Sample Question Paper - 17
Chemistry (043)
Class- XII, Session: 2021-22
TERM II

Time allowed : 2 hours *Maximum marks : 35*

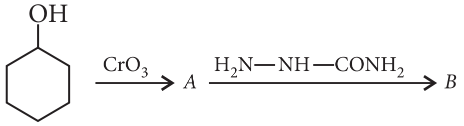
General Instructions :

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

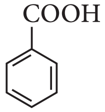
1. Write structures of compounds *A* and *B* in each of the following reactions :



2. What are the differences between molecularity and order of a reaction.

3. Which acid of each pair shown here would you expect to have lower pK_a value

(a) $CCl_3—COOH$ or $CH_3—COOH$

(b) 

or CH_3CH_2COOH

SECTION - B

4. (a) Transition metals have very high melting and boiling points. Why?

(b) In *d*-block element, ionic radii of ions of the same charge decreases progressively with increasing atomic number in a series. Why?

OR

How would you account for the following :

(a) The oxidising power of oxoanions are in the order : $VO_2^+ < Cr_2O_7^{2-} < MnO_4^-$

(b) The third ionization enthalpy of manganese ($Z = 25$) is exceptionally high.

(c) Cr^{2+} is a stronger reducing agent than Fe^{2+}.

5. Hydrogen peroxide, $H_2O_{2(aq)}$ decomposes to $H_2O_{(l)}$ and $O_{2(g)}$ in a reaction that is first order in H_2O_2 and has a rate constant $k = 1.06 \times 10^{-3}\ \text{min}^{-1}$.

(a) How long will it take for 15% of a sample of H_2O_2 to decompose?

(b) How long will it take for 85% of the sample to decompose?

OR

For a first order reaction, calculate the ratio of the time for 75% completion of a reaction to the time for 50% completion.

6. For the complex $[Ni(CN)_4]^{2-}$, write

(a) the IUPAC name

(b) the hybridization

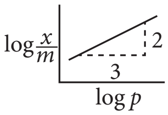
(c) the shape of the complex.

(Atomic no. of Ni = 28)

7. With explanation, arrange the given compounds in decreasing order of their basicity in aqueous solution.

$(CH_3)_2NH$, $(H_3C)_3N$, $C_6H_5NH_2$, H_3CNH_2

8. (a) Adsorption of a gas follows Freundlich adsorption isotherm. x is the mass of the gas adsorbed on mass m of the adsorbent. The plot of $\log \frac{x}{m}$ versus $\log p$ is shown in the given graph. Determine the propotionality of $\frac{x}{m}$.



(b) Define :

(i) Peptization

(ii) Kraft temperature

OR

(a) Define protective colloids. Which type of colloids are used as protective colloids?

(b) Why does sky look blue?

(c) Define CMC.

9. How are the following reactions carried out? (Write the equations and conditions).

(a) Acetic acid to ethylamine

(b) Bromocyclohexane to cyclohexanamine.

(c) Methylamine to dimethylamine.

10. (a) Define crystal field splitting energy. On the basis of crystal field theory, write the electronic configuration of d^6 in terms of t_{2g} and e_g in an octahedral field when

(i) $\Delta_o > P$ (ii) $\Delta_o < P$

(b) Write two limitations of crystal field theory.

11. (a) A compound '*A*' of molecular formula C_2H_3OCl undergoes a series of reactions as shown below. Write the structure of *A*, *B*, *C* and *D* in the following reactions :

$$(C_2H_3OCl)A \xrightarrow{H_2/Pd\text{-}BaSO_4} B \xrightarrow{\text{dil. NaOH}} C \xrightarrow{\text{Heat}} D$$

(b) Write the formula of the precipitate when ethanal is treated with Fehling's Solution.

OR

(a) Write the equations involved in the following reactions :

(i) Stephen reaction

(ii) Etard reaction

(b) Distinguish between CH_3COOH and $HCOOH$.

SECTION - C

12. Read the passage given below and answer the questions that follow.

The electrochemical cell shown below is concentration cell.

$M|M^{2+}$ (saturated solution of a sparingly soluble salt, MX_2) $||$ M^{2+} (0.001 mol dm^{-3}) $|M$

The emf of the cell depends on the difference in concentrations of M^{2+} ions at the two electrodes. The emf of the cell at 298 K is 0.059 V.

(a) Calculate the value of solubility product (K_{sp}, $mol^3\ dm^{-9}$) of MX_2 at 298 K based on the information available for the given concentration cell.

(take $2.303 \times R \times 298/F = 0.059$)

(b) Calculate the value of ΔG (in kJ mol^{-1}) for the given cell. (take 1 F = 96500 C mol^{-1})

(c) Calculate the equilibrium constant for the following reaction.

