CHEMISTRY

Q.1 If the magnetic moment of a dioxygen species is 1.73 B.M, it may be:
   (1) O₂, O₂⁻ or O₂⁺ (2) O₂ or O₂⁻ (3) O₂ + O₂⁻ (4) O₂⁻ or O₂⁺
   Ans. [4]
   Sol. Magnetic moment = 1.73 BM
       Unpaired electron = 1
       O₂ = σ₁s², σ*₁s², σ₂s², σ*₂s², σ₂p², π2p², π*₂p², π*₂p²
       Hence O₂⁻ & O₂⁺ have one unpaired electron.

Q.2 The compound that cannot act both as oxidising and reducing agent is:
   (1) H₂O₂ (2) H₂SO₃ (3) HNO₂ (4) H₃PO₄
   Ans. [4]
   Sol. H₂O₂⁻¹ H₂SO₃⁺⁴
       HNO₂
       H₃P O₄
       In H₃PO₄ phosphorous is in maximum oxidation state so can not increase its oxidation no.

Q.3 [Pd(F)(Cl)(Br)(I)]⁻²⁻ has n number of geometrical isomers. Then, the spin-only magnetic moment and crystal field stabilisation energy [CFSE] of [Fe(CN)₆]³⁻, respectively, are:
   [Note: Ignore the pairing energy]
   (1) 2.84 BM and −1.6Δ₀ (2) 1.73 BM and −2.0Δ₀
   (3) 5.92 BM and 0 (4) 0 BM and −2.4Δ₀
   Ans. [2]
       Hence n = 3
       So, [Fe(CN)₆]³⁻³⁻ = [Fe(CN)₆]⁻³⁻
       Fe³⁺ = 3d⁵ 4s⁰
       Strong field ligand.
       So,
       A/C to C F T
       t₂g,²,¹ eg,⁰,⁰
       n = 1
       Magnetic moment = \sqrt{\frac{n(n + 2)}{4}} = \sqrt{3} = 1.73 B.M.
       CFSE = −0.4Δ₀ × n t₂g + 0.6Δ₀ × n eg
       CFSE = −0.4Δ₀ × 5 = −2.0Δ₀
Q.4  The electronic configurations of bivalent europium and trivalent cerium are:
(atomic number: Xe = 54, Ce = 58, Eu = 63)
(1) [Xe] 4f^7 6s^2 and [Xe] 4f^7 6s^2
(2) [Xe] 4f^7 and [Xe] 4f^7
(3) [Xe] 4f^7 and [Xe] 4f^7
(4) [Xe] 4f^7 and [Xe] 4f^7
Ans.  [2]
Sol.  Eu^{2+} \rightarrow [\text{xe}] 4f^7
Ce^{3+} : [\text{xe}] 4f^7

Q.5  For following reactions

\[
\begin{align*}
A & \xrightarrow{700K} \text{Product} \\
A & \xrightarrow{500K} \text{Product}
\end{align*}
\]

it was found that the Ea is decreased by 30 kJ/mol in the presence of catalyst. If the rate remains unchanged, the activation energy for catalysed reaction is (Assume pre exponential factor is same):
(1) 135 kJ/mol  (2) 105 kJ/mol  (3) 75 kJ/mol  (4) 198 kJ/mol
Ans.  [2]
Sol.  \frac{K_{\text{catalyst}}}{K} = \frac{\frac{E_{a1}}{RT}}{\frac{E_{a2}}{RT}}
Ea_1 = \text{energy of activation in presence of catalyst}
T_1 = 500 K  \quad T_2 = 700 K
\frac{Ea_1}{T_1} = \frac{Ea_2}{T_2}
but Ea_1 = Ea_2 - 30
\frac{Ea_2 - 30}{500} = \frac{Ea_2}{700}
5Ea_2 = 7Ea_2 - 210
Ea_2 = \frac{210}{2} = 105 \text{ kJ/mole.}

