Global Education of Science

Subject : Chemistry
Standard : 12
Total Mark : 100

MCQ and Subjective

Paper Set : 1
Date : 19-07-2024
Time : 0H:20M

Chemistry - Section A (MCQ)

(1) The catalytic activity of transition metals and their compounds is ascribed mainly to [AIPMT 2012]

(A) their magnetic behaviour

(B) their unfilled $d-$ orbitals

(C) their ability to adopt variable oxidation states

(D) their chemical reactivity

(2) For the reaction A $\rightarrow$ B, the rate constant k (in s^{-1}) is given by $\log_{10} k = 20.35 - \frac{(2.47\times10^3)}{T}$. The energy of activation in kJ mol^{-1} is ..... . (Nearest integer) [Given : $R = 8.314$ J K^{-1} mol^{-1}] [JEE MAIN 2021]

(A) 85 (B) 47

(C) 12 (D) 4.7

(3) Which of the following species is not paramagnetic ? [JEE MAIN 2017]

(A) NO (B) CO

(C) O_2 (D) B_2

(4) Which of the following does not have optical isomer [AIIMS 2004]

(A) $[Co(NH_3)_3Cl_3]$ (B) $[Co(en)_3]Cl_3$

(C) $[Co(en)_2Cl_2]Cl$ (D) $[Co(en)(NH_3)_2Cl_2]Cl$

(5) $E^o_{Fe^{2+}/Fe} = -0.441\,V$ and $E^o_{Fe^{3+}/Fe^{2+}} = 0.771\,V$, the standard EMF of the reaction $Fe + 2Fe^{3+} \rightarrow 3Fe^{2+}$ will be .... V. [AIPMT 2006]

(A) 0.111 (B) 0.330

(C) 1.653 (D) 1.212

(6) The homoleptic and octahedral complex of Co^{2+} and H_2O has .... unpaired electron(s) in the t_{2g} set of orbitals. [JEE MAIN 2023]

(A) 1 (B) 2

(C) 3 (D) 4

(7) $A(g) \rightarrow 2B(g) + C(g)$ is a first order reaction. The initial pressure of the system was found to be $800\,mm\,Hg$ which increased to $1600\,mm\,Hg$ after $10\,min$. The total pressure of the system after $30\,min$ will be .... $mm\,Hg$. (Nearest integer) [JEE MAIN 2023]

(A) 2100 (B) 2000

(C) 2300 (D) 2200

(8) NO_2 required for a reaction is produced by decomposition of N_2O_5 in CCl_4 as by equation
$2\,N_2O_{5(g)} \rightarrow 4NO_{2(g)} + O_{2(g)}$ The initial concentration of N_2O_5 is 3 mol L^{-1} and it is 2.75 mol L^{-1} after 30 minutes.The rate of formation of NO_2 is $x \times 10^{-3}$ mol L^{-1} min^{-1}, value of x is_______. [JEE MAIN 2024]

(A) 16 (B) 17

(C) 18 (D) 19

(9) Match List I with List II

List I Complex	List II Crystal Field splitting energy (Δ_0)
$A\ [Ti(H_2O)_6]^{2+}$	$I\ -1.2$
$B\ [V(H_2O)_6]^{2+}$	$II\ -0.6$
$C\ [Mn(H_2O)_6]^{3+}$	$III\ 0$
$D\ [Fe(H_2O)_6]^{3+}$	$IV\ -0.8$

[JEE MAIN 2023]

(A) $A-II, B-IV, C-I, D-III$

(B) $A-IV, B-I, C-II, D-III$

(C) $A-IV, B-I, C-III, D-II$

(D) $A-II, B-IV, C-III, D-I$

(10) The cell potential for the following cell
$Pt\,|H_2(g)|\,H^+(aq)\|Cu^{2+}(0.01M)\,|\,Cu(s)$
is $0.576\,V$ at $298\,K$. The pH of the solution is .... (Nearest integer) [JEE MAIN 2022]

(A) 50 (B) 5

(C) 15 (D) 25

(11) $2NO(g) + Cl_2(g) \rightleftharpoons 2NOCl(s)$
This reaction was studied at $-10°C$ and the following data was obtained

run	$[NO]_0$	$[Cl_2]_0$	r_0
1	0.10	0.10	0.18
2	0.10	0.20	0.35
3	0.20	0.20	1.40

$[NO]_0$ and $[Cl_2]_0$ are the initial concentrations and r_0 is the initial reaction rate.
The overall order of the reaction is ....
(Round off to the Nearest Integer). [JEE MAIN 2021]

(A) 1 (B) 2

(C) 3 (D) 4

(12) The number of f electrons in the ground state electronic configuration of Np($Z = 93$) is .... [JEE MAIN 2021]

(A) 2 (B) 5

(C) 4 (D) 6

(13) For there action of H_2 with I_2, the rate constant is $2.5 \times 10^{-4}\,dm^3\,mol^{-1}\,s^{-1}$ at $327\,^oC$ and $1.0\,dm^3\,mol^{-1}\,s^{-1}$ at $527\,^oC$. The activation energy for the reaction, in $kJ\,mol^{-1}$ is: $(R = 8.314\,J\,K^{-1}\,mol^{-1})$ [JEE MAIN 2019]

(A) 72 (B) 166

(C) 150 (D) 59

(14) A first order reaction has a specific reaction rate of $10^{-2}\,sec^{-1}$. How much time will it take for $20\,g$ of the reactant to reduce to $5\,g$? .... sec [NEET 2017]

(A) 138.6 (B) 346.5

(C) 693.0 (D) 238.6

(15) On electrolysis of dil. sulphuric acid using Platinum (Pt)

electrode, the product obtained at anode will be: [NEET 2020]

(A) SO_2 gas
(B) Hydrogen gas
(C) Oxygen gas
(D) H_2S gas

(16) The rate of the reaction, $2NO + Cl_2 \rightarrow 2NOCl$ is given by the rate equation rate $= k[NO]^2[Cl_2]$. The value of the rate constant can be increased by [AIPMT 2010]

(A) increasing the temperature
(B) increasing the concentration of NO
(C) increasing the concentration of the Cl_2
(D) doing all of these.

(17) Among the following ions which one has the highest paramagnetism [IIT 1993]

(A) $[Cr(H_2O)_6]^{3+}$
(B) $[Fe(H_2O)_6]^{2+}$
(C) $[Cu(H_2O)_6]^{2+}$
(D) $[Zn(H_2O)_6]^{2+}$

(18) Copper becomes green when exposed to moist air for a long period. This is due to [JEE MAIN 2014]

(A) the formation of a layer of cupric oxide on the surface of copper.
(B) the formation of a layer of basic carbonate of copper on the surface of copper.
(C) the formation of a layer of cupric hydroxide on the surface of copper.
(D) the formation of basic copper sulphate layer on the surface of the metal.

(19) The amount of charge required to liberate $9\,gm$ of aluminium (atomic weight = 27 and valency = 3) in the process of electrolysis is .... coulombs (Faraday's number $= 96500\,coulombs/gm$ equivalent)

(A) 321660
(B) 69500
(C) 289500
(D) 96500

(20) Faraday's laws of electrolysis are related to the [IIT 1983]

(A) Atomic number of cation
(B) Atomic number of anion
(C) Equivalent weight of the electrolyte
(D) Speed of the cation

(21) Among the following complexes the one which shows zero crystal field stabilization energy $(CFSE)$ is [NEET 2014]

(A) $[Mn(H_2O)_6]^{3+}$
(B) $[Fe(H_2O)_6]^{3+}$
(C) $[Co(H_2O)_6]^{2+}$
(D) $[Co(H_2O)_6]^{3+}$

(22) The mismatched combinations are
A. Chlorophyll - Co
B. Water hardness - EDTA
C. Photography $- [Ag(CN)_2]^-$
D. Wilkinson catalyst - $[(Ph_3P)_3\,RhCl]$
E. Chelating ligand - D - Penicillamine
Choose the correct answer from the options given below: [JEE MAIN 2023]

(A) A and C Only
(B) A and E Only
(C) D and E Only
(D) A, C and E Only

(23) After adding a solute freezing point of solution decreases to -0.186.
Calculate ΔT_b if $K_f = 1.86$ and $K_b = 0.521$. [AIEEE 2002]

(A) 0.521
(B) 0.0521
(C) 1.86
(D) 0.0186

(24) An example of double salt is [AIPMT 1989]

(A) Bleaching powder
(B) $K_4[Fe(CN)_6]$
(C) Hypo
(D) Potash alum

(25) The correct order of the stoichiometries of $AgCl$ formed when $AgNO_3$ in excess is treated with the complexes : $CoCl_3 \cdot 6NH_3, CoCl_3 \cdot 5NH_3, CoCl_3 \cdot 4NH_3$ respectively is [NEET 2017]

(A) $3\,AgCl,\ 1\,AgCl,\ 2\,AgCl$
(B) $3\,AgCl,\ 2\,AgCl,\ 1\,AgCl$
(C) $2\,AgCl,\ 3\,AgCl,\ 2\,AgCl$
(D) $1\,AgCl,\ 3\,AgCl,\ 2\,AgCl$

(26) For a first order reaction [IIT 1998]

(A) The degree of dissociation is equal to $(1 - e^{-kt})$
(B) A plot of reciprocal concentration of the reactant vs time gives a straight line
(C) The pre-exponential factor in the Arrhenius equation has the dimension of time T^{-1}
(D) Both (a) and (c)

(27) $Pt(s)H_2(g)(1bar)\,|H^+(aq)(1M)|\,\left|M^{3+}(aq), M^+(aq)\right|\,Pt(s)$
The E_{ceil} for the given cell is $0.1115\,V$ at $298\,K$ when
$\frac{[M^+(aq)]}{[M^{3+}(aq)]} = 10^a$
The value of a is
Given : $E_{M^{3+}/M^+} = 0.2\,V$
$\frac{2.303RT}{F} = 0.059\,V$ [JEE MAIN 2023]

(A) 2
(B) 6
(C) 8
(D) 3

(28) When 9.65 ampere current was passed for 1.0 hour into nitrobenzene in acidic medium, the amount of $p-$ amino-phenol produced is .... g [JEE MAIN 2018]

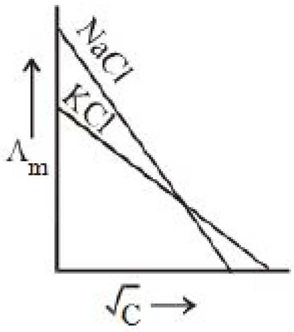
(A) 109
(B) 98.1
(C) 9.81
(D) 10.9

(29) Four successive members of the first row transition elements are listed below with their atomic numbers. Which one of them is expected to have the highest third ionization enthalpy [AIPMT 2005]

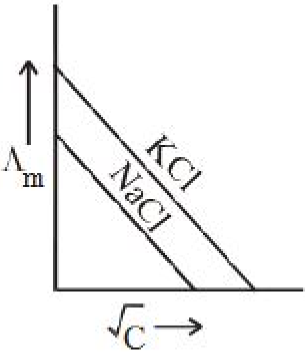
(A) Vanadium $(Z = 23)$
(B) Chromium $(Z = 24)$
(C) Iron $(Z = 26)$
(D) Manganese $(Z = 25)$

(30) Which one of the following graphs between molar conductivity (Λ_m) versus $\sqrt{C}$ is correct? [JEE MAIN 2019]

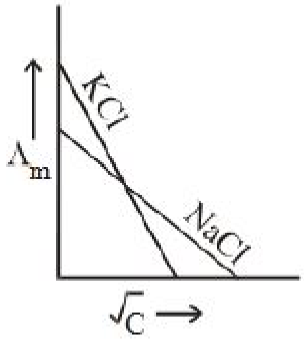
(A)



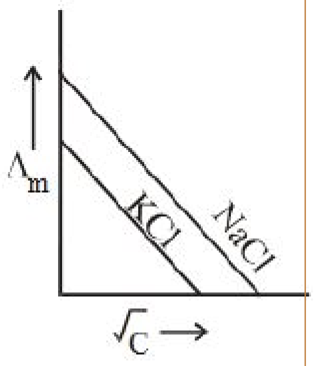
(B)



(C)



(D)



(31) The correct order of the number of unpaired electrons in the given complexes is
$A.\ [Fe(CN)_6]^{3-}$;$B.\ [FeF_6]^{3-}$; $C.\ [CoF_6]^{3-}$; $D.$ $[Cr($ oxalate $)_3]^{3-}$; $E.\ [Ni(CO)_4]$
Choose the correct answer from the options given below: [JEE MAIN 2023]