$Fe^{2+} + Ce^{4+} \rightleftharpoons Ce^{3+} + Fe^{3+}$

(Given: $E^\circ_{Ce^{4+}/Ce^{3+}} = 1.44$ V and $E^\circ_{Fe^{3+}/Fe^{2+}} = 0.68$ V)

(d) The standard electrode potential ($E°$) for OCl^-/Cl^- and $Cl^-/\frac{1}{2}Cl_2$ respectively are 0.94 V and – 1.36 V. What will be the $E°$ value for $OCl^-/\frac{1}{2}Cl_2$?

OR

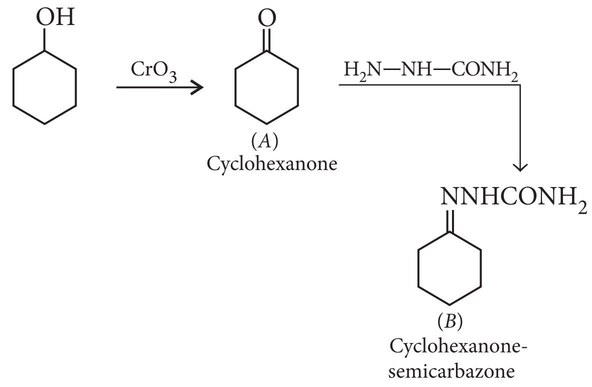
The standard reduction potential values of the three metallic cations X, Y and Z are 0.52, –3.03, and –1.18 V respectively. What will be the order of reducing power of the corresponding metals?

Solution

CHEMISTRY - 043

Class 12 - Chemistry

1.



2.

Order of a reaction		Molecularity of a reaction	
1.	It is the sum of powers of the concentration of the reactants in the rate law expression.	1.	It is the number of reacting species (atoms, ions or molecules) taking part in an elementary reaction which must collide simultaneously in order to bring about a chemical reaction.
2.	It can be zero or even a fraction.	2.	It is always a whole number.

3. (a) CCl_3COOH is stronger acid than CH_3COOH thus, CCl_3COOH has lower pK_a value.

(b) C_6H_5COOH is stronger acid than CH_3CH_2COOH thus C_6H_5COOH has lower pK_a value.

4. (a) The high melting and boiling points of transition metals are attributed to the involvement of greater number of electrons from $(n-1)$ d-orbital in addition to the ns electrons in the interatomic metallic bonding (d-d overlap).

(b) As the atomic number increases, the new electron enters the d-orbital and expected to increase in atomic size, but due to poor shielding effect of d-orbitals the electrostatic attraction between nucleus and outermost orbital increases and hence, the ionic radii decreases.

OR

(a) As the oxidation state increases, the ease with which the oxoanions accept electrons increases. This is why oxidising power of oxoanions are in order : $VO_2^+ < Cr_2O_7^{2-} < MnO_4^-$.

(b) Third ionization enthalpy of Mn is very high because the third electron has to be removed from the stable half-filled 3d-orbital [Mn^{2+} ($Z = 25$) $= 3d^5$].

(c) Cr^{2+} is a stronger reducing agent than Fe^{2+}. $E^\circ_{Cr^{3+}/Cr^{2+}}$ is negative (−0.41 V) whereas $E^\circ_{Fe^{3+}/Fe^{2+}}$ is positive (+ 0.77 V). Thus, Cr^{2+} is easily oxidized to Cr^{3+} but Fe^{2+} cannot be easily oxidized to Fe^{3+}. Hence, Cr^{2+} is stronger reducing agent than Fe^{2+}.

5. (a) $t = \frac{2.303}{k}\log\frac{[A]_0}{[A]}$

Given $k = 1.06 \times 10^{-3}\ \text{min}^{-1}$, $\frac{[A]_0}{[A]} = \frac{100}{85}$

$$t = \frac{2.303}{1.06\times10^{-3}\ \text{min}^{-1}}\log\frac{100}{85}$$

$$t = \frac{2303}{1.06}[2\log10 - \log85]$$

$$t = \frac{2303}{1.06}[2\times1 - 1.9294] = \frac{2303\times0.0706}{1.06}$$

$t = 153.39$ min $= 153.4$ min.