Q.6  The increasing order of basicity for the following intermediates is (from weak to strong)

\[
\begin{align*}
\text{CH}_3 & \\
\text{H}_3\text{C} & \equiv \text{C} & \text{H}_2\text{C} = \text{CH} - \text{CH}_2 & \text{HC} \equiv \text{C} & \text{CH}_2 & \text{CN} \\
(\text{i}) & (\text{ii}) & (\text{iii}) & (\text{iv}) & (\text{v})
\end{align*}
\]
(1) (v) < (iii) < (ii) < (iv) < (i)
(2) (iii) < (i) < (ii) < (iv) < (v)
(3) (v) < (i) < (iv) < (ii) < (iii)
(4) (iii) < (iv) < (ii) < (i) < (v)
Ans.  [1]
Sol.  Basicity is inversly proportional to electronegativity

\[
\begin{align*}
\text{CH}_3 & \\
\text{H}_3\text{C} & \equiv \text{C} & > & \theta \text{CH}_3 & > \theta \text{H}_2\text{C} = \text{CH} - \text{CH}_2 & > \theta \text{HC} \equiv \text{C} & > \theta \text{CH}_2 & > \theta \text{CN} \\
(\text{i}) & (\text{iv}) & (\text{ii}) & (\text{iii}) & (\text{iv})
\end{align*}
\]
i > iv > ii > iii > v
Q.7 'X' melts at low temperature and is a bad conductor of electricity in both liquid and solid state. X is:

(1) Silicon carbide  (2) Mercury  (3) Zinc sulphide  (4) Carbon tetrachloride

Ans. [4]

Sol. CCl₄ is a non conductor in solid and liquid phase.

Q.8 The de Broglie wavelength of an electron in the 4th Bohr orbit is:

(1) 6πa₀  (2) 4πa₀  (3) 2πa₀  (4) 8πa₀

Ans. [4]

Sol. We know

\[ 2\pi r = n\lambda \]

\[ n = 4 \quad \text{and} \quad r = a_0 \frac{n^2}{z} \Rightarrow 2\pi a_0 \frac{n^2}{z} = n\lambda \]

\[ 2\pi \frac{4^2 a_0}{1} = 4\lambda \]

\[ \lambda = 8\pi a_0 \]

Q.9 Identify (A) in the following reaction sequence:

\[ \text{(A)} \quad \text{CH₃MgBr} \quad \text{H}^+ , \text{H}_2\text{O} \quad \text{O}_3/\text{Zn,H}_2\text{O} \]

\[ \text{(B)} \]

\[ \text{(1)} \quad \text{(2)} \quad \text{(3)} \quad \text{(4)} \]

Ans. [2]

Sol.

\[ \text{CH₃MgBr} \quad \text{H}^+ , \text{H}_2\text{O} \quad \text{O}_3/\text{Zn,H}_2\text{O} \]

\[ \text{(1)} \quad \text{(2)} \quad \text{(3)} \quad \text{(4)} \]
Q.10 The major product (Y) in the following reactions is:

\[ \text{CH}_3 \quad \text{CH} \quad \text{C} \equiv \text{CH} \xrightarrow{\text{HgOS}_4, \text{H}_2\text{SO}_4} \text{X} \]

(i) C\text{H}_3\text{MgBr}, \text{H}_2\text{O}  
(ii) Conc. H\text{SO}_4/\Delta  

\[ \text{CH}_3 \quad \text{CH} \quad \text{C} \equiv \text{CH} \]

(1) CH\text{C} = C = CH\text{C}_2\text{H}_3  
(2) CH\text{C} - C = CH - CH\text{C}_2\text{H}_5  
(3) CH\text{C} - CH - C = CH\text{C}_2\text{H}_3  
(4) CH\text{C} - CH - C = CH - CH\text{C}_3  

Ans. [1]  
Sol.  

\[ \text{CH}_3 \quad \text{CH} \quad \text{C} \equiv \text{CH} \xrightarrow{\text{HgOS}_4, \text{H}_2\text{SO}_4} \text{CH}_3 \quad \text{CH} \quad \text{C} \equiv \text{CH} \xrightarrow{\text{H}_2\text{O}} \text{CH}_3 \quad \text{CH} \quad \text{C} \equiv \text{CH} \]

Q.11 Complex X of composition Cr(H\text{O})\text{nCl}_n has a spin only magnetic moment of 3.83 BM. It reacts with AgNO\text{3} and shows geometrical isomerism. The IUPAC nomenclature of X is:

(1) Dichloridotetraaqua chromium (IV) chloride dihydrate  
(2) Tetraaquadichlorido chromium (III) chloride dihydrate  
(3) Tetraaquadichlorido chromium (IV) chloride dihydrate  
(4) Hexaaqua chromium (III) chloride  

Ans. [2]  
Sol.  

