Sample Question Paper - 19
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.*

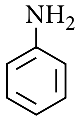
SECTION - A

1. Give reasons for the following (*any two*) :

(a) Primary amines have higher boiling point than tertiary amines.

(b) Complete the reaction:

$CH_3CH_2NH_2 + CHCl_3 + \text{alc. } KOH \longrightarrow$

(c) 

$+ HCl_{(aq)} \longrightarrow$

2. What is meant by rate of reaction? Differentiate between average rate and instantaneous rate of reaction.

3. (i) Arrange the following compounds in an increasing order of basic strength :

$C_6H_5NH_2$, $C_6H_5N(CH_3)_2$, $(C_2H_5)_2NH$ and CH_3NH_2

(ii) Arrange the following compounds in a decreasing order of pK_b values :

$C_2H_5NH_2$, $C_6H_5NHCH_3$, $(C_2H_5)_2NH$ and $C_6H_5NH_2$

SECTION - B

4. Define the following term :

(a) Pseudo first order reaction

(b) Half-life period of reaction ($t_{1/2}$)

(c) Elementary step in a reaction

OR

(a) Define 'order of a reaction'.

(b) For a reaction : $2H_2O_2 \xrightarrow[\text{alkaline medium}]{I^-} 2H_2O + O_2$

the proposed mechanism is as given below :

(1) $H_2O_2 + I^- \longrightarrow H_2O + IO^-$ (slow)

(2) $H_2O_2 + IO^- \longrightarrow H_2O + I^- + O_2$ (fast)

(i) Write rate law for the reaction.

(ii) Write the overall order of reaction.

(iii) Out of steps (1) and (2), which one is rate determining step?

5. Answer the following questions :

(i) Which element of the first transition series has highest second ionisation enthalpy?

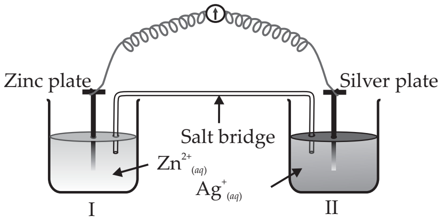
(ii) Which element of the first transition series has highest third ionisation enthalpy?

(iii) Which element of the first transition series has lowest enthalpy of atomisation?

6. How would you determine the standard electrode potential of the system $Mg^{2+} | Mg$?

OR

Consider the figure and answer the questions (i) to (iii) given below.



(i) Redraw the diagram to show the direction of electron flow.

(ii) Silver plate acts as anode or cathode?

(iii) When will the cell stop functioning?

7. Give simple chemical tests to distinguish between the following pairs of compounds.

(i) Propanal and Propanone

(ii) Pentan-2-one and Pentan-3-one

(iii) Ethanal and Propanal

OR

Describe the following:

(i) Acetylation

(ii) Cannizzaro reaction

(iii) Decarboxylation

8. On the basis of Lanthanoid contraction, explain the following :

(i) Nature of bonding in La_2O_3 and Lu_2O_3.

(ii) Trends in the stability of oxo salts of lanthanoids from La to Lu.

(iii) Stability of the complexes of lanthanoids.

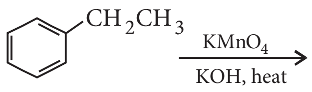
OR

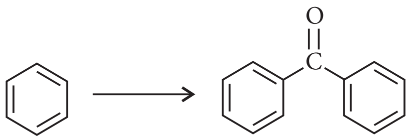
(a) Ionisation enthalpies of Ce, Pr and Nd are higher than Th, Pa and U. Why?

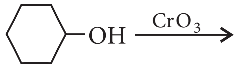
(b) Although fluorine is more electronegative than oxygen, but the ability of oxygen to stabilise higher oxidation states exceeds that of fluorine. Why?

9. Complete each synthesis by giving missing starting material, reagent or products

(i)



(ii) 

(iii) 

10. What is crystal field splitting energy? How does the magnitude of Δ_o decide the actual configuration of *d*-orbitals in a coordination entity?

