of silver nitrate in Carius method.

This method used for quantitative determination of halogens in chemical substance. Method is based on the fact that when organic compound containing halogen (Cl, Br, I) is heated in sealed tube with fuming HNO_3 in presence of excess of $AgNO_3$, silver halide is formed.

28



Consider the above reaction where 6.1 g of benzoic acid is used to get 7.8 g of *m*-bromo benzoic acid. The percentage yield of the product is ..... .

(Round off to the nearest integer).

[Given : Atomic masses : C = 12.0 u, H = 1.0 u, O = 16.0u, Br = 80.0 u] **[2021, 18 March Shift-II]**

Ans. ***(78)***

Moles of benzoic acid

$$= \frac{6.1}{122} \frac{\text{(weight)}}{\text{(molecular weight)}}$$

= moles of *m*-bromobenzoic acid

So, weight of *m*-bromobenzoic acid

$$= \frac{6.1}{122} \times 201 \text{ g}$$

$$= 10.05 \text{ g}$$

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

$$= \frac{7.8}{10.05} \times 100 = 77.61\% \simeq 78\%$$

29 ..... grams of 3-hydroxy propanal (MW = 74) must be dehydrated to produce 7.8 g of acrolein (MW= 56) (C_3H_4O), if the percentage yield is 64 (Round off to the nearest integer).

[Given : Atomic masses : C = 12.0 u, H = 1.0 u, O = 16.0 u] **[2021, 18 March Shift-I]**

Ans. ***(16)***

On reaction

$$\underset{\substack{\text{3-hydroxy propanal} \\ \text{(mol. wt = 74)}}}{HO{-}CH_2{-}CH_2{-}CHO} \xrightarrow[64\%]{\Delta} \underset{\substack{\text{Acrolein} \\ \text{(mol. wt=56)}}}{C_3H_4O} + H_2O$$

Let's assume required man of 3-hydroxypropanal be *x* to produce 0.64 g acrolein.

$\therefore$ Number of moles = $x/74$

So, $\frac{x}{74}$ mol gives 0.64 g yield.

Now, 7.8 g of acrolein gives,

$$\frac{x}{74} \times 0.64 = \frac{7.8}{56}$$

$$\Rightarrow \quad x = 16.10 \text{ or } x \cong 16.00$$

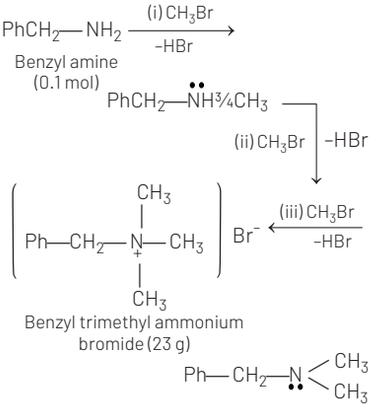
30 A reaction of 0.1 mole of benzylamine with bromomethane gave 23 g of benzyl trimethyl ammonium bromide. The number of moles of bromomethane consumed in this reaction are $n \times 10^{-1}$, when n = ... (Round off to the nearest integer).

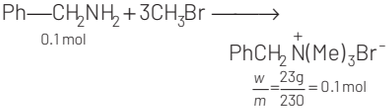
(Given : Atomic masses : C = 12.0 u, H = 1.0 u, N = 14.0 u, Br = 80.0 u] **[2021, 18 March Shift-I]**

Ans. ***(3)***

Benzylamine reacts with bromoethane to produce benzyltrimethyl ammonium bromide.

The reaction is as follows :





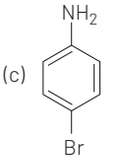
$$\Rightarrow \qquad 0.1 \times 3 = 0.3$$

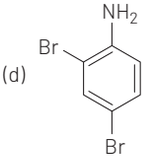
Total moles of $CH_3Br = 0.3$

$$= 3 \times 10^{-1} \text{ mol.}$$

31 In Carius method of estimation of halogen 0.172 g of an organic compound showed presence of 0.08 g of bromine. Which of these is the correct structure of the compound? **[2020, 2 Sep Shift-I]**

(a) $H_3C{-}Br$ (b) $H_3C{-}CH_2Br$

(c) 

(d) 

Ans. ***(c)***

In the organic compound

$$\text{Br\%} = \frac{0.08}{0.172} \times 100 = 46.51$$

Now, let us calculate Br % in the given compounds.

(a) CH_3Br ($M = 95$)

$$\Rightarrow \text{Br \%} = \frac{80}{95} \times 100 = 84.21$$

(b) C_2H_5Br ($M = 109$)

$$\Rightarrow Br\% = \frac{80}{109} \times 100 = 73.39$$

(c) C_6H_6NBr ($M = 172$)

$$\Rightarrow Br\% = \frac{80}{172} \times 100 = 46.51$$

(d) $C_6H_5NBr_2$ ($M = 251$)

$$\Rightarrow Br\% = \frac{160}{251} \times 100 = 63.74$$

So, correct structure of compound is (c).

