Sample Question Paper - 18
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. Given that the standard electrode potential ($E°$) of metals are :

$K^+/K = -2.93$ V, $Ag^+/Ag = 0.80$ V,

$Cu^{2+}/Cu = 0.34$ V,

$Mg^{2+}/Mg = -2.37$ V, $Cr^{3+}/Cr = -0.74$ V,

$Fe^{2+}/Fe = -0.44$ V.

Arrange these metals in an increasing order of their reducing power.

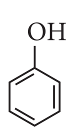
2. Give the structures of *A*, *B* and *C* in the following reactions :

(a) $C_6H_5NO_2 \xrightarrow{Sn + HCl} A \xrightarrow[273\text{ K}]{NaNO_2 + HCl} B \xrightarrow{H_2O} C$

(b) $CH_3CN \xrightarrow{H_2O/H^+} A \xrightarrow[\Delta]{NH_3} B \xrightarrow{Br_2 + KOH} C$

3. Which acid of each pair shown here would you expect to be stronger?

(a) F—CH_2CH_2—COOH or Cl—CH_2CH_2—COOH

(b)  or CH_3COOH

SECTION - B

4. Account for the following :

(a) Transition metals form large number of complex compounds.

(b) $E°$ value for the Mn^{3+}/Mn^{2+} couple is highly positive (+1.57 V) as compared to Cr^{3+}/Cr^{2+}.

(c) Which of following cations are coloured in aqueous solutions and why?

Sc^{3+}, V^{3+}, Ti^{4+}, Mn^{2+}

(At. No. Sc = 21, V = 23, Ti = 22, Mn = 25)

OR

(a) Account for the following :

(i) Transition metals show variable oxidation states.

(ii) Zn, Cd and Hg are soft metals.

(b) Give reason : Iron has higher enthalpy of atomization than that of copper.

(c) What are interstitial compounds? Write their properties.

5. (a) How are the following colloidal solutions prepared?

(i) Sulphur in water

(ii) Gold sol

(b) Why is adsorption always exothermic?

OR

(a) What is the principle of separation of inert gases from its mixture?

(b) Why silica and alumina gels are used for removing moisture and controlling humidity?

(c) How does adsorption of a gas on a solid surface vary with temperature?

6. A compound *X* (C_7H_7Br) reacts with KCN to give *Y* (C_8H_7N). Reduction of *Y* with $LiAlH_4$ yields *Z* ($C_8H_{11}N$). *Z* gives carbylamine reaction, reacts with Hinsberg's reagent in the presence of aq. KOH to give a clear solution. With $NaNO_2$ and HCl at 0°C (*Z*) gives a neutral compound which gives red colour with ammonium cerric nitrate. What are *X*, *Y* and *Z* ?

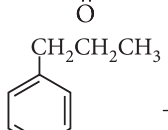
7. During practical exams, lab assistant provided two test tubes containing 5 mL benzoic acid and 5 mL acetaldehyde to every student. A student, Rahul found that test tubes given to him were unlabelled. He informed the teacher before performing any experiment with the given chemicals.

How can the chemicals be distinguished for correct labelling?

OR

(a) Write the main product in the following equations :

(i) $CH_3-\underset{\underset{O}{\|}}{C}-CH_3 \xrightarrow[\text{(ii) } H_2O]{\text{(i) } CH_3MgX} ?$

(ii)  $\xrightarrow[H_3O^+]{KMnO_4\text{-}KOH/\Delta} ?$

(b) Write the product in the following reaction :

$CH_3-CH=CH-CH_2CN \xrightarrow[\text{(ii) } H_2O]{\text{(i) DIBAL-H}}$

8. (a) What is *d-d* transition?

(b) Tetrahedral complexes are always of high spin. Explain.

OR

Explain the following :

(a) Anhydrous $CuSO_4$ is white while hydrated $CuSO_4$ is blue in colour.

