Sample Question Paper - 23
Chemistry (043)
Class- XII, Session: 2021-22
TERM II

Time allowed : 2 hours *Maximum marks : 35*

General Instructions :

Read the following instructions carefully.

1. *There are 12 questions in this question paper with internal choice.*
2. *SECTION A - Q. No. 1 to 3 are very short answer questions carrying 2 marks each.*
3. *SECTION B - Q. No. 4 to 11 are short answer questions carrying 3 marks each.*
4. *SECTION C - Q. No. 12 is case based question carrying 5 marks.*
5. *All questions are compulsory.*
6. *Use of log tables and calculators is not allowed.*

Section - A

1. **Attempt any two question**

(a) Arrange the following compounds in the increasing order of their property indicated: **[2]**
$CH_3\ CH_2CH_3$, $CH_3CH_2NH_2$, CH_3CH_2OH. (dipole moment) AI

(b) Draw the structure of 3-methylpentanal.

(c) Draw the resonating structures of carboxylic acid.

2. The conductivity of a 0.01 M solution of acetic acid at 298 K is 1.65×10^{-4} S cm^{-1}. Calculate molar conductivity of the solution. **[2]**

3. Write the major product (s) in the following : **[1×2=2]**

(a) $CH_3 - CH = CH - CH_2 - CN \xrightarrow[\text{(ii) } H_3O]{\text{(i) Al H(i.Bu)}_2}$

(b) $CH_3 - CH_2 - OH \xrightarrow[\text{Pyridine}]{CrO_3}$

Section - B

4. When a coordination compound $CrCl_3 .6H_2O$ is mixed with $AgNO_3$ solution, 3 moles of AgCl are precipitated per mole of the compound. Write:

(a) Structural formula of the complex.

(b) IUPAC name of the complex.

(c) Magnetic and spin behaviour of the complex. **[1×3=3]** AI

OR

Write the hybridisation, shape and magnetic character of $[Fe(CN)_6]^{4-}$. **[1×3=3]** **AI**

5. **(a)** Which element of first transition series has highest 2nd ionization enthalpy ? **[1×3=3]**

(b) Which element of first transition series has highest 3rd ionization enthalpy?

(c) Why Zn, Cd and Hg are not considered transition metals?

6. Write structures of compounds A, B and C in each of the following chemical reaction: **[3]**

(a) $C_6H_3Br \xrightarrow{\text{Mg/dry ether}} A \xrightarrow[\text{(b) } H_3O^+]{\text{(a) } CO_2(g)} B \xrightarrow{PCl_3} C$

(b) $CH_3CN \xrightarrow[\text{(b) } H_3O^+]{\text{(a) } SnCl_2/HCl} A \xrightarrow{\text{dil NaOH}} B \xrightarrow{\Delta} C$

7. **(a)** What is a colloidal solution? **[1×3=3]**

(b) Explain a dispersed phase and a dispersion medium with an example.

(c) What do you understand by adsorption isotherm?

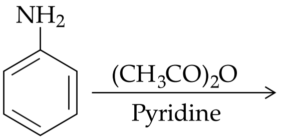
8. **(a)** Explain Kohlrausch's law of independent migration of ions. **[2+1]**

(b) Depict the galvanic cell in which the given reaction takes place.

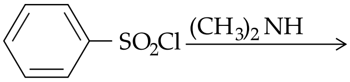
$Cu(s) + 2Ag^+(aq) \rightarrow 2Ag(s) + Cu^{2+}(aq)$

9. Write the structures of the main products of the following reactions: **[1×3=3]**

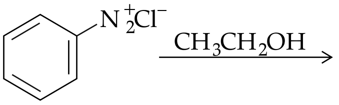
(a)



(b)



(c)



OR

(a) Give a simple chemical test to distinguish between aniline and N, N-dimethylaniline. **[1×3=3]**

(b) Arrange the following in the increasing order of their pk_b values: $C_6H_5NH_2$, $C_2H_5NH_2$, $C_6H_5NHCH_3$

(c) Write the IUPAC name of the compound given: $(CH_3CH_2)_2NCH_3$.