(b) Given $k = 1.06 \times 10^{-3}\ \text{min}^{-1}$, $\frac{[A]_0}{[A]} = \frac{100}{15}$

$$t = \frac{2.303}{1.06\times10^{-3}\ \text{min}^{-1}}\log\frac{100}{15} = \frac{2303}{1.06}[2\log10 - \log15]$$

$$= \frac{2303}{1.06}[2\times1 - 1.1761] = \frac{2303\times0.8239}{1.06}\ \text{min} = 1790\ \text{min}$$

OR

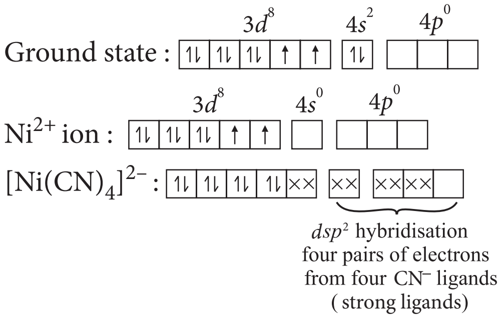
$$t_{75\%} = \frac{2.303}{k}\log\frac{100}{100-75}$$

$$t_{50\%} = \frac{2.303}{k}\log\frac{100}{100-50}$$

$$\frac{t_{75\%}}{t_{50\%}} = \frac{\log100 - \log25}{\log100 - \log50} = \frac{0.6020}{0.3010} = 2$$

6. (a) Tetracyanonickelate(II) ion

(b) Ni atom ($Z = 28$)



(c) The complex ion has square planar geometry and is diamagnetic due to the absence of unpaired electrons.

7. The increasing order of basicity in Aqueous solution of the given compounds is

$$(CH_3)_2NH > CH_3NH_2 > (CH_3)_3N > C_6H_5NH_2$$

Due to the subtle interplay of the inductive effect, solvation effect and steric hinderance of the alkyl group which decides the basic strength of methyl substituted amines in aqueous solution.

Due to the +*I* effect of alkyl groups, the electron density on nitrogen increases and thus the availability of the lone pair of electrons to proton increases and hence the basicity of amines also increases. So aliphatic amines are more basic than aniline.

8. (a) For a plot between log *x*/*m* and log *p* slope is given by 1/*n*.

Thus from the plot $\frac{1}{n} = \frac{y_2 - y_1}{x_2 - x_1} = 2/3$ and

$x/m \propto p^{1/n} \propto p^{2/3}$

(b) (i) **Pep**tization : It is the process of conversion of freshly prepared precipitate into colloidal particles on adding a suitable electrolyte.

(ii) Kraft temperature : it is defined as the minimum temperature from which the micelle formation takes place.

OR

(a) The colloids which protect coagulation of other colloids from the electrolytes are called protective colloids. Lyophilic colloids are used as a protective colloid for lyophobic colloids.

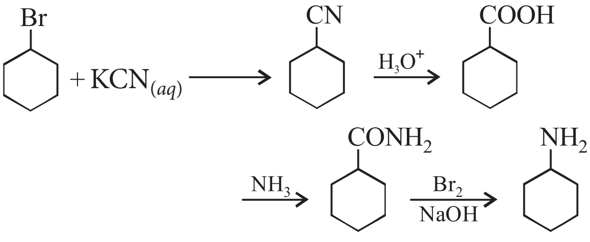
(b) Dust particles along with water suspended in air have size smaller than wavelength of visible light and are more effective in scattering light of shorter wavelength, blue light which has smallest wavelength reaches our eyes and the sky looks blue to us.

(c) CMC : It is the minimum concentration of surfactants above which micelles formation takes place. Below the CMC, the substance forming micelle behave as electrolyte.

9. (a) $\underset{\text{Acetic acid}}{CH_3COOH} + NH_3 \longrightarrow \underset{\text{Acetamide}}{CH_3CONH_2}$

$$\xrightarrow[\text{(ii) } H_2O]{\text{(i) } LiAlH_4} \underset{\text{Ethylamine}}{CH_3CH_2NH_2}$$

(b)

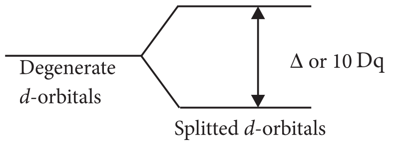


(c) $CH_3NH_2 + CHCl_3 + KOH \xrightarrow{\Delta} CH_3NC$

$$\xrightarrow[Na/C_2H_5OH]{H_2} CH_3NHCH_3$$

10. (a) The difference of energy between two splitted levels of *d*-orbitals is called crystal field splitting energy. It is denoted by Δ or 10 Dq.

For octahedral Δ_o, for tetrahedral it is Δ_t and for square planar Δ_{sp}.



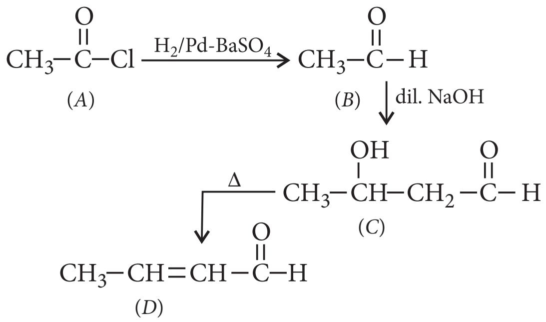
(i) When $\Delta_o > P$, $t_{2g}^6 e_g^0$

(ii) When $\Delta_o < P$, $t_{2g}^4 e_g^2$

(b) (i) It assumes ligand to be point charges.