(A) $A < E < D < C < B$ (B) $E < A < D < C < B$

(C) $E < A < B < D < C$ (D) $A < E < C < B < D$

(32) The osmotic pressure of a dilute solution is 7×10^5 Pa at 273 K. Osmotic pressure of the same solution at 283 K is . . . . $\times 10^4$Nm^{-2}. [JEE MAIN 2024]

(A) 36 (B) 73

(C) 45 (D) 15

(33) When a certain amount of solid A is dissolved in $100\,g$ of water at $25^\circ\,C$ to make a dilute solution, the vapour pressure of the solution is reduced to one-half of that of pure water. The vapour pressure of pure water is $23.76\,mm\,Hg$. The number of moles of solute A added is .... (Nearest Integer) [JEE MAIN 2022]

(A) 2 (B) 3 or 6

(C) 4 (D) 5

(34) Which one of the following complexes shows optical isomerism ?
($en =$ ethylenediamine) [JEE MAIN 2016]

(A) $trans\,[Co(en)_2Cl_2]Cl$ (B) $[Co(NH_3)_4Cl_2]Cl$

(C) $[Co(NH_3)_3Cl_3]$ (D) $cis\,[Co(en)_2Cl_2]Cl$

(35) Molar conductivities (Λ_m^o) at infinite dilution of $NaCl, HCl$ and CH_3COONa are $126.4, 425.9$ and $91.0\,S\,cm^2\,mol^{-1}$ respectively. (Λ_m^o) for CH_3COOH will be .... $S\,cm^2\,mol^{-1}$. [AIPMT 2012]

(A) 425.5 (B) 180.5

(C) 290.8 (D) 390.5

(36) In neutral or faintly alkaline medium, $KMnO_4$ being a powerful oxidant can oxidize, thiosulphate almost quantitatively, to sulphate. In this reaction overall change in oxidation state of manganese will be [JEE MAIN 2022]

(A) 5 (B) 1

(C) 0 (D) 3

(37) A 5.2 molal aqueous solution of methyl alcohol, CH_3OH, is supplied. What is the mole fraction of methyl alcohol in the solution ? [AIEEE 2011]

(A) 0.10 (B) 0.19

(C) 0.086 (D) 0.05

(38) Given :
$E^o_{Cr^{3+}/Cr} = -0.74\,V,\ E^o_{MnO_4^-/Mn^{2+}} = 1.51\,V$
$E^o_{Cr_2O_7^{2-}/Cr^{3+}} = 1.33\,V : E^o_{Cl/Cl^-} = 1.36\,V$
Based on the data given above, strongest oxidising agent will be : [JEE MAIN 2013]

(A) Cl (B) Cr^{3+}

(C) Mn^{2+} (D) MnO_4^-

(39) An aqueous solution of $CoCl_2$ on addition of excess of concentrated HCl turns blue due to formation of [AIIMS 2005]

(A) $[Co(H_2O)_4Cl_2]$ (B) $[Co(H_2O)_2Cl_4]^{2-}$

(C) $[CoCl_4]^{2-}$ (D) $[Co(H_2O)_2Cl_2]$

(40) When common salt is dissolved in water [AIPMT 1988]

(A) Melting point of the solution increases

(B) Boiling point of the solution increases

(C) Boiling point of the solution decreases

(D) Both melting point and boiling point decreases

(41) Yellow compound of lead chromate gets dissolved on treatment with hot NaOH solution. The product of lead formed is a : [JEE MAIN 2024]

(A) Tetraanionic complex with coordination number six

(B) Neutral complex with coordination number four

(C) Dianionic complex with coordination number six

(D) Dianionic complex with coordination number four

(42) Acidified potassium permanganate solution oxidises oxalic acid. The spin-only magnetic moment of the manganese product formed from the above reaction is .... $B.M.$ (Nearest Integer) [JEE MAIN 2022]

(A) 9 (B) 8

(C) 4 (D) 6

(43) Identify the incorrect statement among the following [AIPMT 2007]

(A) Lanthanoid contraction is the accumulation of successive shrinkages.

(B) As a result of lanthanoid contraction, the properties of $4d$ series of the transition elements have no similarities with the $5d$ series of elements.

(C) Shielding power of $4f$ electrons is quite weak.

(D) There is a decrease in the radii of the atoms or ions as one proceeds from La to Lu.

(44) The elevation in boiling point for 1 molal solution of non-volatile solute A is $3\,K$. The depression in freezing point for 2 molal solution of A in the same solvent is $6\,K$. The ratio of K_b and K_f i.e., K_b/K_f is $1 : X$. The value of X is [nearest integer] [JEE MAIN 2022]

(A) 0 (B) 1

(C) 2 (D) 3

(45) Among Co^{3+}, Ti^{2+}, V^{2+} and Cr^{2+} ions, one if used as a reagent cannot liberate H_2 from dilute mineral acid solution,

its spin-only magnetic moment in gaseous state is ......$B.M.$ (Nearest integer) [JEE MAIN 2022]

(A) 6 (B) 5

(C) 3 (D) 4

(46) Spin only magnetic moment of an octahedral complex of Fe^{2+} in the presence of a strong field ligand in $B.M.$ is ..... [JEE MAIN 2021]

(A) 4.89 (B) 0

(C) 2.82 (D) 3.46

(47) A First order reaction is half completed in $45\,minutes$. How long does it need 99.9% of the reaction to be completed .... hr [AIIMS 2001]

(A) 5 (B) 7.5

(C) 10 (D) 20

(48) Given below are two statement: one is labelled as Assertion A and the other is labelled as
Reason R :
Assertion A : Size of Bk^{3+} ion is less than Np^{3+} ion.
Reason R : The above is a consequence of the lanthanoid contraction.
In the light of the above statements, choose the correct answer from the options given below [JEE MAIN 2021]

(A) A is false but R is true

(B) Both A and R are true but R is not the correct explanation of A

(C) Both A and R are true and R is the correct explanation of A

(D) A is true but R is false

(49) The magnetic moment of an octahedral homoleptic $Mn(II)$ complex is $5.9\,BM$. The suitable ligand for this complex is [JEE MAIN 2019]

(A) ethylenediamine (B) CN^-

(C) NCS^- (D) CO

(50) One Faraday of electricity liberates x $\times$ 10^{-1} gram atom of copper from copper sulphate, x is____. [JEE MAIN 2024]

(A) 4 (B) 5

(C) 6 (D) 7

Chemistry - Section B (SUBJECTIVE)

VSQ [1 Mark] (Attempt any 12)

(1) $224\,mL$ of $SO_{2(g)}$ at $298K$ and $1\,atm$ is passed through $100\,mL$ of $0.1\,M\;NaOH$ solution. The non-volatile solute produced is dissolved in $36\,g$ of water. The lowering of vapour pressure of solution (assuming the solution is dilute) $(P_{(H_2O)}=24\,mm$ of $Hg)$ is $x\times 10^{-2}mm$ of Hg the value of x is ....(Integer answer) [JEE MAIN 2021]

(2) Decomposition of X exhibits a rate constant for $0.05\,\mu g/year$. How many years are required for the decomposition of $5\,\mu g$ of X into $2.5\,\mu g$? [JEE MAIN 2019]

(3) A pink coloured salt turns blue on heating. The presence of which cation is most likely ? [JEE MAIN 2015]

(4) A first order reaction is found to have a rate constant, $k=5.5\times 10^{-14}\,s^{-1}$ Find the half-life of the reaction.

(5) The molarity of a solution obtained by mixing $750\,mL$ of $0.5(M)\,HCl$ with $250\,mL$ of $2(M)\,HCl$ will be ....M [JEE MAIN 2013]

(6) Determine the amount of $CaCl_2(i=2.47)$ dissolved in 2.5 litre of water such that its osmotic pressure is $0.75\,atm$ at $27°C$

(7) Which of the following complex ions is not expected to absorb visible light? [AIPMT 2010]

(8) A current of $16\,ampere$ flows through molten $NaCl$ for 10 minute. The amount of metallic sodium that appears at the negative electrode would be .... gm

(9) According to $IUPAC$ nomenclature sodium nitroprussied is named is [AIPMT 2003]

(10) AB_2 is 10% dissociated in water to A^{2+} and B^-. The boiling point of a 10.0 molal aqueous solution of AB_2 is .... $°C$. (Round off to the Nearest Integer).
[Given : Molal elevation constant of water $K_b=0.5\;K\,kg\,mol^{-1}$ boiling point of pure water $=100°C$]
[JEE MAIN 2021]

(11) Given below are two statements :
Statement I : The identification of Ni^{2+} is carried out by dimethyl glyoxime in the presence of NH_4OH.
Statement II : The dimethyl glyoxime is a bidentate neutral ligand.
In the light of the above statements, choose the correct answer from the options given below: [JEE MAIN 2021]

(12) Gaseous cyclobutene isomerizes to butadiene in a first order process which has a $'k'$ value of $3.3\times 10^{-4}s^{-1}$ at $153°C$. The time in minutes it takes for the isomerization to proceed 40% to completion at this temperature is ....
(Rounded off to the nearest integer) [JEE MAIN 2021]

(13) The standard electrode potential for Daniell cell is $1.1\,V$. Calculate the standard Gibbs energy for the reaction:
$Zn(s)+Cu^{2+}(aq)\rightarrow Zn^{2+}(aq)+Cu(s)$

(14) A standard hydrogen electrode has zero electrode potential because [IIT 1997]

Chemistry - Section B (SUBJECTIVE)

S.A [2 Marks] (Attempt any 7)

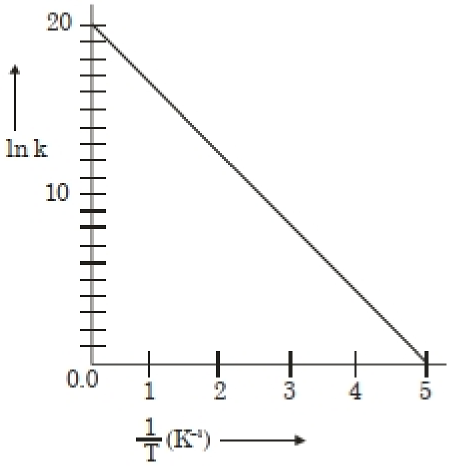
(15) Which of the following compounds shows optical isomerism [AIEEE 2005 , AIPMT 2005]

(16) A solution containing $2.5\times 10^{-3}\,kg$ of a solute dissolved in $75\times 10^{-3}\,kg$ of water boils at $373.535\,K$. The molar mass of the solute is ..... $g\,mol^{-1}$. [nearest integer] (Given: $K_b\,(H_2O)=0.52\,K\,Kg\,mol^{-1}$, boiling point of water $=373.15\,K$) [JEE MAIN 2022]

(17) Which of the following statement is true for the electrochemical Daniel cell [AIIMS 2004]

(18) The vapour pressure of benzene at a certain temperature is $640\,mm$ of Hg. A non-volatile and non-electrolyte solid weighing $2.175\,g$ is added to $39.08\,g$ of benzene. The vapour pressure of the solution is $600\;mm$ of Hg. What is the molecular weight of solid substance [AIPMT 1999]

(19) For a reaction, given below is the graph of ln $k\,vs\frac{1}{T}$. The activation energy for the reaction is equal to ......$cal\;mol^{-1}$. (Nearest integer). (Given : $R=2\,cal\,K^{-1}\,mol^{-1}$) [JEE MAIN 2022]



(20) The osmotic pressure of a dilute solution of an ionic compound XY in water is four times that of a solution of $0.01\,M\ BaCl_2$ in water. Assuming complete dissociation of the given ionic compounds in water, the concentration of XY (in $mol\ L^{-1}$) in solution is [JEE MAIN 2019]

(21) Calculate the half-life of a first order reaction from their rate constants given below:
$(i)\ 200\ s^{-1}$
$(ii)\ 2\,min^{-1}$
$(iii)\ 4\ years^{\ -1}$

(22) Match $List-I$ with $List-II$

$List-I$	$List-II$
$A\ Ni(CO)_4$	$I\ sp^3$
$B\ [Ni(CN)_4]^{2-}$	$II\ Sp^3d^2$
$C\ [Co(CN)_6]^{3-}$	$III\ d^2$
$D\ [CoF_6]^{3-}$	$IV\ sp^3dsp^2$

Choose the correct answer from the options given below. [JEE MAIN 2022]

(23) The osmotic pressure exerted by a solution prepared by dissolving $2.0\,g$ of protein of molar mass $60\,kg\,mol^{-1}$ in $200\,mL$ of water at $27°C$ is .....$Pa.$ [integer value] (use $R=0.083L\,bar\,mol^{-1}\ K^{-1}$) [JEE MAIN 2022]

Chemistry - Section B (SUBJECTIVE)

3 marks (Attempt any 4)

(24) Amongst the following compounds, identify which are insoluble, partially soluble and highly soluble in water?
(i) phenol (ii) toluene (iii) formic acid (iv) ethylene glycol (v) chloroform (vi) pentanol.