11. What product will be formed on reaction of propanal with 2-methylpropanal in the presence of NaOH? Write the name of the reaction also.

SECTION - C

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

Adsorption is a spontaneous process and involves unequal distribution of the molecules of the gaseous substance on the surface of solid or liquid. Adsorption is an exothermic process. The attractive forces between adsorbate and adsorbent are either van der Waals' forces or chemical bonds. Adsorption of gases on solids is generally controlled by the factors like temperature, pressure and nature of adsorbate and adsorbent.

(a) In physisorption what is the attractive force between adsorbate and adsorbent.

(b) Draw the graph $\frac{x}{m}$ *vs* temperature for physisorption.

(c) Write any one application of adsorption.

(d) Why does physisorption decrease with the increase of temperature?

OR

Why is adsorption always exothermic?

Solution

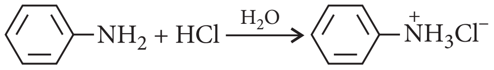
CHEMISTRY - 043

Class 12 - Chemistry

1. (a) Primary amines ($R - NH_2$) have two hydrogen atoms on nitrogen which can undergo intermolecular hydrogen bonding whereas no such hydrogen bonding is present in tertiary amines (R_3N). So, primary amines boil at a higher temperature than tertiary amines.

(b) $CH_3—CH_2—NH_2 + CHCl_3 + 3KOH \longrightarrow CH_3—CH_2—NC + 3KCl + 3H_2O$

(c)



2. Change in concentration (*i.e.*, either decrease in concentration of reactant or increase in concentration of product) per unit time is called rate of reaction.

$$\text{Rate of reaction} = \frac{C_2 - C_1}{t_2 - t_1} = \frac{\Delta C}{\Delta t}$$

The ratio of change of concentration of reactants to the time consumed in that change is called average rate of reaction.

$$r_{av} = \frac{\Delta x}{\Delta t} = -\frac{C_2 - C_1}{t_2 - t_1}$$

The rate of reaction at a particular instant (time) is called instantaneous rate of reaction.

$$r_{ins} = \frac{dx}{dt}$$

dx = small change in concentration

dt = small time interval

3. (i) Increasing order of basic strength is

$C_6H_5NH_2 < C_6H_5N(CH_3)_2 < CH_3NH_2 < (C_2H_5)_2NH$

(ii) Stronger the base lower will be its pK_b value hence, the decreasing order of pK_b values :

$C_6H_5NH_2 > C_6H_5NHCH_3 > C_2H_5NH_2 > (C_2H_5)_2NH$

4. (a) Those reactions which are not truly of the first order but under certain conditions become reactions of the first order are called pseudo first order reactions. *e.g.,* Inversion of cane sugar :

$$\underset{\text{Cane sugar}}{C_{12}H_{22}O_{11}} + H_2O \xrightarrow{H^+} \underset{\text{Glucose}}{C_6H_{12}O_6} + \underset{\text{Fructose}}{C_6H_{12}O_6}$$

$\text{Rate} = k[C_{12}H_{22}O_{11}]^1[H_2O]^0$

(b) The time taken for half of the reaction to complete, *i.e.*, the time in which the concentration of a reactant is reduced to half of its original value is called half-life period of the reaction.

$$t = t_{1/2} \text{ when } [R] = \frac{[R_0]}{2}$$

(c) Elementary step : Each step of a complex reaction is called an elementary step.

OR

(a) It is defined as "the sum of the powers or exponents to which the concentration terms are raised in the rate law expression."

(b) If rate = $k[A]^m [B]^n$, then order = $m + n$.

(i) Rate = $k[H_2O_2][I^-]$

(ii) Overall order of reaction is 2.

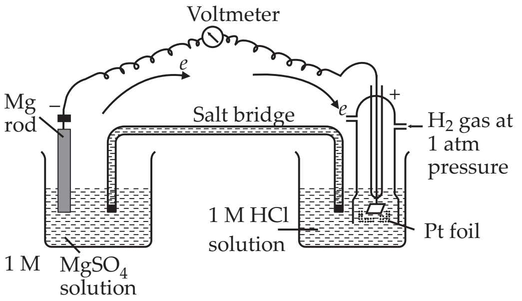
(iii) Step (1) being the slow step is the rate determining step of the reaction.