10. Give reasons: **[1×3=3]**

(a) Aniline does not undergo Friedal Crafts reaction.

(b) Aromatic primary amines cannot be prepared by Gabriel's phthalimide synthesis.

(c) Aliphatic amines are stronger base than ammonia.

OR

How does the following conversions take place as given below: **[1×3=3]**

(a) Nitrobenzene into aniline

(b) Ethanoic acid into methanamine

(c) Aniline to N-phenylethanamide

(Write the chemical equations involved.)

11. **(a)** Although, Zr belongs to 4*d* and Hf belongs to 5*d* transition series but it is quite difficult to separate them, explain why? **[2+1]**

(b) Out of Cu^+ and Cu^{2+}, which ion is unstable in aqueous solution and why?

OR

Give reasons: **[1×3=3]**

(a) Transition metals and their compounds show catalytic activities.

(b) Separation of a mixture of Lanthanoid elements is difficult.

(c) Zn, Cd and Hg are soft and have low melting point.

Section - C

12. Read the passage given below and answer the following questions:

Concentration dependence of rate is called differential rate equation. Integrated differential equations give relation between directly measured experimental data *i.e.*, concentration at different times and rate constant. The integrated rate equations are different for the reactions of different reaction orders. The first-order reaction has a rate constant $1.15 \times 10^{-3}\ s^{-1}$.

(a) How long will 5 g of this reactant take to reduce to 3 g?

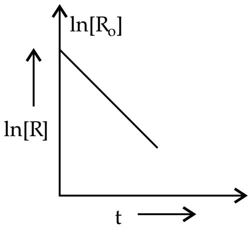
(b) Under which condition a bimolecular reaction is kinetically first order reaction?

(c) Calculate the half life of the reaction.

(d) Derive integrated rate equation for rate constant of a first order reaction.

OR

(d) For a chemical reaction $R \rightarrow P$, variation in ln $[R]$ vs time (t) plot is given below:



For this chemical reaction:

(i) Predict the order of reaction.

(ii) What is the unit of rate constant (k)? **[1+1+1+2]**

❑❑❑

Solution

CHEMISTRY - 043

Class 12 - Chemistry

Section - A

1. **(a)** $CH_3CH_2CH_3 < CH_3CH_2NH_2 < CH_3CH_2OH$

Since O is more electronegative than N, therefore, dipole moment of ethyl alcohol is higher than that of ethyl amine. Propane however, has the least dipole moment since it is almost a non-polar molecule. **[1]**

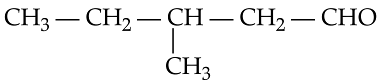
Commonly Made Error

- Students often do mistake in explanation of dipole moment order.
- Instead of electronegativity concept, they follow nature of electron withdrawing groups attached to $CH_3 - CH_2$ and answer is reversed.

Answering Tip

- More the electronegativity difference, more is the dipole moment. *E.g.*, Nitrogen is less electronegative than Oxygen.

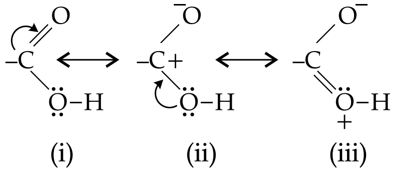
(b)



$$CH_3 - CH_2 - \underset{\displaystyle CH_3}{\underset{|}{CH}} - CH_2 - CHO$$ **[1]**

3-methylpentanal

(c) Carboxylic acid has three resonating structures.