(25) Given :
$E^o_{Fe^{3+}/Fe}=-0.036\,V, E^o_{Fe^{2+}/Fe}=-0.439\,V$
The value of standard electrode potential for the change, $Fe^{3+}(aq)+e^- \rightarrow Fe^{2+}(aq)$ will be .... $V.$ [AIEEE 2009]

(26) Among the statements $(a)-(d)$, the incorrect ones are
(a) Octahedral $Co(III)$ complexes with strong field ligands have very high magnetic moments
(b) When $\Delta_0 < P$, the $d-$electron configuration of $Co(III)$ in an octahedral complex is $t^4_{eg}\,e^2_g$
(c) Wavelength of light absorbed by $[\mathrm{Co(en)_3}]^{3+}$ is lower than that of $[\mathrm{CoF_6}]^{3-}$
(d) If the Δ_0 for an octahedral complex of Co(III) is $18,000\ \mathrm{cm}^{-1}$, the Δ_t for its tetrahedral complex with the same ligand will be $16,000\ \mathrm{cm}^{-1}$ [JEE MAIN 2020]

(27) What is molarity of a solution of HCl which contains 49% by weight of solute and whose specific gravity is 1.41 [AIPMT 2001]

(28) The octahedral complex of a metal ion M^{3+} with four monodentate ligands L_1, L_2, L_3 and L_4 absorb wave lengths in the region of red, green, yellow and blue, respectively. The increasing order of ligand strength of the four ligands is : [JEE MAIN 2014]

Chemistry - Section B (SUBJECTIVE)

4 marks (Attempt any 3)

(29) A 5% solution (by mass) of cane sugar in water has freezing point of $271\,K$ Calculate the freezing point of 5% glucose in water if freezing point of pure water is $273.15\,K$

(30) Two elements A and B form compounds having formula AB_2 and AB_4. When dissolved in $20\ g$ of benzene (C_6H_6). $1\,g$ of AB_2 lowers the freezing point by $2.3\,K$ whereas $1.0\,g$ of AB_4 lowers it by $1.3\,K$. The molar depression constant for benzene is $5.1\,K\ kg\ mol^{-1}$. Calculate atomic masses of A and B.

(31) Calculate the depression in the freezing point of water when $10\,g$ of $CH_3CH_2CHClCOOH$ is added to $250\,g$ of water. $K_a=1.4\times10^{-3}, K_f=1.86\,K\,kg\,mol^{-1}$

(32) Consider the cell at $25°$C
$\mathrm{Zn}\left|\mathrm{Zn}^{2+}(\mathrm{aq}),(1\mathrm{M})\right\|\mathrm{Fe}^{3+}(\mathrm{aq}),\mathrm{Fe}^{2+}(\mathrm{aq})\left|\ \mathrm{Pt(s)}\right.$
The fraction of total iron present as Fe^{3+} ion at the cell potential of $1.500\ \mathrm{V}$ is X $\times\ 10^{-2}$. The value of x is ..... (Nearest integer).
$\left(\text{Given } E^0_{\mathrm{Fe^{3+}/Fe^{2+}}}=0.77\ \mathrm{V}, \mathrm{E}^0_{\mathrm{Zn^{2+}/Zn}}=-0.76\ \mathrm{V}\right)$ [JEE MAIN 2021]

Global Education of Science

Subject : Chemistry
Standard : 12
Total Mark : 100

MCQ and Subjective

(Answer Key)

Paper Set : 1
Date : 19-07-2024
Time : 0H:20M

Chemistry - Section A (MCQ)

1 - C	2 - B	3 - B	4 - A	5 - D	6 - A	7 - D	8 - B	9 - B	10 - B
11 - C	12 - C	13 - B	14 - A	15 - C	16 - A	17 - B	18 - D	19 - D	20 - C
21 - B	22 - A	23 - B	24 - D	25 - B	26 - D	27 - D	28 - C	29 - D	30 - B
31 - B	32 - B	33 - B	34 - C	35 - D	36 - D	37 - C	38 - D	39 - C	40 - B
41 - D	42 - D	43 - B	44 - B	45 - B	46 - B	47 - B	48 - C	49 - C	50 - B

Global Education of Science

Subject : Chemistry
Standard : 12
Total Mark : 100

MCQ and Subjective

(Solutions)

Paper Set : 1
Date : 19-07-2024
Time : 0H:20M

Chemistry - Section A (MCQ)

(1) The catalytic activity of transition metals and their compounds is ascribed mainly to [AIPMT 2012]

(A) their magnetic behaviour

(B) their unfilled $d-$ orbitals

(C) their ability to adopt variable oxidation states

(D) their chemical reactivity

Solution:(Correct Answer:C)

Transition metals are show variable oxidation states
$2SO_2 + O_2 \xrightarrow{V_2O_5} 2SO_3$
$SO_2 + V_2^{+5}O_5 \longrightarrow SO_3 + V_2^{+4}O_4$
$V_2^{+4}O_4 + O_2 \longrightarrow V_2^{+5}O_5$

(2) For the reaction A $\rightarrow$ B, the rate constant k (in s^{-1}) is given by $\log_{10} k = 20.35 - \frac{(2.47\times10^3)}{T}$. The energy of activation in kJ mol^{-1} is ..... . (Nearest integer) [Given : $R = 8.314$ J K^{-1} mol^{-1}] [JEE MAIN 2021]

(A) 85

(B) 47

(C) 12

(D) 4.7

Solution:(Correct Answer:B)

Given $\log K = 20.35 - \frac{2.47\times10^3}{T}$
We know $\log K = \log A - \frac{E_a}{2.303RT}$
$\Rightarrow \quad \frac{E_a}{2.303R} = 2.47 \times 10^3$
$E_a = 2.47 \times 10^3 \times 2.303 \times \frac{8.314}{1000}$ KJ/mole
$= 47.29 = 47$(Nearest integer)

(3) Which of the following species is not paramagnetic ? [JEE MAIN 2017]

(A) NO

(B) CO

(C) O_2

(D) B_2

Solution:(Correct Answer:B)

The electronic configuration of the given species is as follows:

$$O_2 : \sigma 1s^2, \sigma^* 1s^2, \sigma 2s^2, \sigma^* 2s^2, \sigma 2p_x^2, \begin{cases} \pi 2p_y^2, \\ \pi 2p_z^2, \end{cases} \begin{cases} \pi^* 2p_y^1 \\ \pi^* 2p_z^1 \end{cases}$$

$$B_2 : \sigma 1s^2, \sigma^* 1s^2, \sigma 2s^2, \sigma^* 2s^2, \begin{cases} \pi 2p_y^1 \\ \pi 2p_z^1 \end{cases}$$

$$NO : \sigma 1s^2, \sigma^* 1s^2, \sigma 2s^2, \sigma^* 2s^2, \sigma 2p_x^2, \begin{cases} \pi 2p_y^2, \\ \pi 2p_z^2, \end{cases} \begin{cases} \pi^* 2p_y^1 \\ \pi^* 2p_z^0 \end{cases}$$

CO: No unpaired electron is present in the molecule, therefore, is not paramagnetic.

(4) Which of the following does not have optical isomer [AIIMS 2004]

(A) $[Co(NH_3)_3Cl_3]$

(B) $[Co(en)_3]Cl_3$

(C) $[Co(en)_2Cl_2]Cl$

(D) $[Co(en)(NH_3)_2Cl_2]Cl$

Solution:(Correct Answer:A)

(a)$[Co(NH_3)_3Cl_3]$ does not have optical isomers because it is of formula MA_3B_3 which does not show optical isomerism.

(5) $E^o_{Fe^{2+}/Fe} = -0.441\,V$ and $E^o_{Fe^{3+}/Fe^{2+}} = 0.771\,V$, the standard EMF of the reaction $Fe + 2Fe^{3+} \rightarrow 3Fe^{2+}$ will be .... V. [AIPMT 2006]

(A) 0.111

(B) 0.330

(C) 1.653

(D) 1.212

Solution:(Correct Answer:D)

$E^0_{Fe^{2+}/re} = -0.441V$
So, $Fe \rightarrow Fe^{2+} + 2e^-, E^\circ = +0.441V \ldots.$ (i)
and $E^0_{Fe^{3+}/F_e^2} = 0.771V$
So, $Fe^{3+} + e^- \rightarrow Fe^{2+}, E^\circ = 0.771V \ldots\ldots$ (ii)
Cell reaction (i) $Fe \rightarrow Fe^{2+} + 2e^-, \quad E^\circ = 0.441V$
(ii) $2Fe^{3+} + 2e^- \rightarrow 2Fe^{2,+} \quad E^\circ = +0.771V$
$Fe^{2+} + 2Fe^{3+} \rightarrow 3Fe^{2+}, \quad E^0_{cell} = 1.212V$
So, on the basis of cell reaction following half-cell reactions are written
At anode:
$Fe \rightarrow Fe^{2+} + 2e^-$ (oxidation)
At cathode:
$2Fe^{3+} + 2e^- \rightarrow 2Fe^{2+}$(reduction)
So
$E^0_{cell} = E^0_{cathode} - E^0_{anode}$
$= E^0_{Fe^{3+}//Fe^{2+}} - E^0_{Fe^{2+}/Fe}$
$(0 + .771) - (-0.441) = +1.212V$

(6) The homoleptic and octahedral complex of Co^{2+} and H_2O has .... unpaired electron(s) in the t_{2g} set of orbitals. [JEE MAIN 2023]

(A) 1

(B) 2

(C) 3

(D) 4

Solution:(Correct Answer:A)

Co^{2+} : $3d^7$ configuration
$t_{2g}^{221} e_g^{11}$

(7) $A(g) \rightarrow 2B(g) + C(g)$ is a first order reaction. The initial pressure of the system was found to be $800\,mm\,Hg$ which increased to $1600\,mm\,Hg$ after $10\,min$. The total pressure of the system after $30\,min$ will be .... $mm\,Hg$. (Nearest integer) [JEE MAIN 2023]

(A) 2100

(B) 2000

(C) 2300

(D) 2200

Solution:(Correct Answer:D)

$t_{\frac{1}{2}} = 10$ minutes
$(P_A)_{30\,min} = (P_A)_0 \left(\frac{1}{2}\right)^{30/10}$
$(P_A)_{30\,min} = 100\,mm\,Hg$
$A(g) \rightarrow 2B(g) + C(g)$
at $t = 0$ $\quad 800\,mm \quad 0 \quad 0$
at $t = 30$ $\quad 100\,mm \quad 1400\,mm \quad 700\,mm$
Total pressure after 30 minutes $= 2200\,mm\,Hg$

(8) NO_2 required for a reaction is produced by decomposition of N_2O_5 in CCl_4 as by equation
$2\,N_2O_{5(g)} \rightarrow 4NO_{2(g)} + O_{2(g)}$ The initial concentration of N_2O_5 is 3 mol L^{-1} and it is 2.75 mol L^{-1} after 30 minutes.The rate of formation of NO_2 is x $\times 10^{-3}$ mol L^{-1} min^{-1}, value of x is_______. [JEE MAIN 2024]

(A) 16 **(B)** 17

(C) 18 (D) 19

Solution:(Correct Answer:B)

Rate of reaction (ROR)
$= -\frac{1}{2}\frac{\Delta[N_2O_5]}{\Delta t} = \frac{1}{4}\frac{[NO_2]}{\Delta t} = \frac{\Delta[O_2]}{\Delta t}$
$ROR = -\frac{1}{2}\frac{\Delta[N_2O_5]}{\Delta t} = -\frac{1}{2}\frac{(2.75-3)}{30} molL^{-1}\ min^{-1}$
$ROR = -\frac{1}{2}\frac{(-0.25)}{30} molL^{-1}\ min^{-1}$
$ROR = \frac{1}{240} molL^{-1}\ min^{-1}$
Rate of formation of $NO_2 = \frac{\Delta[NO_2]}{\Delta t} = 4 \times ROR$
$= \frac{4}{240} = 16.66 \times 10^{-3} molL^{-1}\ min^{-1} \simeq 17 \times 10^{-3}$