(ii) It does not take into account the covalent character of bonding between the ligand and the central atom.

11. (a)



$$\underset{(A)}{CH_3-\overset{\overset{O}{\|}}{C}-Cl} \xrightarrow{H_2/Pd\text{-}BaSO_4} \underset{(B)}{CH_3-\overset{\overset{O}{\|}}{C}-H} \xrightarrow{\text{dil. NaOH}} \underset{(C)}{CH_3-\overset{\overset{OH}{|}}{CH}-CH_2-\overset{\overset{O}{\|}}{C}-H} \xrightarrow{\Delta} \underset{(D)}{CH_3-CH=CH-\overset{\overset{O}{\|}}{C}-H}$$

(b) $CH_3CHO + Cu^{2+} + OH^- \longrightarrow CH_3COO^- + Cu_2O + 3H_2O$

The precipitate formed is Cu_2O.

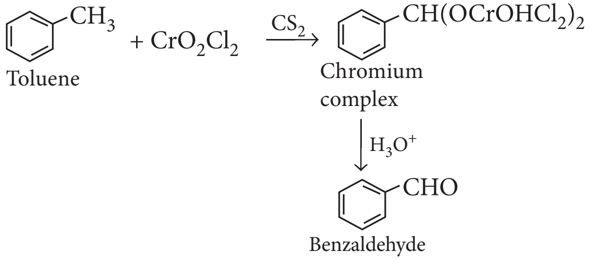
OR

(a) (i) Stephen reduction :

$R—CN + SnCl_2 + HCl \longrightarrow R—CH{=}NH$

$$\xrightarrow{H_3O^+} R—CHO$$

(ii) Etard reaction :



(b) Add Tollens' reagent to formic acid and warm. Silver mirror is formed.

$$\underset{\text{Formic acid}}{HCOOH} + 2[Ag(NH_3)_2]^+ + 2OH^- \xrightarrow{\text{Warm}}$$

$$\underset{\text{Silver mirror}}{2Ag} + CO_2 + 2NH_3 + 2NH_4OH$$

Acetic acid does not give this test.

12. (a) $0.059 = \frac{+0.059}{2} \log \frac{0.001}{[M^{2+}]}$

$\log \frac{0.001}{[M^{2+}]} = 2$ or $[M^{2+}] = 10^{-5}$

Let solubility of salt be s mol/litre.

Thus, $MX_2 \longrightarrow M^{2+} + 2X^-$

$\quad 0 \qquad s \qquad 2s$

$K_{sp} = [s][2s]^2$

$\therefore \; K_{sp} = 4s^3 = 4 \times (10^{-5})^3 = 4 \times 10^{-15}$

(b) $\Delta G = -nFE = -2 \times 96500 \times 0.059$

$= -11387 \text{ J mol}^{-1} = -11.4 \text{ kJ mol}^{-1}$

(c) $E^\circ_{\text{cell}} = \frac{0.059}{1} \log K_C$

$E^\circ_{\text{cell}} = E^\circ_{\text{Ce}^{4+}/\text{Ce}^{3+}} - E^\circ_{\text{Fe}^{3+}/\text{Fe}^{2+}}$

$= 1.44 - 0.68 = 0.76$ V

$\log_{10} K_c = \frac{0.76}{0.059} = 12.88$

$K_c = 7.6 \times 10^{12}$

(d) $\text{OCl}^- \longrightarrow \text{Cl}^-; E^\circ_1 = 0.94$ V

$\text{Cl}^- \longrightarrow 1/2\text{Cl}_2 \; ; E^\circ_2 = -1.36$ V

$\text{OCl}^- \longrightarrow 1/2\text{Cl}_2 \; ; E^\circ_3 = ?$

Applying, $\Delta G^\circ = -nFE^\circ$

$$\Delta G^\circ_3 = \Delta G^\circ_1 + \Delta G^\circ_2$$

$$-n_3FE^\circ_3 = -(n_1FE^\circ_1) + (-n_2FE^\circ_2)$$

$$n_1 = 2, \; n_2 = 1, n_3 = 1$$

$$-n_3E^\circ_3 = -(n_1E^\circ_1 + n_2E^\circ_2)$$

$$E^\circ_3 = ((2 \times 0.94) - 1.36) \text{ V}$$

$$E^\circ_3 = 0.52 \text{ V}$$

OR

Smaller the value of reduction potential stronger is the reducing agent. *i.e.,* the order of reducing power is $y < z < x$.