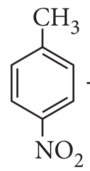
(b) $[Ti(H_2O)_6]Cl_3$ is violet in colour but becomes colourless on heating.

9. If $E°$ for copper electrode is 0.34 V, how will you calculate its emf value when the solution in contact with it is 0.1 M in copper ions? How does emf for copper electrode change when concentration of Cu^{2+} ions in the solution is decreased?

10. Write the structures of the main products of the following reactions :

(a)  $+ C_6H_5COCl \xrightarrow[CS_2]{\text{anhydrous } AlCl_3}$

(b) $H_3C-C\equiv C-H \xrightarrow{Hg^{2+},\ H_2SO_4}$

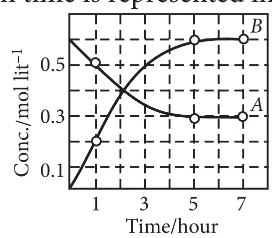
(c)  $\xrightarrow[2.\ H_2O]{1.\ CrO_2Cl_2}$

11. $[Mn(CN)_6]^{3-}$ has two unpaired electrons whereas $[MnCl_6]^{3-}$ has four unpaired electrons. Why?

SECTION - C

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

The progress of the reaction, $A \rightleftharpoons nB$ with time is represented in the following figure :



(a) What is the value of n?

(b) Find the value of the equilibrium constant.

(c) What will be the initial rate of conversion of A?

(d) What will be the value of $-\dfrac{d[A]}{dt}$ for the reaction, $\dfrac{d[B]}{dt} = 2 \times 10^{-4}$?

OR

Mention any two factors that affect the rate of reaction.

Solution

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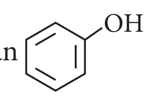
1. The reducing power increases with decreasing value of electrode potential. Hence, the order is
Ag < Cu < Fe < Cr < Mg < K.

2. (a) $C_6H_5NO_2 \xrightarrow{Sn + HCl} \underset{A}{C_6H_5NH_2} \xrightarrow[273\ K]{NaNO_2 + HCl} \underset{B}{C_6H_5N_2^+Cl^-} \xrightarrow{H_2O} \underset{C}{C_6H_5OH}$

(b) $CH_3CN \xrightarrow{H_2O/H^+} \underset{A}{CH_3COOH} \xrightarrow{NH_3} \underset{B}{CH_3CONH_2} \xrightarrow{Br_2+KOH} \underset{C}{CH_3NH_2}$

3. (a) F—CH_2CH_2COOH is stronger acid than Cl—CH_2CH_2COOH.

(b) CH_3COOH is stronger acid than .

4. (a) Transition metals form a large number of complex compounds due to following reasons :
- Comparatively smaller size of metal ions.
- High ionic charges.
- Availability of *d*-orbitals for bond formation.

(b) Because Mn^{2+} is stable due to half–filled configuration. Thus Mn^{3+} has high tendency to form Mn^{2+} while Cr^{3+} is more stable than Cr^{2+}.

(c) Only those ions will be coloured which have partially filled *d*-orbitals facilitating *d-d* transition. Ions with d^0 and d^{10} will be colourless.
From electronic configuration of the ions, $V^{3+}(3d^2)$ and $Mn^{2+}(3d^5)$, are all coloured. $Ti^{4+}(3d^0)$ and $Sc^{3+}(3d^0)$ are colourless.

OR

(a) (i) Transition elements can use their *ns* and $(n-1)d$ orbital electrons for bond formation therefore, they show variable oxidation states.
For example, Sc has $ns^2\ (n-1)\ d^1$ electronic configuration.
It utilizes two electrons from its *ns* subshell then its oxidation state = +2. When it utilizes both the electrons then its oxidation state = +3.
(ii) In Zn, Cd and Hg, all the electrons in *d*-subshell are paired. Hence, the metallic bonds are weak. That is why they are soft metals with low melting and boiling points.
(b) Greater the number of unpaired electrons, stronger is the metallic bond and therefore, higher is the enthalpy of atomisation. Since, iron has greater number of unpaired electrons than copper hence has higher enthalpy of atomisation.