(9) Match List I with List II [JEE MAIN 2023]

List I Complex	List II Crystal Field splitting energy (Δ_0)
$A\ [Ti(H_2O)_6]^{2+}$	$I\ -1.2$
$B\ [V(H_2O)_6]^{2+}$	$II\ -0.6$
$C\ [Mn(H_2O)_6]^{3+}$	$III\ 0$
$D\ [Fe(H_2O)_6]^{3+}$	$IV\ -0.8$

(A) $A-II, B-IV, C-I, D-III$

(B) $A-IV, B-I, C-II, D-III$

(C) $A-IV, B-I, C-III, D-II$

(D) $A-II, B-IV, C-III, D-I$

Solution:(Correct Answer:B)

(A) $[Ti(H_2O)_6]^{2+}$
$Ti^{2+} \Rightarrow 3d^2 4s^0$
$t_{2g}e^- = 2$
$e_g e^- = 0$
$CFSE = [-0.4 \times 2 + 0.6 \times 0]\Delta_0$
$-0.8\,\Delta$
(B) $[V(H_2O)_6]^{2+}$
$V^{2+} \Rightarrow 3d^3 4s^0$
$t_{2g}e^- = 3$
$e_g e^- = 0$
$CFSE = [-0.4 \times 3 + 0.6 \times 0]\Delta_0$
$-1.2\Delta_0$
(C) $[Mn(H_2O)_6]^{3+}$
$Mn^{3+} \Rightarrow 3d^4 4s^0$
$t_{2g}e^- = 3$
$e_g e^- = 1$
$CFSE = [-0.4 \times 3 + 0.6 \times 1]\Delta_0$
$= -0.6\Delta_0$
(D) $[Fe(H_2O)_6]^{3+}$
$Fe^{3+} \Rightarrow 3d^5 4s^0$
$t_{2g}e^- = 3 \quad e_g = 2$
$CFSE = [-0.4 \times 3 + 0.6 \times 2]\Delta_0$
$= 0\Delta_0$

(10) The cell potential for the following cell
$Pt\,|H_2(g)|\,H^+(aq)\|Cu^{2+}(0.01M)\,|\,Cu(s)$
is $0.576\,V$ at $298\,K$. The pH of the solution is .... (Nearest integer) [JEE MAIN 2022]

(A) 50 **(B)** 5

(C) 15 (D) 25

Solution:(Correct Answer:B)

Anode : $H_2 \rightarrow 2H^+ + 2e^-$
Cathode: $Cu^{2+} + 2e^- \rightarrow Cu$
$Cu^{2+} + H_2 \rightarrow 2H^+ + Cu$
$E_{cell} = E^0_{cell} - \frac{0.06}{2}\log\frac{[H^+]^2}{[Cu^{2+}]}$
$0.576 = 0.34 - \frac{0.06}{2}\log\left\{\frac{[H^+]^2}{(0.01)}\right\}$
$+3.93 - \log(H^+) + \log 0.1$
$\Rightarrow pH = 4.93 \simeq 5$

(11) $2NO(g) + Cl_2(g) \rightleftharpoons 2NOCl(s)$
This reaction was studied at $-10°C$ and the following data was obtained

run	$[NO]_0$	$[Cl_2]_0$	r_0
1	0.10	0.10	0.18
2	0.10	0.20	0.35
3	0.20	0.20	1.40

$[NO]_0$ and $[Cl_2]_0$ are the initial concentrations and r_0 is the initial reaction rate.
The overall order of the reaction is ....
(Round off to the Nearest Integer). [JEE MAIN 2021]

(A) 1 (B) 2

(C) 3 (D) 4

Solution:(Correct Answer:C)

$r = k[NO]^m\,[Cl_2]^n$
$= k(0.1)^m(0.1)^n \quad .....(1)$
$= k(0.1)^m(0.2)^n \quad .....(2)$
$= k(0.2)^m(0.2)^n ......(3)$
$n = 1$
$m = 2$
$m + n = 3$

(12) The number of f electrons in the ground state electronic configuration of Np$(Z = 93)$ is .... [JEE MAIN 2021]

(A) 2 (B) 5

(C) 4 (D) 6

Solution:(Correct Answer:C)

Np $= 1\,s^2 2\,s^2 2p^6 3\,s^2 3p^6 4\,s^2 3\,d^{10} 4p^6 5\,s^2 4\,d^{10} 5p^6 6\,s^2$ $4f^{14} 5\,d^{10} 6p^6 7\,s^2 - 5f^4 6\,d^1$
Total no. of $'f'$ electron $= 14e^- + 4e^- = 18$

(13) For there action of H_2 with I_2, the rate constant is $2.5 \times 10^{-4}\,dm^3\,mol^{-1}\,s^{-1}$ at $327\,°C$ and $1.0\,dm^3\,mol^{-1}\,s^{-1}$ at $527\,°C$. The activation energy for the reaction, in $kJ\,mol^{-1}$ is: $(R = 8.314\,J\,K^{-1}\,mol^{-1})$ [JEE MAIN 2019]

(A) 72 **(B)** 166

(C) 150 (D) 59

Solution:(Correct Answer:B)

$H_2(g)\ +\ I_2(g)\ \rightarrow\ 2HI\,(g)$
Apply Arrhenius equation
$\log\frac{K_2}{K_1} = \frac{E_a}{2.303\,R}\left(\frac{1}{600} - \frac{1}{800}\right)$
$\log\frac{1}{2.5\times10^{-4}} = \frac{E_a}{2.303\times8.31}\left(\frac{200}{600\times800}\right)$
$\therefore\ E_a \approx 166\ kJ\,/\,mol$

(14) A first order reaction has a specific reaction rate of $10^{-2}\,sec^{-1}$. How much time will it take for $20\,g$ of the reactant to reduce to $5\,g$? .... sec [NEET 2017]

(A) 138.6 (B) 346.5

(C) 693.0 (D) 238.6

Solution:(Correct Answer:A)

$t = \frac{2.303}{K} \log \frac{[A]_o}{[A]_t}$
$t = \frac{2.303}{10^{-2}} \log \frac{20}{5} \Rightarrow t = 138.6$ sec

(15) On electrolysis of dil. sulphuric acid using Platinum (Pt) electrode, the product obtained at anode will be: [NEET 2020]

(A) SO_2 gas
(B) Hydrogen gas
(C) Oxygen gas
(D) H_2S gas

Solution:(Correct Answer:C)

H_2SO_4
At Anode : $2H_2O \rightarrow O_{2(g)} + 4H^+_{(aq)} + 4e^-$
Oxygen gas will liberate at anode

(16) The rate of the reaction, $2NO + Cl_2 \rightarrow 2NOCl$ is given by the rate equation rate $= k[NO]^2[Cl_2]$. The value of the rate constant can be increased by [AIPMT 2010]

(A) increasing the temperature
(B) increasing the concentration of NO
(C) increasing the concentration of the Cl_2
(D) doing all of these.

Solution:(Correct Answer:A)

Rate constant is only affected by temperature.

(17) Among the following ions which one has the highest paramagnetism [IIT 1993]

(A) $[Cr(H_2O)_6]^{3+}$
(B) $[Fe(H_2O)_6]^{2+}$
(C) $[Cu(H_2O)_6]^{2+}$
(D) $[Zn(H_2O)_6]^{2+}$

Solution:(Correct Answer:B)

(b) $[Fe(H_2O)_6]^{2+}$ has four unpaired electrons, $[Cr(H_2O)_6]^{3+}$,$[Cu(H_2O)_6]^{2+}$ and $[Zn(H_2O)_6]^{2+}$ have $3, 1, 0$ unpaired electrons respectively.

(18) Copper becomes green when exposed to moist air for a long period. This is due to [JEE MAIN 2014]

(A) the formation of a layer of cupric oxide on the surface of copper.
(B) the formation of a layer of basic carbonate of copper on the surface of copper.
(C) the formation of a layer of cupric hydroxide on the surface of copper.
(D) the formation of basic copper sulphate layer on the surface of the metal.

Solution:(Correct Answer:D)

Copper when exposed to moist air having CO_2. It gets superficially coated with a green layer of basic carbonate $CuCO_3.Cu(OH)_2$.

(19) The amount of charge required to liberate $9\,gm$ of aluminium (atomic weight = 27 and valency = 3) in the process of electrolysis is .... coulombs (Faraday's number $= 96500\,coulombs/gm$ equivalent)

(A) 321660
(B) 69500
(C) 289500
(D) 96500

Solution:(Correct Answer:D)

(d) Equivalent weight of aluminium $= \frac{27}{3} = 9$
So 1 faraday = $96500\,C$ are required to liberate $9\,gm$ of Al.

(20) Faraday's laws of electrolysis are related to the [IIT 1983]

(A) Atomic number of cation
(B) Atomic number of anion
(C) Equivalent weight of the electrolyte
(D) Speed of the cation

Solution:(Correct Answer:C)

(c)$w \propto E$ if i and t are constant.

(21) Among the following complexes the one which shows zero crystal field stabilization energy $(CFSE)$ is [NEET 2014]

(A) $[Mn(H_2O)_6]^{3+}$
(B) $[Fe(H_2O)_6]^{3+}$
(C) $[Co(H_2O)_6]^{2+}$
(D) $[Co(H_2O)_6]^{3+}$

Solution:(Correct Answer:B)

H_2O is a weak field ligand, hence
$\Delta_o <$ pairing energy.
CFSE $= (-0.4x + 0.6y)\Delta_o$
where, x and y are no. of electrons occupying t_{2g} and es orbitals respectively.
For $[Fe\,(H_2O)_6]^{3+}$ complex ion.
$Fe^{3+}\left(3d^5\right) = t_{2g}^3 e_g^2 = -0.4 \times 3 + 0.6 \times 2$
$= 0.0$ or 0 Dq

(22) The mismatched combinations are
A. Chlorophyll - Co
B. Water hardness - EDTA
C. Photography $-\,[Ag(CN)_2]^-$
D. Wilkinson catalyst - $[(Ph_3P)_3\,RhCl]$
E. Chelating ligand - D - Penicillamine
Choose the correct answer from the options given below: [JEE MAIN 2023]

(A) A and C Only
(B) A and E Only
(C) D and E Only
(D) A, C and E Only

Solution:(Correct Answer:A)

Mg is present in chlorophyll and in black and white photography the developed film is fixed by washing with hypo solution which dissolves the undecomposed $AgBr$ to form a complex ion $[Ag\,(S_2O_3)_2]^{3-}$

(23) After adding a solute freezing point of solution decreases to -0.186.
Calculate ΔT_b if $K_f = 1.86$ and $K_b = 0.521$. [AIEEE 2002]

(A) 0.521
(B) 0.0521
(C) 1.86
(D) 0.0186

Solution:(Correct Answer:B)

(b) $\Delta T_f = K_f \times m \Rightarrow 0.186 = 1.86 \times m$
So $m = 0.1$, Put the value of m in $\Delta T_b = K_b \times m$
$\Delta T_b = 0.521 \times (0.1) = 0.0521$

(24) An example of double salt is [AIPMT 1989]

(A) Bleaching powder
(B) $K_4[Fe(CN)_6]$
(C) Hypo
(D) Potash alum

Solution:(Correct Answer:D)

(d)Potash alum $K_2SO_4.Al_2(SO_4)_3.24H_2O$

(25) The correct order of the stoichiometries of $AgCl$ formed when $AgNO_3$ in excess is treated with the complexes : $CoCl_3 \cdot 6NH_3, CoCl_3 \cdot 5NH_3, CoCl_3 \cdot 4NH_3$ respectively is [NEET 2017]

(A) $3\,AgCl,\ 1\,AgCl,\ 2\,AgCl$
(B) $3\,AgCl,\ 2\,AgCl,\ 1\,AgCl$
(C) $2\,AgCl,\ 3\,AgCl,\ 2\,AgCl$
(D) $1\,AgCl,\ 3\,AgCl,\ 2\,AgCl$

Solution:(Correct Answer:B)

$[CO\,(NH_3)_6]\,Cl_3 \xrightarrow{AgNO_3} 3$ mol AgCl
$[CO\,(NH_3)_5\,Cl]Cl_2 \xrightarrow{AgNO_3} 2$ mol AgCl
$[CO\,(NH_3)_4\,Cl_2]\,Cl \xrightarrow{AgNO_3} 1$ mol AgCl

(26) For a first order reaction [IIT 1998]

(A) The degree of dissociation is equal to $(1-e^{-kt})$

(B) A plot of reciprocal concentration of the reactant vs time gives a straight line

(C) The pre-exponential factor in the Arrhenius equation has the dimension of time T^{-1}

(D) Both (a) and (c)

Solution:(Correct Answer:D)

(a) is correct because degree of dissociation $=1-e^{-kt}$ at any time t.
(b) is wrong because plot of log $[A]$ vs t is a straight line
(c) is wrong because time taken for 75% reaction is two half life.
(d) is correct because in $k=Ae^{-E_a/RT}$, $E_{a/RT}$ is dimensionless hence A has the unit of K.