[1]

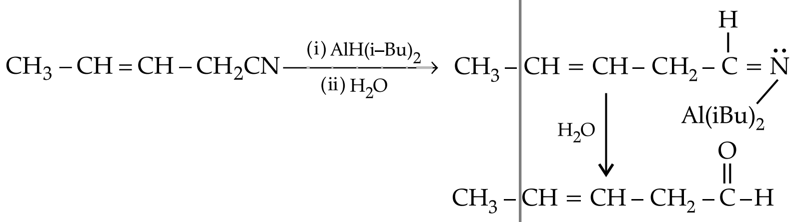
2. $$\Lambda_m = \frac{1000\kappa}{C}$$ ½

$$\Lambda_m = \frac{1.65 \times 10^{-4} \, S\,cm^{-1} \times 1000 \, cm^3 L^{-1}}{0.01 \, mol \, L^{-1}}$$ ½

$= 16.5 \, S \, cm^2 \, mol^{-1}$ 1

[CBSE Marking Scheme, 2018]

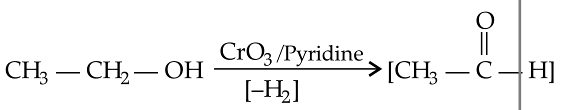
3. **(a)**



$$CH_3 - CH = CH - CH_2CN \xrightarrow[\text{(ii) } H_2O]{\text{(i) } AlH(i\text{–}Bu)_2} CH_3 - CH = CH - CH_2 - \overset{H}{C} = \ddot{N} - Al(iBu)_2 \xrightarrow{H_2O} CH_3 - CH = CH - CH_2 - \overset{O}{\overset{\|}{C}} - H$$

[1]

(b)



$$CH_3 - CH_2 - OH \xrightarrow[{[-H_2]}]{CrO_3/\text{Pyridine}} [CH_3 - \overset{O}{\overset{\|}{C}} - H]$$

[1]

Section - B

4. **(a)** $[Cr(H_2O)_6]Cl_3$ **[1]**

(b) Hexaquachromium (III) chloride **[1]**

(c) Paramagnetic and high spin **[½ + ½]**

[CBSE Marking Scheme, 2017]

OR

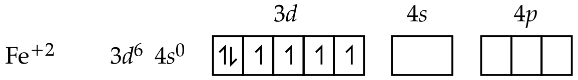
Hybridisation: d^2sp^3 **[1]**

Shape: Octahedral **[1]**

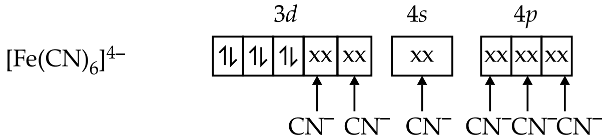
Magnetic character: Diamagnetic **[1]**

[CBSE Marking Scheme, 2016]

Detailed Answer:



CN⁻ is a strong field ligand



Hybridisation : d^2sp^3

Shape: Octahedral

There is no unpaired electron. Thus, it is diamagnetic in nature.

5. **(a)** Cu (Electronic configuration: $[Ar]3d^{10}4s^1$) has the highest 2nd ionization enthalpy as the second electron to be removed from the completely filled *d*-orbital. **[1]**

(b) Zinc (Electronic configuration $[Ar]3d^{10}4s^2$) has the highest 3rd ionization enthalpy as third electron is to be removed from completely filled *d*-orbital and has maximum stability. **[1]**

Commonly Made Error

- Students often misread the question and answer for 1st ionisation enthalpy.

Answering Tip

- Please note that in question, it has been asked about 2nd and 3rd ionization enthalpy.