5. (i) Cu – The electronic configuration of Cu is $3d^{10}4s^1$ second electron will be removed from $3d$ which is completely filled and extra stable.

(ii) Zn – The third electron of zinc will be removed from $3d^{10}$.

(iii) Zn – Zinc has no unpaired electron hence it cannot form metallic bond.

6. Set up an electrochemical cell consisting of $Mg|MgSO_4(1M)$ as one electrode by dipping a magnesium wire in 1 M $MgSO_4$ solution and standard hydrogen electrode Pt, $H_2(1\ atm)|H^+(1\ M)$ as the second electrode. Measure the EMF of the cell and also note the direction of deflection in the voltmeter. The direction of deflection shows that the electrons flow from magnesium electrode to hydrogen electrode, *i.e.*, oxidation takes place on magnesium electrode and reduction on hydrogen electrode.



Thus, the cell may be represented as follows :

$Mg|Mg^{2+}(1\ M)||H^+(1\ M)|H_2\ (1\ atm), Pt_{(s)}$

$$E^\circ_{cell} = E^\circ_{H^+/H_2} - E^\circ_{Mg^{2+}/Mg}$$

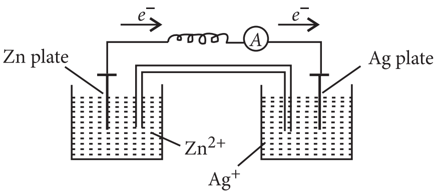
$$\text{Put } E^\circ_{H^+/H_2} = 0$$

$$\text{Hence } E^\circ_{Mg^{2+}/Mg} = -E^\circ_{cell}$$

It is observed that EMF of the cell comes out to be 2.36 V. Hence standard electrode potential for $Mg^{2+}|Mg$ system will be $E^\circ = -2.36$ V.

OR

(i)

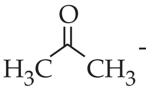
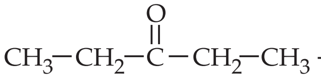
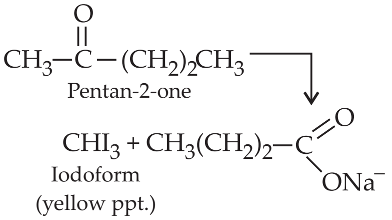


Electrons flow from Zn → Ag

(ii) Ag acts as cathode, because at Ag plate reduction of Ag^+ ions takes place.

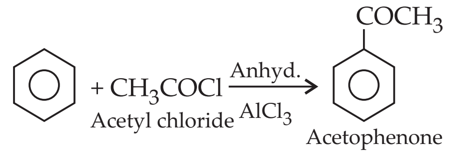
(iii) The cell will stop functioning when $E_{cell} = 0$.

7. The given set of compounds may be distinguish by the following reaction.

Compound → Reagent ↓	**Compound I**	**Compound II**
(i) Ammoniacal silver nitrate $2[Ag(NH_3)_2]^+$ (Tollens' reagent)	CH_3-CH_2-CHO Propanal $\downarrow$ $CH_3CH_2COO^- + 2Ag + 2H_2O + 4NH_3$ Silver mirror	 $\longrightarrow$ No reaction Propanone
(ii) NaOI	 $CH_3-CH_2-\overset{O}{\overset{\|}{C}}-CH_2-CH_3 \longrightarrow$ No reaction Pentan-3-one	 $CH_3-\overset{O}{\overset{\|}{C}}-(CH_2)_2CH_3$ Pentan-2-one $\downarrow$ $CHI_3 + CH_3(CH_2)_2-C(=O)ONa^-$ Iodoform (yellow ppt.)
(iii) NaOI	$CH_3CHO \longrightarrow 2CHI_3 + HCOONa$ Ethanal, Yellow ppt.	$CH_3CH_2CHO \longrightarrow$ No reaction Propanal