(27) $Pt(s)H_2(g)(1bar)\left|H^+(aq)(1M)\right|\left|M^{3+}(aq),M^+(aq)\right|Pt(s)$
The E_{ceil} for the given cell is $0.1115\,V$ at $298\,K$ when
$\frac{[M^+(aq)]}{[M^{3+}(aq)]}=10^a$
The value of a is
Given : $E_{M^{3+}/M^+}=0.2\,V$
$\frac{2.303RT}{F}=0.059\,V$ [JEE MAIN 2023]

(A) 2 (B) 6

(C) 8 **(D)** 3

Solution:(Correct Answer:D)

Overall reaction :-
$H_{2(g)}+M^{3+}_{(aq)}\longrightarrow M^+_{(aq)}+2H^+_{(aq)}$
$E_{\text{Coll}}=E^\circ_{\text{Cathode}}-E^\circ_{\text{amode}}-\frac{0.059}{2}\log\frac{[M^+]\times 1^2}{[M^{+3}]1}$
$0.1115=0.2-\frac{0.059}{2}\log\frac{[M^+]}{[M^{+3}]}$
$3=\log\frac{[M^+]}{[M^{+3}]}$
$\therefore a=3$

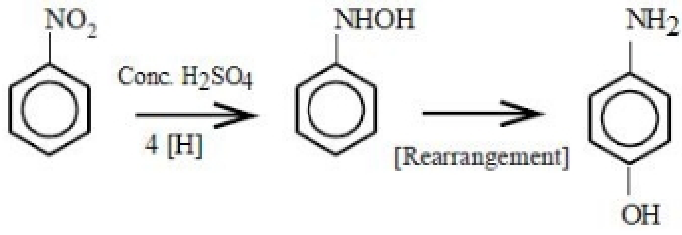
(28) When 9.65 ampere current was passed for 1.0 hour into nitrobenzene in acidic medium, the amount of $p-$amino-phenol produced is .... g [JEE MAIN 2018]

(A) 109 (B) 98.1

(C) 9.81 (D) 10.9

Solution:(Correct Answer:C)

9.65 ampere current was passed for 1.0 hour (3600 seconds)
Number of moles of electrons passed
$=\frac{I(A)\times t(s)}{96500}=\frac{9.65A\times 3600s}{96500}=0.36\,moles$
$C_6H_5NO_2+4e^-+4H^+\rightarrow$ p - Aminophenol $+H_2O$
4 moles of electrons will reduce 1 mole of nitrobenzene to $p-$ aminophenol. 0.36 moles of electrons will reduce $\frac{0.36}{4}=0.09$ moles of nitrobenzene to $p-$ aminophenol $p-$ aminophenol molar mass $=109.14\ g/mol$ Mass of $p-$ aminophenol obtained $=109.14\,g/mol\times 0.09\,mol=9.81\,g$



(29) Four successive members of the first row transition elements are listed below with their atomic numbers. Which one of them is expected to have the highest third ionization enthalpy [AIPMT 2005]

(A) Vanadium $(Z=23)$ (B) Chromium $(Z=24)$

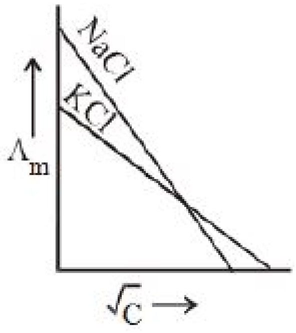
(C) Iron $(Z=26)$ **(D)** Manganese $(Z=25)$

Solution:(Correct Answer:D)

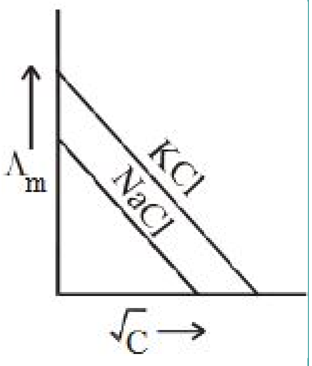
(d)$_{25}Mn=3d^5 4s^2$
After losing two electron electronic configuration will be like this $({}_{25}Mn^{+2}3d^5)$ and this is most stable configuration due to half filled orbitals hence third ionization enthalpy will be highest in this case.

(30) Which one of the following graphs between molar conductivity (Λ_m) versus $\sqrt{C}$ is correct? [JEE MAIN 2019]

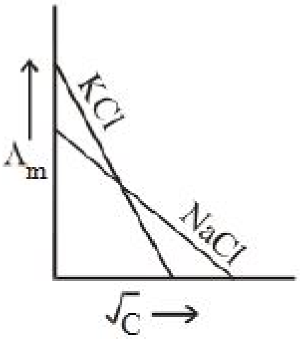
(A)



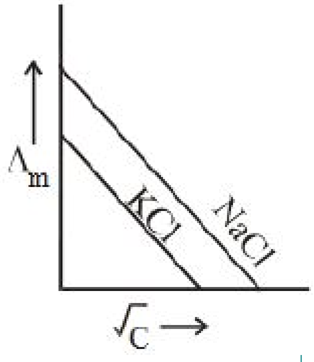
(B)



(C)



(D)



Solution:(Correct Answer:B)

Both $NaCl$ and KCl are strong electrolytes and as $Na^+(aq.)$ has less conductance than $K^+(aq.)$ due to more hydration therefore the graph of option (B) is correct.

(31) The correct order of the number of unpaired electrons in the given complexes is
$A.\ [Fe(CN)_6]^{3-}$;$B.\ [FeF_6]^{3-}$; $C.\ [CoF_6]^{3-}$; $D.$ $[Cr($ oxalate $)_3]^{3-}$; $E.\ [Ni(CO)_4]$
Choose the correct answer from the options given below:
[JEE MAIN 2023]

(A) $A<E<D<C<B$ **(B)** $E<A<D<C<B$

(C) $E<A<B<D<C$ (D) $A<E<C<B<D$

Solution:(Correct Answer:B)

$A.\ [Fe(CN)_6]^{3-}\ n=1$
$B.\ [FeF_6]^{3-}\ n=5$
$C.\ [CoF_6]^{3-}\ n=4$
$D.\ [\text{Cr(oxalate)}_3]^{3-}\ n=3$
$E.\ [Ni(CO)_4]\ n=0$

(32) The osmotic pressure of a dilute solution is 7×10^5 Pa at 273 K. Osmotic pressure of the same solution at 283 K is . . . .$\times10^4\text{Nm}^{-2}$. [JEE MAIN 2024]

(A) 36 **(B)** 73

(C) 45 (D) 15

Solution:(Correct Answer:B)

(72.56) or (73)
$\pi=$ CRT
$\Rightarrow \frac{\pi_1}{\pi_2}=\frac{T_1}{T_2}$
$\Rightarrow \pi_2=\frac{\pi_1 T_2}{T_1}=\frac{7\times10^5\times283}{273}$
$=72.56\times10^4\text{Nm}^{-2}$

(33) When a certain amount of solid A is dissolved in $100\,g$ of water at $25^\circ\,C$ to make a dilute solution, the vapour pressure of the solution is reduced to one-half of that of pure water. The vapour pressure of pure water is $23.76\,mm\,Hg$. The number of moles of solute A added is .... (Nearest Integer) [JEE MAIN 2022]

(A) 2 **(B)** 3 or 6

(C) 4 (D) 5

Solution:(Correct Answer:B)

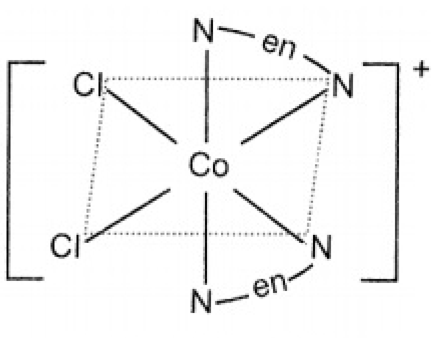
$\because$ Diliute solution given:
$\frac{P^0-P_s}{P^0}\sim\frac{{}^n\text{ solute}}{{}^n\text{ solvent}}$
$\frac{P^0-P^0/2}{P^0}=\frac{{}^n\text{ solute}}{n_\text{solvent}}$
$'\text{ solute}\sim\frac{{}^n\text{ solvent}}{2}=\frac{100}{18\times2}=2.78\,mol$
More accurate approach:
$\frac{P^0-P_S}{P_S}=\frac{{}^n\text{ solute}}{{}^n\text{ solvent}}$
$\frac{P^0-P^0/2}{P^0/2}=\frac{{}^n\text{ solute}}{{}^n\text{ solvent}}$
$'\text{ solute}={}^n\text{ solvent}=\frac{100}{18}=5.55\,mol$

(34) Which one of the following complexes shows optical isomerism ?
$(en=$ ethylenediamine) [JEE MAIN 2016]

(A) $trans\,[Co(en)_2Cl_2]Cl$ (B) $[Co(NH_3)_4Cl_2]Cl$

(C) $[Co(NH_3)_3Cl_3]$ (D) $cis\,[Co(en)_2Cl_2]Cl$

Solution:(Correct Answer:C)



$cis[Co(en)_2Cl_2]Cl$

(35) Molar conductivities (Λ_m^o) at infinite dilution of $NaCl, HCl$ and CH_3COONa are $126.4, 425.9$ and $91.0\,S\,cm^2\,mol^{-1}$ respectively. (Λ_m^o) for CH_3COOH will be ....
$S\,cm^2\,mol^{-1}$. [AIPMT 2012]

(A) 425.5 (B) 180.5

(C) 290.8 **(D)** 390.5

Solution:(Correct Answer:D)

$\text{CH}_3\text{COONa}+\text{HCl}\to\text{NaCl}+\text{CH}_3\text{COOH}$
$91+425.9=126.4+x$
$x=516.9-126.4$
$=390.5\text{ S cm}^2\text{mol}^{-1}$

(36) In neutral or faintly alkaline medium, $KMnO_4$ being a powerful oxidant can oxidize, thiosulphate almost quantitatively, to sulphate. In this reaction overall change in oxidation state of manganese will be [JEE MAIN 2022]

(A) 5 (B) 1

(C) 0 **(D)** 3

Solution:(Correct Answer:D)

$8MnO_4{}^{+7}+3S_2O_3{}^{2-}+H_2O\to8MnO_2+6SO_4{}^{2-}+2OH^-$
Change in oxidation state of Mn is from $+7$ to $+4$ which is 3.

(37) A 5.2 molal aqueous solution of methyl alcohol, CH_3OH, is supplied. What is the mole fraction of methyl alcohol in the solution ? [AIEEE 2011]

(A) 0.10 (B) 0.19

(C) 0.086 (D) 0.05

Solution:(Correct Answer:C)

$m=\frac{X_\text{solute}}{X_\text{solvent}}\times\frac{1000}{M_\text{solvent}}$
$m=$ molality, $X_\text{solute}=$ Mole fraction of solute, $X_\text{solvent}=$ Mole fraction of solvent, $M_\text{solvent}=$ Molar mass of solvent
Here solute is methyl alcohol (CH_3OH) and solvent is water $(H_2\text{O})$ Here water is solvent because question says solution is aqueous
Assume mole fraction of methyl alcohol $=x$
So mole fraction of water $=1-X$
and given molality $(\text{m})=5.2$
$\text{M}_\text{solvent}=18$ (as molar mass of $\text{H}_2\text{O}=18$)
$\therefore 5.2=\frac{X}{1-X}\times\frac{1000}{18}$
by solving this we get,
$X=0.086$

(38) Given :
$E^o_{Cr^{3+}/Cr}=-0.74\,V,\ E^o_{MnO_4^-/Mn^{2+}}=1.51\,V$
$E^o_{Cr_2O_7^{2-}/Cr^{3+}}=1.33\,V:E^o_{Cl/Cl^-}=1.36\,V$
Based on the data given above, strongest oxidising agent will be : [JEE MAIN 2013]

(A) Cl (B) Cr^{3+}

(C) Mn^{2+} **(D)** MnO_4^-

Solution:(Correct Answer:D)

Higher the value of standard reduction potential stronger will be the oxidising agent, hence MnO_4^- is the strongest oxidising agent.