(c) Elements of Group 12, Zn Cd and Hg are not considered as transition metals due to their fully filled *d*-orbitals. These do not show general properties of transition elements. **[1]**

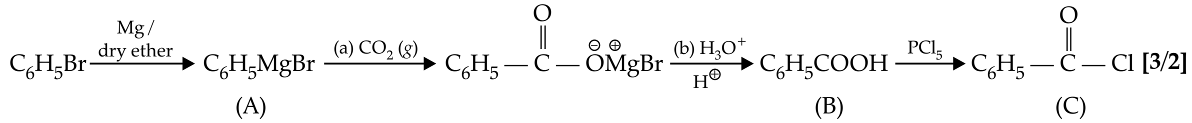
6. **(a)** A : C_6H_5MgBr B : C_6H_5COOH C : C_6H_5COCl **[½×3]**

(b) A : CH_3CHO B : $CH_3CH(OH)CH_2CHO$ C : $CH_3CH = CHCHO$ **[½×3]**

[CBSE Marking Scheme, 2017]

Detailed Answer :

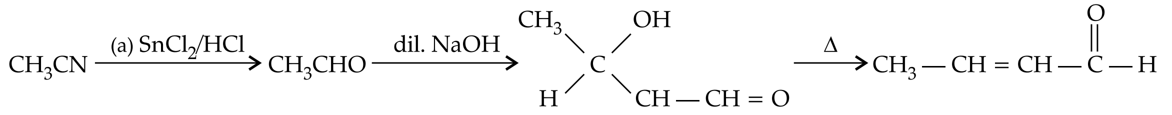
(a)



$$C_6H_5Br \xrightarrow{\text{Mg / dry ether}} \underset{(A)}{C_6H_5MgBr} \xrightarrow{\text{(a) } CO_2\,(g)} C_6H_5-\overset{O}{\overset{\|}{C}}-\overset{\ominus\ \oplus}{OMgBr} \xrightarrow[H^{\oplus}]{\text{(b) } H_3O^+} \underset{(B)}{C_6H_5COOH} \xrightarrow{PCl_5} \underset{(C)}{C_6H_5-\overset{O}{\overset{\|}{C}}-Cl}$$

[3/2]

(b)



$$CH_3CN \xrightarrow{\text{(a) } SnCl_2/HCl} CH_3CHO \xrightarrow{\text{dil. NaOH}} CH_3-\underset{H}{\overset{OH}{C}}-CH-CH=O \xrightarrow{\Delta} CH_3-CH=CH-\overset{O}{\overset{\|}{C}}-H$$

[3/2]

7. **(a)** Colloidal solution is the heterogenous mixture in which a material (dispersed phase) is evenly suspended in a liquid (dispersion medium). Some of the examples of colloidal solution are gelatin, muddy water, butter, blood and coloured glass. **[1]**

(b) Colloidal particles diameter ranges between 1 and 1000 nm.

The phase in which finely divided colloidal particles are dispersed is called the dispersed phase. The medium in which the colloidal particles are distributed is called the dispersion medium. Example: Starch represents the dispersed phase in a starch solution, while water is the dispersing medium. **[1]**

(c) A graph drawn between of adsorption of gas on the adsorbent and the pressure of the gas at constant temperature is called adsorption isotherm. **[1]**

8. **(a)** The Kohlrausch law of independent migration of ions states that limiting molar conductivity of an electrolyte can be represented as the sum of the individual contributions of the anion and cation of the electrolyte. **[1]**

Limiting equivalent molar conductivity of an electrolyte is the algebraic sum of limiting molar equivalent conductivities of its constituent ions.

$\Lambda_m^{\infty} = v_+\lambda_+^{\circ} + v_-\lambda_-^{\circ}$

Where, v_+, v_- = Number of cations and anions respectively.

$\lambda_+^{\circ}, \lambda_-^{\circ}$ = Limiting molar conductivities of cations and anions respectively.