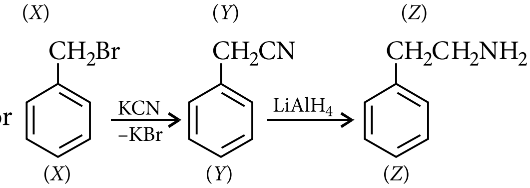
(c) When small atoms of non-metals like H, C, B, N etc., occupy vacant interstitial spaces in crystal lattice of metals it gives rise to interstitial compound like hydrides, carbides. Few properties are as follow:
(i) They have high melting points than pure metals.
(ii) They are conductive.
(iii) They are chemically inert.

5. (a) (i) Sulphur sol is prepared by the oxidation of H_2S with SO_2.
$$SO_2 + 2H_2S \xrightarrow{\text{Oxidation}} \underset{\text{(Sol)}}{3S} + 2H_2O$$
(ii) Gold sol is prepared by Bredig's arc process or by the reduction of $AuCl_3$ with HCHO.
$$2AuCl_3 + 3HCHO + 3H_2O \xrightarrow{\text{Oxidation}} \underset{\text{(Sol)}}{2Au} + 3HCOOH + 6HCl$$
(b) In adsorption, there is always a decrease in residual unbalanced forces on the surface. This results in decrease in surface energy which appears as heat. Hence, adsorption is unconditionally an exothermic process.

OR

(a) The separation of inert gases from a mixture is based on the difference in degree of adsorption of gases by the coconut charcoal.
(b) Alumina and silica are good adsorbents. They can adsorb even small amount of moisture present in atmosphere.
(c) Adsorption of gas on solid surface decreases with rising temperature.

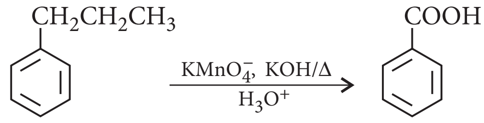
6. $\underset{(X)}{C_7H_7Br} \xrightarrow[-KBr]{KCN} \underset{(Y)}{C_8H_7N} \xrightarrow{LiAlH_4} \underset{(Z)}{C_8H_{11}N}$

or 

7. Chemicals can be distinguished by sodium bicarbonate test and iodoform test.
Benzoic acid will give brisk effervescence due to evolution of carbon dioxide gas with sodium bicarbonate solution while acetaldehyde does not.
Acetaldehyde will give yellow precipitate of iodoform with iodine and sodium hydroxide solution while benzoic acid does not.

OR

(a) (i) $CH_3-\underset{\underset{O}{\|}}{C}-CH_3 \xrightarrow[\text{(ii) } H_2O]{\text{(i) } CH_3MgX} CH_3-\overset{\overset{CH_3}{|}}{\underset{\underset{OH}{|}}{C}}-CH_3$

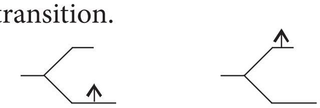
(ii) 

Benzoic acid

(b) $CH_3-CH=CH-CH_2CN \xrightarrow[\text{(ii) } H_2O]{\text{(i) DIBAL-H}}$

$CH_3-CH=CH-CH_2CHO$

8. (a) When ligands approach the central metal, atom or ion of complex its d-orbital splits into two energy levels t_{2g} and e_g. When light falls on the complex the complex absorbs light of suitable frequency for transfer of electron from lower level to higher level. This jump of electron from one d-level to another is called d-d transition.



Before absorption After absorption

(b) For tetrahedral complexes crystal field splitting energy Δ_t is always less than pairing energy. Thus, tetrahedral complexes are always high spin.

OR

(a) Anhydrous $CuSO_4$ has no ligand. So, crystal field splitting does not occur so, it does not show any colour but in hydrated form it is linked with H_2O ligand so, it shows colour due to d-d transition.