(39) An aqueous solution of $CoCl_2$ on addition of excess of concentrated HCl turns blue due to formation of [AIIMS 2005]

(A) $[Co(H_2O)_4Cl_2]$ (B) $[Co(H_2O)_2Cl_4]^{2-}$

(C) $[CoCl_4]^{2-}$ (D) $[Co(H_2O)_2Cl_2]$

Solution:(Correct Answer:C)

(c)$CoCl_2$ is a weak Lewis acid, reacting with chloride ion to produce salt containing the tetrahedral $[CoCl_4]^{2-}$ ion. $CoCl_2$ is blue when anhydrous, and a deep magneta colour when hydrated, for this reason it is widely used as an indicator for water.

(40) When common salt is dissolved in water [AIPMT 1988]

(A) Melting point of the solution increases

(B) Boiling point of the solution increases

(C) Boiling point of the solution decreases

(D) Both melting point and boiling point decreases

Solution:(Correct Answer:B)

(b)Common salt is non-volatile and rises the b.pt.

(41) Yellow compound of lead chromate gets dissolved on treatment with hot NaOH solution. The product of lead formed is a : [JEE MAIN 2024]

(A) Tetraanionic complex with coordination number six

(B) Neutral complex with coordination number four

(C) Dianionic complex with coordination number six

(D) Dianionic complex with coordination number four

Solution:(Correct Answer:D)

PbCrO$_4$ + NaOH (hot excess) $\rightarrow$ [Pb(OH)$_4$]$^{-2}$ + Na$_2$CrO$_4$
Dianionic complex with coordination number four

(42) Acidified potassium permanganate solution oxidises oxalic acid. The spin-only magnetic moment of the manganese product formed from the above reaction is .... $B.M.$ (Nearest Integer) [JEE MAIN 2022]

(A) 9 (B) 8

(C) 4 **(D)** 6

Solution:(Correct Answer:D)

$2KMnO_4 + 5H_2C_2O_4 + 3H_2SO_4 \rightarrow$
$K_2SO_4 + 2MnSO_4 + 10CO_2 + 8H_2O$
Mn^{2+} has 5 unpaired electrons therefore the magnetic moment is $\sqrt{35}\,BM$

(43) Identify the incorrect statement among the following [AIPMT 2007]

(A) Lanthanoid contraction is the accumulation of successive shrinkages.

(B) As a result of lanthanoid contraction, the properties of $4d$ series of the transition elements have no similarities with the $5d$ series of elements.

(C) Shielding power of $4f$ electrons is quite weak.

(D) There is a decrease in the radii of the atoms or ions as one proceeds from La to Lu.

Solution:(Correct Answer:B)

The regular decrease in the radil of lanthanide ions from La^{3+} to Lu^{3+} is known as lanthanides contraction. It is due to the greater effect of the increased nuclear charge than that of screening effect (shielding effect). As a result of lanthanide contraction, the atomic radii of element of 4d and 5d come closetr, so the properties of 4d and 5d -transition element shows the similarities

(44) The elevation in boiling point for 1 molal solution of non-volatile solute A is $3\,K$. The depression in freezing point for 2 molal solution of A in the same solvent is $6\,K$. The ratio of K_b and K_f i.e., K_b/K_f is $1 : X$. The value of X is [nearest integer] [JEE MAIN 2022]

(A) 0 **(B)** 1

(C) 2 (D) 3

Solution:(Correct Answer:B)

$\Delta T_b = iK_bm_1 \quad \Delta T_f = iK_fm_2$
$\frac{\Delta T_b}{\Delta T_f} = \frac{K_b\times1}{K_f\times2} \Rightarrow \frac{3}{6} = \frac{1}{2} = \frac{K_b}{K_f} \times \frac{1}{2}$
$\frac{K_b}{K_f} = \frac{1}{1} \Rightarrow x = 1$

(45) Among Co^{3+}, Ti^{2+}, V^{2+} and Cr^{2+} ions, one if used as a reagent cannot liberate H_2 from dilute mineral acid solution, its spin-only magnetic moment in gaseous state is ......$B.M.$ (Nearest integer) [JEE MAIN 2022]

(A) 6 **(B)** 5

(C) 3 (D) 4

Solution:(Correct Answer:B)

Co^{3+} can't liberate H_2.
It has d^6 configuration,
Number of unpaired electrons $= 4$
$\mu = \sqrt{4 \times 6} = 4.92\ B.M.$

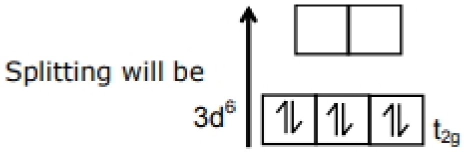
(46) Spin only magnetic moment of an octahedral complex of Fe^{2+} in the presence of a strong field ligand in $B.M.$ is ..... [JEE MAIN 2021]

(A) 4.89 **(B)** 0

(C) 2.82 (D) 3.46

Solution:(Correct Answer:B)

In presence of SFL $\Delta_0\ >$ P means pairing occurs therefore
For Fe^{+2} 3 d^6
$\therefore$ No of unpaired e $-$ (s) $= 0$
$\therefore \mu = \sqrt{n(n(n+2)}$ BM $= 0$
[n $=$ No of unpaired e $-$ (s)]
In NiCl$_2$Ni^{+2} is having configuration 3 d^8
$\therefore$ Number of unpaired electron $= 2$
After formation of oxidised product
[Ni(CN)$_6$]$^{-2}$ Ni^{+4} is obtained
Ni^t $\Rightarrow 3$ d^6 and CN$^-$is strong field ligand
$\therefore$ number of unpaired electrons $= 0$
$\therefore$ The charge is $2 - 0 = 2$



(47) A First order reaction is half completed in $45\,minutes$. How long does it need 99.9% of the reaction to be completed .... hr [AIIMS 2001]

(A) 5 **(B)** 7.5

(C) 10 (D) 20

Solution:(Correct Answer:B)

(b) $k = \frac{0.693}{45}$ min^{-1} $= \frac{2.303}{t_{99.9\%}}$ log $\frac{a}{a-0.999a}$ or
$t_{99.9\%} = \frac{2.303\times45}{0.693}$ log $10^3 = 448$ min $\approx 7.5\ hrs$

(48) Given below are two statement: one is labelled as Assertion A and the other is labelled as
Reason R :
Assertion A : Size of Bk^{3+} ion is less than Np^{3+} ion.
Reason R : The above is a consequence of the lanthanoid contraction.
In the light of the above statements, choose the correct answer from the options given below [JEE MAIN 2021]

(A) A is false but R is true

(B) Both A and R are true but R is not the correct explanation of A

(C) Both A and R are true and R is the correct explanation of A

(D) A is true but R is false

Solution:(Correct Answer:C)

Size of $_{97}Bk^{3+}$ ion is less than that of $_{93}Np^{3+}$ due to actinoid contraction.
As we know that in a period from left to right ionic radius decreases and in actinide series it is due to actinoid contraction.

(49) The magnetic moment of an octahedral homoleptic $Mn(II)$ complex is $5.9\,BM$. The suitable ligand for this complex is [JEE MAIN 2019]

(A) ethylenediamine
(B) CN^-
(C) NCS^-
(D) CO

Solution:(Correct Answer:C)

Homoleptic complexes contain identical ligands,
$e.g., [Mn(NCS)_6]^{4-}$.

(50) One Faraday of electricity liberates x $\times\ 10^{-1}$ gram atom of copper from copper sulphate, x is____. [JEE MAIN 2024]

(A) 4
(B) 5
(C) 6
(D) 7

Solution:(Correct Answer:B)

$\mathrm{Cu}^{2+} + 2\mathrm{e}^- \rightarrow \mathrm{Cu}$
2 Faraday $\rightarrow 1$ molCu
1 Faraday $\rightarrow 0.5$ molCu deposit
0.5 mol $= 0.5$ g atom $= 5 \times 10^{-1}$
x $= 5$

Chemistry - Section B (SUBJECTIVE)

VSQ [1 Mark] (Attempt any 12)

(1) $224\,mL$ of $SO_{2(g)}$ at $298K$ and $1\,atm$ is passed through $100\,mL$ of $0.1\,M\ NaOH$ solution. The non-volatile solute produced is dissolved in $36\,g$ of water. The lowering of vapour pressure of solution (assuming the solution is dilute) $(P_{(H_2O)} = 24\,mm$ of $Hg)$ is $x \times 10^{-2} mm$ of Hg the value of x is ....(Integer answer) [JEE MAIN 2021]

Solution:

$SO_2 + NaOH \rightarrow NaHSO_3$
$9.2 \qquad 10 \qquad -$
$- \qquad 0.8 \qquad 9.2$
$\Delta P = P^0 \cdot X_{\text{solute}}$
$= 24 \times \frac{(1.6+18.4)}{2020}$
$= 0.2376 = 23.76 \times 10^{-2}$

(2) Decomposition of X exhibits a rate constant for $0.05\,\mu g/year$. How many years are required for the decomposition of $5\,\mu g$ of X into $2.5\,\mu g$? [JEE MAIN 2019]

Solution:

According to unit of rate constant it is a zero order reaction then half life of reaction will be
$t_{1/2} = \frac{C_0}{2k} = \frac{5\,\mu g}{2\times 0.05\,\mu g/year} = 50\,years$

(3) A pink coloured salt turns blue on heating. The presence of which cation is most likely ? [JEE MAIN 2015]

Solution:

Zn^{2+} salts are white. Usually Fe^{2+} salts are rarely pink.
Cu^{2+} salts are usually blue in hydrated form. Co^{2+} is pink in aqueous solution

(4) A first order reaction is found to have a rate constant, $k = 5.5 \times 10^{-14}\,s^{-1}$ Find the half-life of the reaction.

Solution:

Half-life for a first order reaction is
$t_{1/2} = \frac{0.693}{k}$
$t_{1/2} = \frac{0.693}{5.5\times 10^{-14}\,s^{-1}} = 1.26 \times 10^{13}\,s$

(5) The molarity of a solution obtained by mixing $750\,mL$ of $0.5(M)\,HCl$ with $250\,mL$ of $2(M)\,HCl$ will be ....M [JEE MAIN 2013]

Solution:

From Molarity equation:
$M_1V_1 + M_2V_2 = M \times V$
$M = \frac{M_1V_1+M_2V_2}{V}$
where V = total volume
$= \frac{750\times 0.5+250\times 2}{1000} = 0.875\,M$

(6) Determine the amount of $CaCl_2 (i = 2.47)$ dissolved in 2.5 litre of water such that its osmotic pressure is $0.75\,atm$ at $27°C$

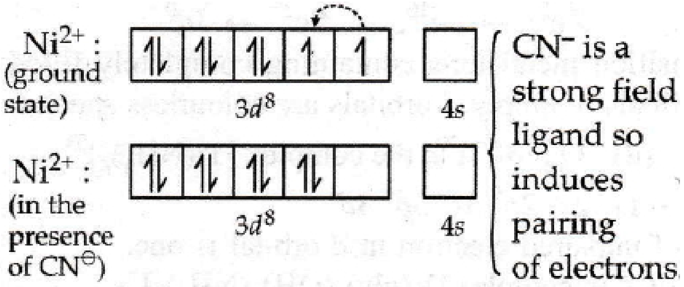
Solution:

We know that,
$\pi = i\frac{n}{V}RT$
$\Rightarrow \pi = i\frac{w}{MV}RT$
$\Rightarrow w = \frac{\pi MV}{iRT}$
$\pi = 0.75\,atm$
$V = 2.5\,L$
$i = 2.47$
$T = (27+273)K = 300\,K$
Here,
$R = 0.0821\,L\,atm\,K^{-1}\,mol^{-1}$
$M = 1\times 40 + 2\times 35.5$
$= 111\,g\,mol^{-1}$
Therefore, $w = \frac{0.75\times 111\times 2.5}{2.47\times 0.0821\times 300}$
$= 3.42\,g$
Hence, the required amount of $CaCl_2$ is $3.42\,g$

(7) Which of the following complex ions is not expected to absorb visible light? [AIPMT 2010]

Solution:

A transition metal complex absorbs visible tight only if it has unpaired electrons.
No unpaired electron so does not absorb visible light.