Λ_+^{∞} = Limiting molar conductivity of electrolyte. **[1]**

(b) Oxidation half reaction:

$Cu(s) \rightarrow Cu^{2+}(aq) + 2e^-$

Reduction half reaction:

$Ag^+(aq) + e^- \rightarrow Ag(s)$

$Cu(s) \mid Cu^{2+}(aq) \mid\mid Ag^+(aq) \mid Ag(s)$

Anode (Oxidation) salt bridge Cathode (Reduction) **[1]**

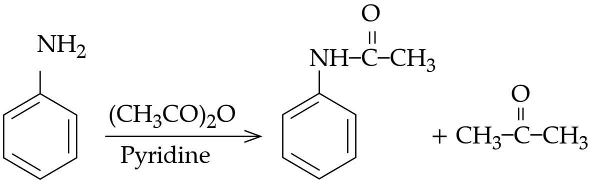
9. **(a)** N–Phenylethanamide, $C_6H_5NHCOCH_3$ **[1]**

(b) N, N-Dimethylbenzenesulphonamide, $C_6H_5SO_2N(CH_3)_2$ **[1]**

(c) C_6H_6, Benzene **[1]**

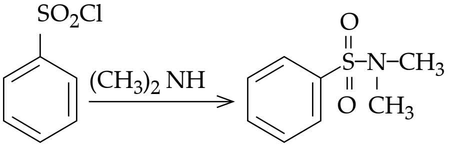
Detailed Answer:

(a)



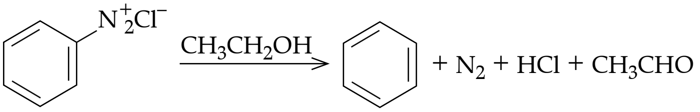
Acetanilide

(b)