(b) $[Ti(H_2O)_6]Cl_3$ is a complex compound. In presence of 6 H_2O molecules the d-orbitals of Ti^{3+} undergo splitting. The compound is coloured (violet) due to d-d transition. On heating water molecules escape, d-orbitals become degenerate. There is no d-d transition. Hence compound becomes colourless.

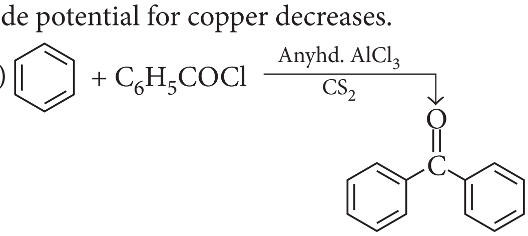
9. $Cu^{2+}_{(aq)} + 2e^- \rightarrow Cu_{(s)}$

$$E_{Cu^{2+}/Cu} = E^\circ_{Cu^{2+}/Cu} - \frac{0.059}{2}\log\frac{[Cu]}{[Cu^{2+}]}$$

$$= 0.34 - \frac{0.059}{2}\log\frac{1}{0.1} = 0.34 - \frac{0.059}{2}\log 10$$

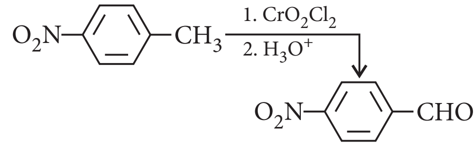
$$= 0.34 - \frac{0.059}{2}\times(1) = 0.34 - 0.0295 = 0.3105 \text{ V}$$

When the concentration of Cu^{2+} ions is decreased, the electrode potential for copper decreases.

10. (a) 

(b) $CH_3-C\equiv CH \xrightarrow{Hg^{2+}, H_2SO_4} CH_3-\overset{\overset{\large O}{\|}}{C}-CH_3$

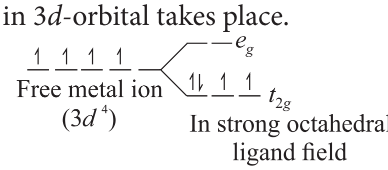
Propanone

(c) 

p-Nitrobenzaldehyde

11. In $[Mn(CN)_6]^{3-}$, Mn is in +3 oxidation state so, it has configuration of $3d^4$.

Since CN^- is a strong field ligand hence pairing of electrons in $3d$-orbital takes place.



So, $[Mn(CN)_6]^{3-}$ has two unpaired electrons. But in $[MnCl_6]^{3-}$, Cl^- is a weak field ligand, so no pairing takes place and it has 4 unpaired electrons.

12. (a) According to the figure, in the given time of 4 hours (1 to 5) concentration of A falls from 0.5 to 0.3 M,while in the same time concentration of B increases from 0.2 to 0.6 M.

Decrease in concentration of A in 4 hours

$= 0.5 - 0.3 = 0.2$ M

Increase in concentration of B in 4 hours

$= 0.6 - 0.2 = 0.4$ M

Thus, increase in concentration of B in a given time is twice the decrease in concentration of A. Thus, $n = 2$.

(b) $K = \frac{[B]^2}{[A]} = \frac{(0.6)^2}{0.3} = 1.2$ M

(c) From $t = 0$ to $t = 1$ hr,

For A, $dx = 0.6 - 0.5 = 0.1$ mol L^{-1}

$\therefore$ Initial rate of conversion of $A = \frac{dx}{dt}$

$$= \frac{0.1 \text{ mol L}^{-1}}{1 \text{ hr}} = 0.1 \text{ mol L}^{-1}\text{ hr}^{-1}$$

(d) $A \rightleftharpoons 2B$

$$-\frac{d[A]}{dt} = +\frac{1}{2}\frac{d[B]}{dt} = \frac{1}{2}\times 2\times 10^{-4} = 10^{-4}$$

OR

Rate of reaction depends upon the experimental conditions such as concentration of reactants, temperature and catalyst.