(8) A current of $16\,ampere$ flows through molten $NaCl$ for 10 minute. The amount of metallic sodium that appears at the negative electrode would be .... gm

Solution:

(c) Amount of metallic sodium appears $m = Zit = \left(\frac{A}{VF}\right) it$
$= \left(\frac{23}{1 \times 96500}\right) \times 16 \times 10 \times 60 = 2.3\,gm$

(9) According to $IUPAC$ nomenclature sodium nitroprussied is named is [AIPMT 2003]

Solution:

NO readily forms coordination complexes with transition metla ions. These complex are called nitrosyls. F^{2+} and NO form the complex $[Fe\,(H_2O)_5\,NO]^{2+}$ which is responsible for the colour in the brown ring test for nitrates. The colour is due to change transfer. This complex formally contains $Fe(+1)$ and NO^+. Its magnetic moment is approximately $3.9BM$, confirming the presence of three - unpaired electrons. Note that NO^+ is a strong field ligand, thus, it reshuffles the electronic configuration:
$Fe^+\left(3d^6 4s^1\right) \to Fe + \left(3d^7 4s^0\right)$
Most nitrosyl complexes are colourd. Another example is sodium nitroprusside $Na_2\,[Fe(CN)_5NO]\,.2H_2O$. The colour (brown - red) is again due to charge transfer. This complex has NO^+ as a ligands and Fe^+ as the central metal ion. Thus, its IUPAC name should be sodium pentacyanidonitrosonium ferrat (II).

(10) AB_2 is 10% dissociated in water to A^{2+} and B^-. The boiling point of a 10.0 molal aqueous solution of AB_2 is .... $^\circ C$. (Round off to the Nearest Integer).
[Given : Molal elevation constant of water
$K_b = 0.5\ K\,kg\,mol^{-1}$ boiling point of pure water $= 100^\circ C$]
[JEE MAIN 2021]

Solution:

$AB_2 \to A^{2+} + 2B^-$
$t = 0a00$
$t = ta - a\alpha a\alpha 2a\alpha$
$n_T = a - a\alpha + a\alpha + 2a\alpha$
$= a(1 + 2\alpha)$
so $i = 1 + 2\alpha$
Now $\Delta T_b = i \times m \times K_b$
$\Delta T_b = (1 + 2\alpha) \times m \times K_b$
$\alpha = 0.1 \quad m = 10 \quad K_b = 0.5$
$\Delta T_b = 1.2 \times 10 \times 0.5$
$= 6$
So boiling point $= 106$

(11) Given below are two statements :
Statement I : The identification of Ni^{2+} is carried out by dimethyl glyoxime in the presence of NH_4OH.
Statement II : The dimethyl glyoxime is a bidentate neutral ligand.
In the light of the above statements, choose the correct answer from the options given below: [JEE MAIN 2021]

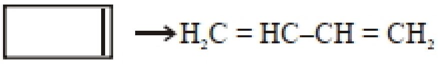
Solution:

Neutral dimethyl glyoxime does not act as ligand.
When Ni^{2+} reacts with dimethyl glyoxime in presence of NH_4OH, it produce dimethyl glyoximate then it form rozy red ppt.
$Ni^{2+}{}_{(aq)} + 2dmg^- \to [Ni(dmg)_2]$
Rosy Red ppt.

(12) Gaseous cyclobutene isomerizes to butadiene in a first order process which has a $'k'$ value of $3.3 \times 10^{-4} s^{-1}$ at $153^\circ C$. The time in minutes it takes for the isomerization to proceed 40% to completion at this temperature is ....
(Rounded off to the nearest integer) [JEE MAIN 2021]

Solution:

$Kt = \ell n \frac{[A]_0}{[A]_t}$
$3.3 \times 10^{-4} \times t = \ell n\left(\frac{100}{60}\right)$
$t = 1547.956\,sec$
$t = 25.799\,min$
$26\,min$



(13) The standard electrode potential for Daniell cell is $1.1\,V$. Calculate the standard Gibbs energy for the reaction:
$Zn(s) + Cu^{2+}(aq) \to Zn^{2+}(aq) + Cu(s)$

Solution:

$\Delta_r G^\ominus = -nFE^\ominus_{(cell)}$
n in the above equation is 2, $F = 96487\,C\,mol^{-1}$ and
$E^\ominus_{(cell)} = 1.1\,V$
Therefore, $\Delta_r G^\ominus = -2 \times 1.1\,V \times 96487\ C\,mol^{-1}$
$= -21227\,J\,mol^{-1}$
$= -212.27\,kJ\,mol^{-1}$

(14) A standard hydrogen electrode has zero electrode potential because [IIT 1997]

Solution:

Potential is a relative term i.e. it is always measured with respect to a reference. In electrochemistry, hydrogen is taken to be the reference to measure the potential and hence to form a basis for comparison with all other electrode reactions, hydrogen's standard electrode potential is declared to be zero volts at all temperatures.

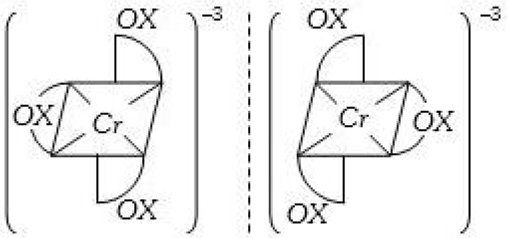
Chemistry - Section B (SUBJECTIVE)

S.A [2 Marks] (Attempt any 7)

(15) Which of the following compounds shows optical isomerism
[AIEEE 2005 , AIPMT 2005]

Solution:

(c)



(16) A solution containing $2.5 \times 10^{-3}\,kg$ of a solute dissolved in $75 \times 10^{-3}\,kg$ of water boils at $373.535\,K$. The molar mass of the solute is ..... $g\,mol^{-1}$. [nearest integer] (Given: $K_b\,(H_2O) = 0.52\,K\,Kg\,mol^{-1}$, boiling point of water $= 373.15\,K$) [JEE MAIN 2022]

Solution:

$w = 2.5\,g \qquad K_b = 0.52$
$w_{solvent} = 75g \qquad M =$ Mol . Wt .of solute
$T'_B = 373.535\,K$
$T^o_B = 373.15\,K$
$\Delta T_B = 0.385 = K_b$ molality
$0.385 = 0.52 \times \left(\frac{2.5}{M} \times \frac{1000}{75}\right)$
$M = 45\,g\,mol^{-1}$

(17) Which of the following statement is true for the electrochemical Daniel cell [AIIMS 2004]

Solution:

(c)In daniel cell copper rod acts as cathode so there cations move towards copper electrode and reduction take place on copper rod.

(18) The vapour pressure of benzene at a certain temperature is $640\,mm$ of Hg. A non-volatile and non-electrolyte solid weighing $2.175\,g$ is added to $39.08\,g$ of benzene. The vapour pressure of the solution is $600\ mm$ of Hg. What is the molecular weight of solid substance [AIPMT 1999]

Solution:

(c) $\frac{P^0-P_s}{P^0}=\frac{\frac{w}{m}}{\frac{w}{m}+\frac{W}{M}}$

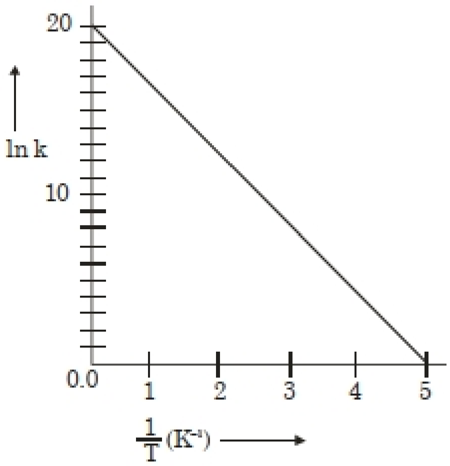
$\because\ \frac{W}{M}>\frac{w}{m}\Rightarrow\frac{640-600}{640}$

$=\frac{w}{m}\times\frac{M}{W}\Rightarrow\frac{40}{640}=\frac{2.175\times78}{m\times39.08}$;

$m=\frac{2.175\times78}{39.08}\times\frac{640}{40}$

$m=69.45.$

(19) For a reaction, given below is the graph of In $k\ vs\frac{1}{T}$. The activation energy for the reaction is equal to ......$cal\ mol^{-1}$. (Nearest integer). (Given : $R=2\,cal\,K^{-1}\,mol^{-1}$) [JEE MAIN 2022]



Solution:

$K=Ae^{-Ea/RT}$

In $k=\frac{-Ea}{RT}+$ In A

Slope $=\frac{Ea}{R}=\frac{20}{5}$

$E_a=4\,R=8\,Cal/mol$

(20) The osmotic pressure of a dilute solution of an ionic compound XY in water is four times that of a solution of $0.01\,M\ BaCl_2$ in water. Assuming complete dissociation of the given ionic compounds in water, the concentration of XY (in $mol\ L^{-1}$) in solution is [JEE MAIN 2019]

Solution:

$\pi_{xy}\ =\ 4\pi_{BaCl_2}$

$\pi_{xy}\ =\ iCRT$

$\pi_{xy}\ =\ 2CRT$

$\pi_{BaCl_2}\ =\ 3\ \times\ 0.01\,RT$

$RT\ =\ 12\ \times\ 0.01RT$

$\frac{12\times0.01}{2}\ =\ 0.06$

(21) Calculate the half-life of a first order reaction from their rate constants given below:

$(i)\ 200\,s^{-1}$

$(ii)\ 2\,min^{-1}$

$(iii)\ 4\ years\ ^{-1}$

Solution:

(i) Half life, $t_{1/2}=\frac{0.693}{k}$

$=\frac{0.693}{200\,s^{-1}}$

$=3.47\ s$ (approximately)

(ii) Half life,$t_{1/2}=\frac{0.693}{k}$

$=\frac{0.693}{2\text{ min}^{-1}}$

$=0.35\,min$ (approximately)

(iii) Half life,$t_{1/2}=\frac{0.693}{k}$

$=\frac{0.693}{4\text{ years }^{-1}}$

$=0.173$ years (approximately)

(22) Match $List-I$ with $List-II$

$List-I$	$List-II$
$A\ Ni(CO)_4$	$I\ sp^3$
$B\ [Ni(CN)_4]^{2-}$	$II\ Sp^3d^2$
$C\ [Co(CN)_6]^{3-}$	$III\ d^2$
$D\ [CoF_6]^{3-}$	$IV\ sp^3dsp^2$

Choose the correct answer from the options given below.

[JEE MAIN 2022]

Solution:

$Ni(CO)_4$ Hybridisation sp^3

$[Ni(CN)_4]^{2-}$ Hybridisation dsp^2

$[Co(CN)_6]^{3-}$ Hybridisation d^2sp^3

$[Co(F)_6]^{3-}$ Hybridisation sp^3d^2

(23) The osmotic pressure exerted by a solution prepared by dissolving $2.0\,g$ of protein of molar mass $60\,kg\,mol^{-1}$ in $200\,mL$ of water at $27°C$ is .....Pa. [integer value] (use $R=0.083L\,bar\,mol^{-1}\ K^{-1}$) [JEE MAIN 2022]

Solution:

$\pi=iCRT$

$=\frac{1\times2}{60000\times0.2}\times0.083\times300$

$=0.00415$ bar $\quad(\because 1$ bar $=10^5Pa)$

So, $0.00415\times10^5Pa=415\,Pa$

Chemistry - Section B (SUBJECTIVE)

3 marks (Attempt any 4)

(24) Amongst the following compounds, identify which are insoluble, partially soluble and highly soluble in water?

(i) phenol (ii) toluene (iii) formic acid (iv) ethylene glycol (v) chloroform (vi) pentanol.

Solution:

(i) Phenol (C_6H_5OH) has the polar group $-OH$ and non-polar group $-C_6H_5$. Thus, phenol is partially soluble in water.

(ii) Toluene $(C_6H_5-CH_3)$ has no polar groups. Thus, toluene is insoluble in water.

(iii) Formic acid (HCOOH) has the polar group $-OH$ and can form $H-$ bond with water Thus, formic acid is highly soluble in water.

(iv) Ethylene glyvol $(C_2H_6O_2$ has polar $-OH$ group and can form $H-$ bond. Thus, it is highly soluble in water.

(v) Chloroform is insoluble in water.