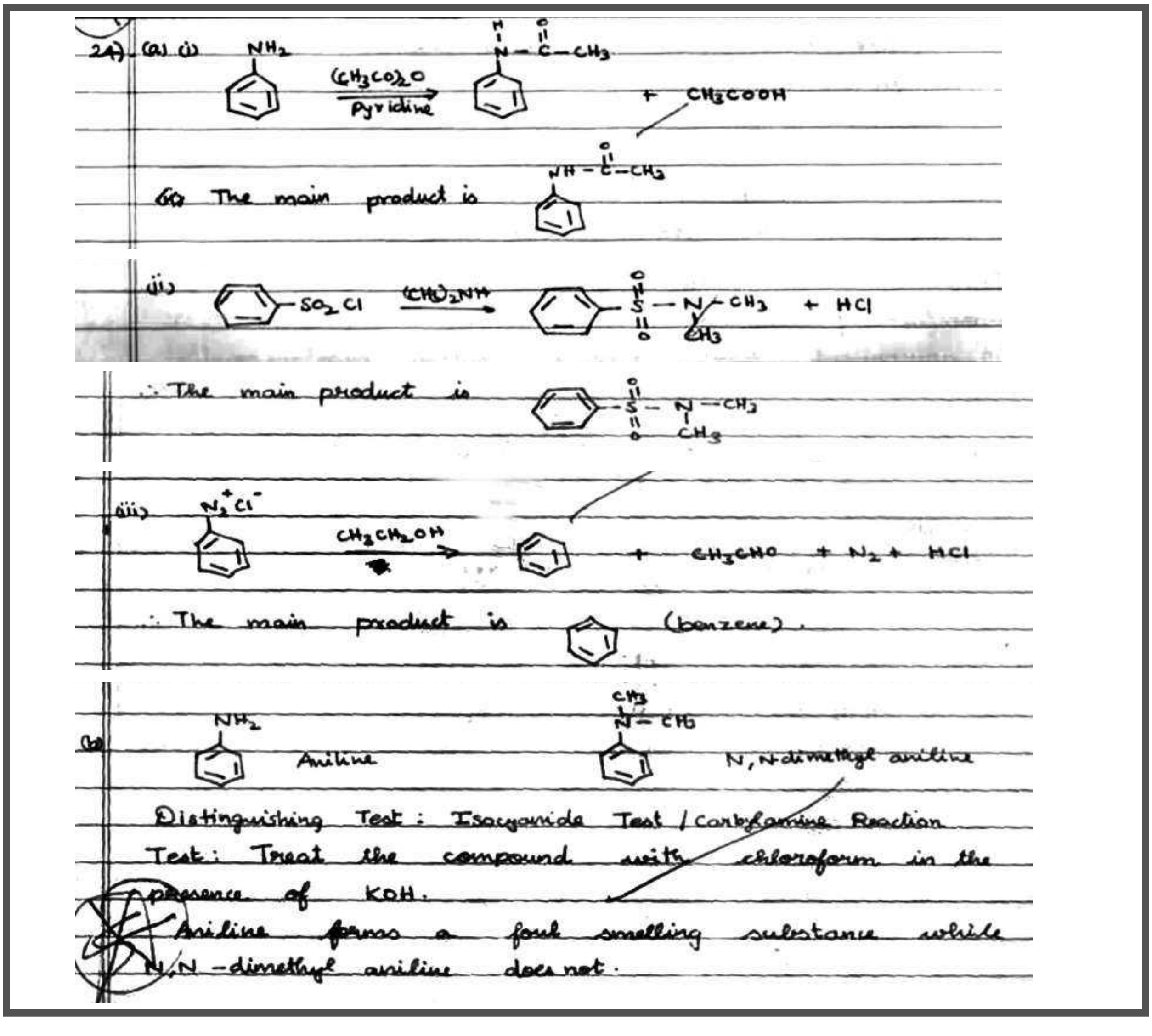
N, N-dimethyl benzene sulphonamide

(c)



Benzene

OR



24) (a) (i) NH_2 $\xrightarrow[\text{Pyridine}]{(CH_3CO)_2O}$ + CH_3COOH

(b) The main product is

(ii) $-SO_2Cl$ $\xrightarrow{(CH_3)_2NH}$ + HCl

∴ The main product is

(iii) $N_2^+Cl^-$ $\xrightarrow{CH_3CH_2OH}$ + CH_3CHO + N_2 + HCl

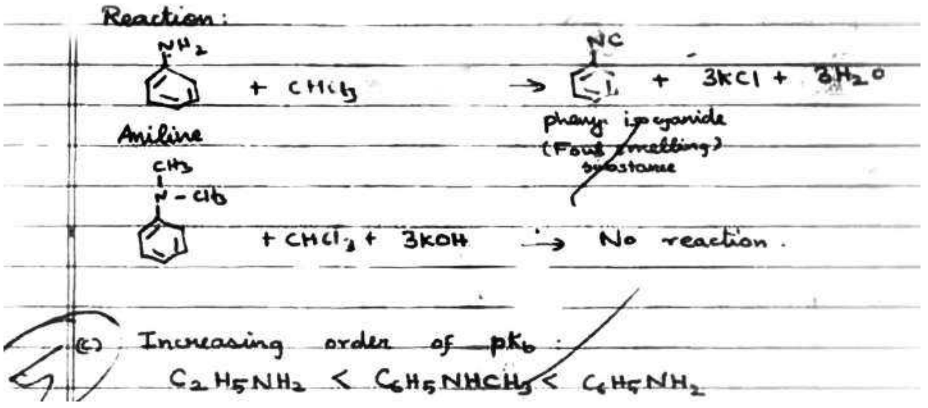
∴ The main product is (benzene).

(b) NH_2 Aniline N, N-dimethyl aniline

Distinguishing Test : Isocyanide Test / Carbylamine Reaction

Test: Treat the compound with chloroform in the presence of KOH.

Aniline forms a foul smelling substance while N,N-dimethyl aniline does not.



Reaction:

Aniline + $CHCl_3$ → + 3KCl + $3H_2O$

phenyl isocyanide (Foul smelling) substance

+ $CHCl_3$ + 3KOH → No reaction.