32 In an estimation of bromine by Carius method, 1.6 g of an organic compound gave 1.88 g of AgBr. The mass percentage of bromine in the compound is ..... . (Atomic mass, Ag = 108, Br = 80 g mol^{-1})

[2020, 6 Sep Shift-I]

Ans. ***(50)***

Molar mass of AgBr = 108 + 80 $\Rightarrow$ 188 g/mol

Weight of organic compound = 1.6 g

Weight of AgBr = 1.88 g

$$\% \text{ of Br} = \frac{\text{Weight of AgBr} \times 80}{\text{Weight of organic compound} \times 188} \times 100$$

$$= \frac{1.88 \times 80}{1.6 \times 188} \times 100 = 50\%$$

Hence, the correct answer is 50.

33 An organic compound is estimated through Dumas method and was found to evolved 6 moles of CO_2, 4 moles of H_2O and 1 mole of nitrogen gas. The formula of the compound is **[2019, 11 Jan Shift-I]**

(a) C_6H_8N (b) $C_{12}H_8N$
(c) $C_{12}H_8N_2$ (d) $C_6H_8N_2$

Ans. ***(d)***

In Dumas method, organic compound is heated with dry cupric oxide in a combustion tube in the atmosphere of CO_2. Upon heating, C and H present are oxidised to CO_2 and water vapours while N_2 is set free.

Let, the molecular formula of the organic compound (1 mol) be $C_xH_yN_z$. In Dumas method,

$$\underset{1\text{ mol}}{C_xH_yN_z} + \left(2x + \frac{y}{2}\right)CuO \rightarrow xCO_2$$

$$x \text{ mol} \quad \frac{y}{2} \text{ mol} \quad \frac{z}{2} \text{ mol}$$

$$+ \frac{y}{2}H_2O + \frac{z}{2}N_2 + \left(2x + \frac{y}{2}\right)Cu$$

Now, $x = 6, \frac{y}{2} = 4 \Rightarrow y = 8$ and $\frac{z}{2} = 1$

$\Rightarrow \quad z = 2$

$\therefore$ Molecular formula of the compound is $C_6H_8N_2$.

34 In Carius method of estimation of halogens, 250 mg of an organic compound gave 141 mg of AgBr. The percentage of bromine in the compound is (at. mass Ag = 108, Br = 80) **[JEE Main 2015]**

(a) 24 (b) 36
(c) 48 (d) 60

Ans. ***(a)***

Given, Weight of organic compound = 250 mg

Weight of AgBr = 141 mg

$\therefore$ According to formula of % of bromine by Carius method

$$\% \text{ of Br} = \frac{\text{Atomic weight of Br}}{\text{Molecular weight of Ag Br}} \times \frac{\text{Weight of AgBr}}{\text{Weight of organic bromide}} \times 100$$

$$\therefore \% \text{ of Br} = \frac{80}{188} \times \frac{141}{250} \times 100$$

$$= \frac{1128000}{47000}$$

$$= 24\%$$

35 For the estimation of nitrogen, 1.4 g of an organic compound was digested by Kjeldahl's method and the evolved ammonia was absorbed in 60 mL of $M/10$ sulphuric acid. The unreacted acid required 20 mL of $M/10$ sodium hydroxide for the complete neutralization. The percentage of nitrogen in the compound is

[JEE Main 2014]

(a) 6% (b) 10%
(c) 3% (d) 5%

Ans. ***(b)***

Mass of an organic compound (OC) = 1.4 g

Suppose x m mole of N-atom is present in organic compound. Thus,

$$\text{Organic compound} \xrightarrow[\text{method}]{\text{Kjeldahl's}} \underset{x \text{ m mole}}{NH_3}$$

Initial m mol of $H_2SO_4 = 60 \times \frac{M}{10} = 6$ mmol

mmoles of NaOH required by

$$H_2SO_4 = 20 \times \frac{M}{10} = 2 \text{ mmol}$$

Involved reactions are

$$2NH_3 + \underset{\left(\begin{smallmatrix}6\text{ mmol}\\ \text{Initially taken}\end{smallmatrix}\right)}{H_2SO_4} \longrightarrow (NH_4)_2SO_4$$

$$H_2SO_4 + \underset{2\text{ mmol reacted}}{2NaOH} \longrightarrow Na_2SO_4 + 2H_2O$$

Hence, 1 mmole of H_2SO_4 reacted with NaOH.

$\Rightarrow$ mmoles of H_2SO_4 reacted from first equation = 6 – 1 = 5 mmoles

$\Rightarrow$ mmoles of NH_3 in first equation = 2 × 5 = 10 mmoles

$\Rightarrow$ mmoles of N atoms in the organic compound = 10 m moles

$$\Rightarrow \text{ mass of N} = 10 \times 10^{-3} \times 14$$

$$= 0.14 \text{ g \% of N in}$$

$$\text{OC} = \frac{\text{Mass of N in OC}}{\text{Total mass of OC}} \times 100$$

$$\therefore \quad \% \text{ of N} = \frac{0.14}{1.4} \times 100 = 10\%$$