OR

(i) Acetylation : Acetylation is the process of introducing an $CH_3-\overset{O}{\overset{\|}{C}}-$ group in compounds that contain a replaceable hydrogen atom. The best example of acetylation is Friedel-Crafts acylation reaction where *R*CO group is introduced on the benzene ring. Reagents employed for the purpose of acylation are acyl chloride, acid anhydride etc. *e.g.*, Friedel-crafts acylation:

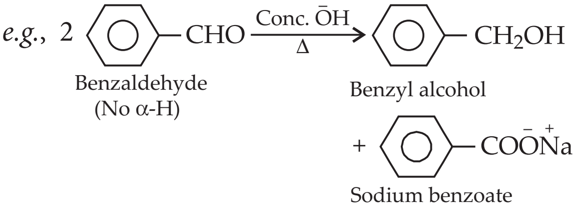


$$CH_3COCl + C_2H_5OH \xrightarrow{\text{Pyridine}} CH_3COOC_2H_5 + HCl$$

Ethyl acetate

(ii) Cannizzaro reaction : Cannizzaro reaction is undergone by aldehydes that lack α-hydrogen atom. Such carbonyl compounds in the presence of conc. NaOH and heat undergo disproportionation reaction to produce the corresponding carboxylate ion and alcohol.

e.g.,



(iii) Decarboxylation : Carboxylic acids lose carbon dioxide to form hydrocarbons when their sodium salts are heated with sodalime (NaOH and CaO in the ratio of 3 : 1). The reaction is

$$R-COONa \xrightarrow[\text{Heat}]{\text{NaOH + CaO}} R-H + Na_2CO_3$$

8. (i) As the size decreases covalent character increases. Therefore La_2O_3 is more ionic and Lu_2O_3 is more covalent.

(ii) As the size decreases from La to Lu, stability of oxosalts also decreases.

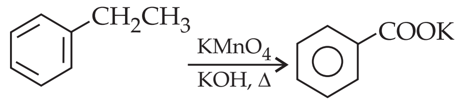
(iii) Stability of complexes increases as the size decreases.

OR

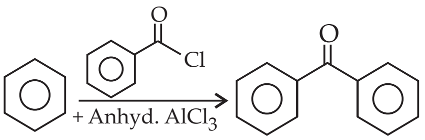
(a) In the begining when electrons start occupying 5*f* orbitals they will penetrate less into the inner core of electrons. 5*f* electrons will be more effectively shielded from nuclear charge than 4*f* electrons of corresponding lanthanoids. Therefore outer electrons are less firmly held and they are available for bonding in actinoids. Hence Th, Pa and U have lower ionisation enthalpies.

(b) The ability of oxygen to stabilise higher oxidation states exceeds that of fluorine. It is due to the ability of oxygen to form multiple bonds to metals.

9. (i)

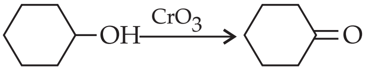


(ii)



+ HCl

(iii)



10. The difference in energies of two sets of *d*-orbitals t_{2g} and e_g is called crystal field splitting energy (Δ_o).

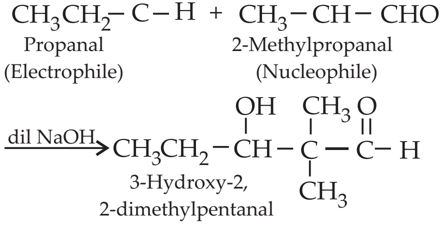
For example for d^4 configuration :

(i) If $\Delta_o < P$, the configuration will be $t_{2g}^3 e_g^1$ and it is there in case of weak field ligands and high spin complex will be formed.

(ii) If $\Delta_o > P$, the configuration will be $t_{2g}^4 e_g^0$ and it is in case of a strong field ligands and low spin complex will be formed.