(c) Increasing order of pK_b:

$C_2H_5NH_2 < C_6H_5NHCH_3 < C_6H_5NH_2$

[3]

[Topper's Answer 2018]

OR

(a) Add chloroform in the presence of KOH and heat, then, aniline gives an offensive smell while N, N dimethylaniline does not. (or any other correct test) **[1]**

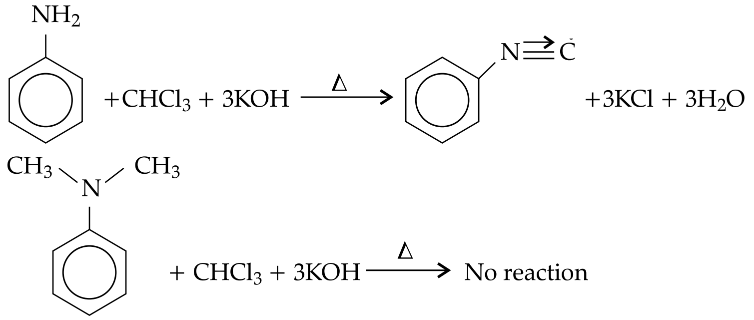
(b) $C_2H_5NH_2 < C_6H_5NHCH_3 < C_6H_5NH_2$ **[1]**

(c) N-Ethyl–N–methylethanamine. **[1]**

Detailed Answer:

(a) Aniline being a primary amine and N, N-dimethyl aniline being a tertiary amine are distinguished by carbylamine test.

Primary aniline on heating with chloroform and ethanolic potassium hydroxide, a foul smell of isocyanides or carbylamines is observed. Aniline is aromatic primary amine, thus it gives positive test but N, N-dimethylaniline is tertiary amine, so it does not give carbylamine test.



(b) Aliphatic amines are more basic than aromatic amines. Its is due to +I effect of alkyl groups of aliphatic amines and –R effect of aromatic amines. Thus, order of basic strength is:

$C_6H_5NH_2 < C_6H_2NHCH_3 < C_2H_5NH_2$

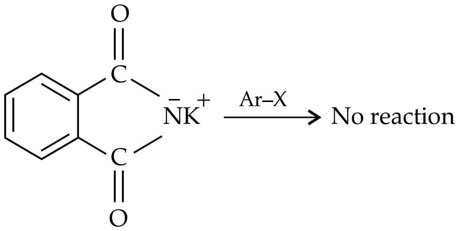
Hence, order of pk_b is:

$C_2H_5NH_2 < C_6H_5NHCH_3 < C_6H_5NH_2$

10. **(a)** Aniline does not undergo Friedel-Crafts reaction because aniline being a lewis base forms a salt with $AlCl_3$ which is a lewis acid. The amino group is not in a position to activate the benzene ring towards electrophilic substitution. Therefore, the reaction is not possible. **[1]**

$$C_6H_5\ddot{N}H_2 + AlCl_3 \longrightarrow C_6H_5NH_2^{+}AlCl_3^{-}$$

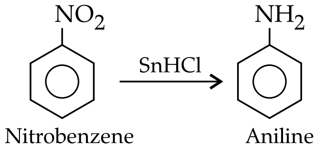
(b) Aromatic primary amines can not be prepared by Gabriel's phthalimide synthesis because aryl halides do not undergo nucleophilic substitutions (S_N2) with the potassium salt of phthalimide. So, the bond cleavage does not take place. **[1]**



(c) Aliphatic amines are stronger base than ammonia because the alkyl group in aliphatic amines has +I effect. So, the alkyl group tends to increase the electron density on the nitrogen atom. Thus, the electron releasing tendency of amines becomes more than that of ammonia. **[1]**

OR

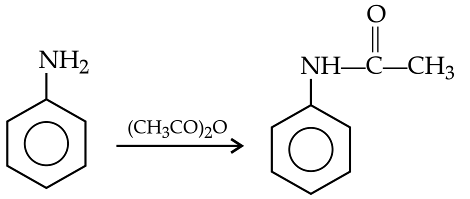
(a) Nitrobenzene into aniline **[1]**



(b) Ethanoic acid into methanamine **[1]**

$$\underset{\text{Ethanoic acid}}{CH_3COOH} \xrightarrow{NH_3} CH_3CONH_2 \xrightarrow{Br_2} \underset{\text{Methanamine}}{CH_3NH_2}$$