(vi) Pentanol $(C_5H_{11}OH)$ has polar $-OH$ group, but it also contains a very bulky nonpolar $-C_5H_{11}$ group. Thus, pentanol is partially soluble in water.

(25) Given :

$E^o_{Fe^{3+}/Fe}=-0.036\,V,\ E^o_{Fe^{2+}/Fe}=-0.439\,V$

The value of standard electrode potential for the change, $Fe^{3+}(aq)+e^-\rightarrow Fe^{2+}(aq)$ will be .... V. [AIEEE 2009]

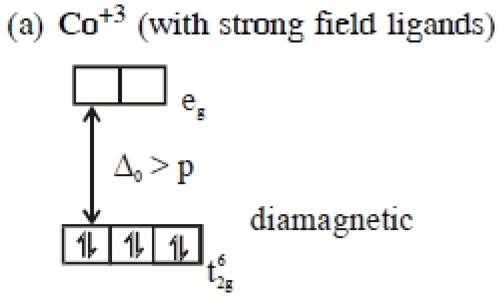
Solution:

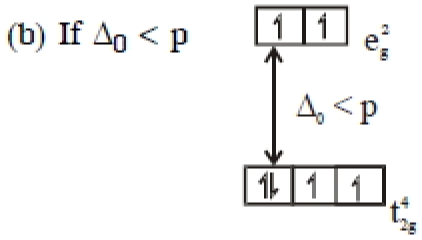
$Fe^{3+} + 3e^- \rightarrow Fe, E^o_{Fe^34/Fe}$
$= -0.036V \ldots (i)$
$Fe^{2+} + 2e^- \rightarrow Fe, E^\circ_{Fe^2//Fe}$
$= -0.439V \ldots (ii)$
we have to calculate
$Fe^{3+} + e^- \rightarrow Fe^{2+}, \Delta G = ?$
To obtain this equation subtract equ (ii) from (i) we get
$Fe^{3+} + e^- \rightarrow Fe^{2+} \ldots (iii)$
As we know that $\Delta G = -nFE$
Thus for reaction (iii)
$\Delta G = \Delta G_1 - \Delta G$
$-nFE^\circ = -nFE_1 - (-nFE_2)$
$-nFE^\circ = nFE_2 - nFE_1$
$-1FE^\circ = 2 \times 0.439F - 3 \times 0.036F$
$-FE^\circ = 0.770F$
$\therefore \quad E^\circ = -0.770V$
$O^- > F^- > Na^+ > Mg^{++} > Al^{3+}$

(26) Among the statements $(a) - (d)$, the incorrect ones are
(a) Octahedral $Co(III)$ complexes with strong field ligands have very high magnetic moments
(b) When $\Delta_0 < P$, the $d-$electron configuration of $Co(III)$ in an octahedral complex is $t_{\text{eg}}^4 e_g^2$
(c) Wavelength of light absorbed by $[\text{Co(en)}_3]^{3+}$ is lower than that of $[\text{CoF}_6]^{3-}$
(d) If the Δ_0 for an octahedral complex of Co(III) is $18,000$ cm^{-1}, the Δ_t for its tetrahedral complex with the same ligand will be $16,000$ cm^{-1} [JEE MAIN 2020]

Solution:

(c) Splitting power of ethylenediamine (en) is greater than fluoride (F) ligand therefore more energy absorbed by $[\text{Co(en)}_3]^{3+}$ as compared to $[\text{CoF}_6]^{3-}$
So wave length of light absorbed by $[\text{Co(en)}_3]^{3+}$ is lower than that of $[\text{CoF}_6]^{3-}$
(d) $\Delta_t = \frac{4}{9}\Delta_0$
so if $\Delta_0 = 18,000\text{cm}^{-1}$
$\Delta_t = \frac{4}{9} \times 18000 = 8000\text{cm}^{-1}$
Statement (a) and (d) are incorrect.





(27) What is molarity of a solution of HCl which contains 49% by weight of solute and whose specific gravity is 1.41 [AIPMT 2001]

Solution:

Given, $49\,\%$ weight by volume HCl solution
Therefore, weight of HCl in $1\,ml$ of solution = specific gravity $x\,49\,\%$
$= 1.41 \times 49/100$
$= 0.6909\,g/ml$
Weight of HCl in $1000\,ml$ of solution
$= 0.6909 \times 1000 = 690.9\,g$
Molarity = weight of HCl in $1000\,ml/$ mol.weight of HCl
$= 690.9/36.4$
$= 18.9\,M$

(28) The octahedral complex of a metal ion M^{3+} with four monodentate ligands L_1, L_2, L_3 and L_4 absorb wave lengths in the region of red, green, yellow and blue, respectively. The increasing order of ligand strength of the four ligands is : [JEE MAIN 2014]

Solution:

Ligand field strength $\propto$ Energy of light absorbed
$\propto \frac{1}{\text{Wavelength of light absorbed}}$

λ	λ_1	λ_2	λ_3	λ_4
Absorbed	lightRed	Green	Yellow	Blue

Wavelength of absorbed light decreases.
$\therefore$ Increasing order of energy of wavelengths absorbed reflect greater extent of crystal fleld splitting, hence, higher field strength ot the ligand.
$Energy\ blue\,(L_4) >$ green $(L_2) >$ yellow $(L_3) > red\,(L_1)$
$\therefore \quad L_4 > L_2 > L_3 > L_1$ in fleld strength of ligands.

Chemistry - Section B (SUBJECTIVE)

4 marks (Attempt any 3)

(29) A 5% solution (by mass) of cane sugar in water has freezing point of $271\,K$ Calculate the freezing point of 5% glucose in water if freezing point of pure water is $273.15\,K$

Solution:

Here, $\Delta T_f = (273.15 - 271)K$
$= 2.15\,K$
Molar mass of sugar
$(C_{12}H_{22}O_{11}) = 12 \times 12 + 22 \times 1 + 11 \times 16$
$= 342\,g\,mol^{-1}$
5% solution (by mass) of cane sugar in water means $5\ g$ of cane sugar is present in $(100 - 5)\ g = 95\,g$ of water.
Now, number of moles of cane sugar $= \frac{5}{342}mol$
$= 0.0146\,mol$
Therefore, molality of the solution, $m = \frac{0.0146\,mol}{0.095\,kg}$
$= 0.1537\,mol\,kg^{-1}$
Applying the relation,
$\Delta T_f = K_f \times m$
$\Rightarrow K_f = \frac{\Delta T_f}{m}$
$= 13.99\,K\,kg\,mol^{-1}$
Molar of glucose
$(C_6H_{12}O_6) = 6 \times 12 + 12 \times 1 + 6 \times 16 = 180\,g\,mol^{-1}$
5% glucose in water means $5\ g$ of glucose is present in $(100 - 5)\ g = 95\ g$ of water.
Number of moles of glucose $= \frac{5}{180}\ mol$
$= 0.0278\,mol$
Therefore, molality of the solution, $m = \frac{0.0278\,mol}{0.095\,kg}$
$= 0.2926\,mol\,kg^{-1}$
Applying the relation,
$\Delta T_f = K_f \times m$
$= 13.99\,K\,kg\,mol^{-1} \times 0.2926\,mol\,kg^{-1}$
$= 4.09\ K$ (approximately)
Hence, the freezing point of 5% glucose solution is
$(273.15 - 4.09)K = 269.06\ K$

(30) Two elements A and B form compounds having formula AB_2 and AB_4. When dissolved in $20\ g$ of benzene (C_6H_6). $1\ g$ of AB_2 lowers the freezing point by $2.3\ K$ whereas $1.0\ g$

of AB_4 lowers it by $1.3\,K$. The molar depression constant for benzene is $5.1\,K\ kg\ mol^{-1}$. Calculate atomic masses of A and B.

Solution:

We know that,
$M_2 = \frac{1000 \times w_2 \times k_f}{\Delta T_f \times w_1}$
Then, $M_{AB_2} = \frac{1000 \times 1 \times 5.1}{2.3 \times 20}$
$= 110.87\,g\,mol^{-1}$
$M_{AB_4} = \frac{1000 \times 1 \times 5.1}{1.3 \times 20}$
$= 196.15\,g\,mol^{-1}$
Now, we have the molar masses of AB_2 and AB_4 as $110.87\,g\,mol^{-1}$ and $196.15\,g\,mol^{-1}$ respectively.
Let the atomic masses of A and B be x and y respectively.
Now, we can write:
$x + 2y = 110.87$ ....(i)
$x + 4y = 196.15$ ....(ii)
Subtracting equation (i) from (ii), we have
$2y = 85.28$
$\Rightarrow y = 42.64$
Putting the value of $'y'$ in equation (1), we have x
$+2 \times 42.64 = 110.87$
$\Rightarrow x = 25.59$
Hence, the atomic masses of A and B are $25.59\,u$ and $42.64\,u$ respectively.

(31) Calculate the depression in the freezing point of water when $10\,g$ of $CH_3CH_2CHClCOOH$ is added to $250\,g$ of water. $K_a = 1.4 \times 10^{-3}, K_f = 1.86\,K\,kg\,mol^{-1}$

Solution:

Molar mass of
$CH_3CH_2CHCICOOH = 15+14+13+35.5+12+16+16+1$
$= 122.5\,g\,mol^{-1}$
$\therefore$ No. of moles present in $10\,g$ of
$CH_3CH_2CHClCOOH = \frac{10\,g}{122.5\,g\,mol^{-1}}$
$= 0.0816\,mol$
It is given that $10\,g$ of is added to $250\,g$ of water.
$CH_1CH_2, CHClCOOH$
$\therefore$ Molality of the solution, $= \frac{0.0186}{250} \times 1000$
$= 0.3264\,mol\,kg^{-1}$
Let a be the degree of dissociation of
$CH_3CH_2CHClCOOH$
$CH_3CH_2CHClCOOH$ undergoes dissociation according to the following equation:

$CH_3CH_2CHClCOOH \leftrightarrow CH_3CH_2CHClCOO^- + H^+$
Initial cone.
At equilibrium

Total moles of equilibrium $= 1 - a + a + a$
$= 1 + a$
$\therefore i = \frac{1+\alpha}{1}$
$= 1 + \alpha$
$= 1 + 0.0655$
$= 1.0655$
Hence, the depression in the freezing point of water is given as:
$\Delta T_f = i \cdot K_f m$
$= 1.0655 \times 1.86\,K\,kg\,mol^{-1} \times 0.3264\,mol\,kg^{-1}$
$= 0.65\,K$

(32) Consider the cell at 25°C
$\text{Zn} \left| \text{Zn}^{2+}(\text{aq}), (1\text{M}) \right\| \text{Fe}^{3+}(\text{aq}), \text{Fe}^{2+}(\text{aq}) \right| \text{Pt(s)}$
The fraction of total iron present as Fe^{3+} ion at the cell potential of 1.500 V is $\text{X} \times 10^{-2}$. The value of x is ..... (Nearest integer).
$\left(\text{Given } E^0_{\text{Fe}^{3+}/\text{Fe}^{2+}} = 0.77\ \text{V}, \text{E}^0_{\text{Zn}^{2+}/\text{Zn}} = -0.76\ \text{V}\right)$ [JEE MAIN 2021]

Solution:

$\text{Zn} \longrightarrow \text{Zn}^{2+} + 2\text{e}^-$
$2\text{Fe}^{3+} \longrightarrow \text{e}^- + \text{e}^{2+}$
——————————————————————————————-
——————————
$\text{Zn} + 2\text{Fe}^{3+} \longrightarrow \text{Zn}^{2+} + 2\text{Fe}^{2+}$
——————————————————————————————-
————————
$\text{E}^0_{\text{cell}} = 0.77 - (0.76)$
$= 1.53$ V
$1.50 = 1.53 - \frac{0.06}{2} \log\left(\frac{\text{Fe}^{2+}}{\text{Fe}^{3+}}\right)^2$
$\log\left(\frac{\text{Fe}^{2+}}{\text{Fe}^{3+}}\right) = \frac{0.03}{0.06} = \frac{1}{2}$
$\frac{[\text{Fe}^{2+}]}{[\text{Fe}^{3+}]} = 10^{1/2} = \sqrt{10}$
$\frac{[\text{Fe}^{3+}]}{[\text{Fe}^{2+}]} = \frac{1}{\sqrt{10}} frac [\text{Fe}^{3+}] [\text{Fe}^{2+}] + [\text{Fe}^{3+}]$
$\frac{1}{1+\sqrt{10}} = \frac{1}{4.16}$
$= 0.2402$
$= 24 \times 10^{-2}$