11. Propanal and 2-methylpropanal both have α-hydrogen atom, thus, these undergo cross-aldol condensation in which each one of them can act either as an electrophile or a nucleophile. Thus,

(i)

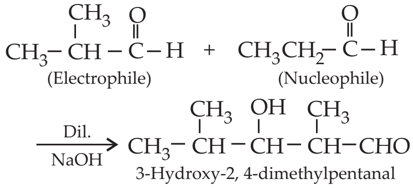


$$CH_3CH_2-\overset{O}{\overset{\|}{C}}-H + CH_3-\overset{CH_3}{\overset{|}{CH}}-CHO \xrightarrow{\text{dil NaOH}} CH_3CH_2-\overset{OH}{\overset{|}{CH}}-\underset{CH_3}{\overset{CH_3}{C}}-\overset{O}{\overset{\|}{C}}-H$$

Propanal (Electrophile) 2-Methylpropanal (Nucleophile)

3-Hydroxy-2, 2-dimethylpentanal

(ii)



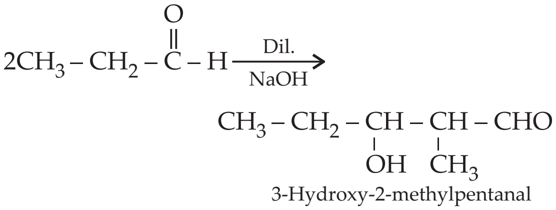
$$CH_3-\overset{CH_3}{\overset{|}{CH}}-\overset{O}{\overset{\|}{C}}-H + CH_3CH_2-\overset{O}{\overset{\|}{C}}-H \xrightarrow[\text{NaOH}]{\text{Dil.}} CH_3-\overset{CH_3}{\overset{|}{CH}}-\overset{OH}{\overset{|}{CH}}-\overset{CH_3}{\overset{|}{CH}}-CHO$$

(Electrophile) (Nucleophile)

3-Hydroxy-2, 4-dimethylpentanal

Also, self aldol-condensation reaction takes place.

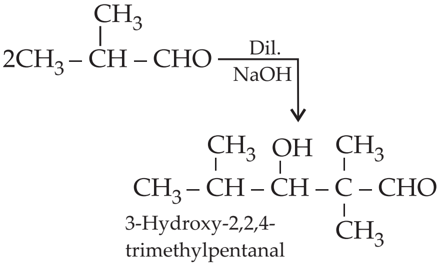
(iii)



$$2CH_3-CH_2-\overset{O}{\overset{\|}{C}}-H \xrightarrow[\text{NaOH}]{\text{Dil.}} CH_3-CH_2-\underset{OH}{\underset{|}{CH}}-\underset{CH_3}{\underset{|}{CH}}-CHO$$

3-Hydroxy-2-methylpentanal

(iv)

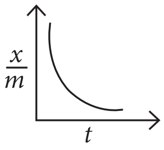


$$2CH_3-\overset{CH_3}{\overset{|}{CH}}-CHO \xrightarrow[\text{NaOH}]{\text{Dil.}} CH_3-\overset{CH_3}{\overset{|}{CH}}-\overset{OH}{\overset{|}{CH}}-\underset{CH_3}{\overset{CH_3}{C}}-CHO$$

3-Hydroxy-2,2,4-trimethylpentanal

12. (a) In physisorption process, the attractive forces between adsorbate and adsorbent are van der Waals' forces.

(b)



(c) Adsorption is used in removal of colouring matter from solutions : Animal Charcoal removes colours of solutions by adsorbing coloured impurities.

(d) Physical adsorption of a gas by a solid is generally reversible. Thus,

$$\text{Solid} + \text{Gas} \rightleftharpoons \text{Gas/ Solid} + \text{Heat}$$

Since the adsorption process is exothermic, the physical adsorption occurs readily at low temperature and decreases with increasing temperature (Le Chatelier's principle).

OR

During adsorption, there is always a decrease in residual forces of the surface, i.e., there is decrease in surface energy which appears as heat. Adsorption therefore, is invariably an exothermic process. In other words, ΔH of adsorption is always negative to keep the value of ΔG negative for the reaction to be spontaneous as ΔS decreases during adsorption.