(c) Aniline to N-Phenylethanamide **[1]**



11. **(a)** Zr, a member of 4*d* series and Hf, a member of 5*d* series, belong to the same group (Group 4). They are chemically so similar that their separation is difficult. This is because both have almost similar size due to lanthanide contraction. The radii of these elements are 160 pm (Zr) and 159 pm (Hf). **[2]**

(b) Cu^+, due to disproportionation reaction and low hydration enthalpy. **[1]**

OR

(a) The catalytic activities of transition metals and their compounds is due to the ability of adopt variable oxidation states and to form complexes. It can also provide a large surface area for the reactants to be adsorbed. **[1]**

(b) Separation of lanthanoid elements is difficult because all lanthanoid elements have almost similar physical as well as chemical properties. Due to the lanthanoid contraction the change in the atomic or ionic radii is very small. **[1]**

(c) Zn, Cd and Hg are soft and have low melting point because no *d*-orbitals are available for metallic bond formation and bonds formed are very weak. **[1]**

Section - C

12. **(a)** Initial amount= 5 g

Final concentration = 3 g

Rate constant= $1.15 \times 10^{-3}\ s^{-1}$

For a first order reaction

$$t = \frac{2.303}{k}\log\frac{[R_{\text{initial}}]}{[R_{\text{final}}]}$$
$$= \frac{2.303}{1.15 \times 10^{-3}}\log\frac{5}{3}$$
$$= \frac{2.303}{1.15 \times 10^{-3}} \times 0.2219$$
$$= 444.379\,s$$ **[1]**

(b) For a reaction, $A + B \rightarrow P$

Rate = $k[A][B]$

If B is in excess then, R = $k'[A]$.

Thus, a bimolecular reaction is kinetically first order reaction, if concentration of due of the reaction is in excess such that it does not affect the rate of reaction.

(c) Given,

$k = 1.15 \times 10^{-3}\ s^{-1}$

For first order reaction,

$$t_{1/2} = \frac{0.693}{k} = \frac{0.693}{1.15 \times 10^{-3}}$$
$$= \frac{0.693 \times 10^3}{1.15}$$
$$= \frac{693}{1.15} = 602.6\ s$$ **[1]**

(d) $R \rightarrow P$

$$\text{Rate} = -\frac{d[R]}{dt} = k[R]$$

or $$\frac{d[R]}{[R]} = -k\,dt$$

Integrating this equation, we get

ln [R] = –kt + I …(i)

When t = 0, R = $[R]_o$,

where $[R]_o$ is the initial concentration of the reactant.

Therefore, equation (i) can be written as

In $[R]_o$ = –k × 0 + I

In $[R]_o$ = I

Substituting the value of I in equation (i)

In [R] = –kt + ln$[R]_o$

Rearranging this equation

$$\text{In}\frac{[\text{R}]}{[\text{R}]_o} = -kt$$ **[1]**

$$k = \frac{1}{t}\text{In}\frac{[\text{R}]_o}{[\text{R}]}$$

$$k = \frac{2.303}{t}\log\frac{[\text{R}]_o}{[\text{R}]}$$

[CBSE Marking Scheme 2017] **[1]**

OR

(d) (i) First order. **[1]**

(ii) s^{-1}/time^{-1} **[1]**

[CBSE Marking Scheme 2017]

Commonly Made Error

- Students often misinterpret graph either in hurry or overlook the details.

Answering Tip

- Read the concept, understand and practice the interpretation of graphs of various orders.

Detailed Answer:

(d) (i) The given graph is of first order reaction where slope is $(-k)$

For first order reaction,

$$\ln[\text{R}] = -kt + \ln[\text{Ro}]$$

compare with $y = mx + c$

$$\text{Slope} = -k$$

(ii) $[kt]$ is dimensionless number. unit of

$$k = [t^{-1}] = s^{-1}.$$

■■■