Cr(H\text{O})\text{nCl}_n  
(\text{H}_{\text{complex}})^{\text{spin}} = 3.8 \text{ B.M.}  
n = 3  
\text{cr(H\text{O})}_0\text{Cl}_3  
oxid\text{°} \text{No of Cr should be} +3.  
Compound So G.I so it will be  
[Cr(H\text{O})\text{nCl}_2] \text{Cl}_2\text{H}_2\text{O}  
IUPAC NAME \rightarrow \text{Tetraaquadichlorido chromium(III)-chloride dihydrate}  

Q.12 The acidic, basic and amphoteric oxides, respectively, are:

(1) Cl\text{O}_2, \text{CuO}, \text{P}_2\text{O}_{10}  
(2) MgO, \text{Cl}_2\text{O}, \text{Al}_2\text{O}_3  
(3) \text{Na}_2\text{O}, \text{SO}_2, \text{Al}_2\text{O}_3  
(4) \text{N}_2\text{O}_3, \text{Li}_2\text{O}, \text{Al}_2\text{O}_3  

Ans. [4]  
Sol.  

Non metal oxide ________ acidic  
Metal oxide ________ basic  
Al\text{O}_3 amphoteric
Q.13  The $K_{sp}$ for the following dissociation is $1.6 \times 10^{-5}$

$$\text{PbCl}_2(s) \rightleftharpoons \text{Pb}^{2+}(aq) + 2\text{Cl}^-(aq)$$

Which of the following choices is correct for a mixture of 300 mL 0.134 M $\text{Pb(NO}_3)_2$ and 100 mL 0.4 M NaCl?

(1) Not enough data provided  (2) $Q > K_{sp}$
(3) $Q < K_{sp}$  (4) $Q = K_{sp}$

Ans. [2]

Sol.  

$$Q = [\text{Pb}^{2+}][\text{Cl}^-]^2$$

$$= \left( \frac{300 \times 0.134}{400} \right) \left( \frac{100 \times 0.4}{400} \right)^2$$

$$= \frac{3 \times 0.134}{4} (0.1)^2$$

$$Q = 1.005 \times 10^{-3}$$

$Q > K_{sp}$.  

Q.14  A chemist has 4 samples of artificial sweetener A, B, C and D. To identify these samples, he performed certain experiments and noted the following observations:

(i) A and D both form blue-violet colour with ninhydrin.
(ii) Lassaigne extract of C gives positive AgNO$_3$ test and negative Fe$_4[\text{Fe(CN)}_6]_3$ test.
(iii) Lassaigne extract of B and D gives positive sodium nitroprusside test.

Based on these observations which option is correct?

(1) A : Aspartame; B : Alitame; C : Saccharin; D : Sucralose
(2) A : Aspartame; B : Saccharin; C : Sucralose; D : Alitame
(3) A : Alitame; B : Saccharin; C : Aspartame; D : Sucralose
(4) A : Saccharin; B : Alitame; C : Sucralose; D : Aspartame

Ans. [2]

Sol.  

A – Aspartame
B – Saccharine
C – Sucralose
D – Alitame

(i) A & D give positive test with ninhydrin because both have free carboxylic and amine group.
(ii) C form precipitate with AgNO$_3$ because it has chlorine atoms
(iii) B & D give positive test because Both have S–atom.

Q.15  The major product Z obtained in the following reaction scheme is:

$$\text{NH}_2$$

$$\begin{array}{c}
\text{Br} \\
\text{Br}
\end{array} \text{NaNO}_3/\text{HCl} \rightleftharpoons X \rightleftharpoons \text{Cu}_2\text{Br}_2 \rightleftharpoons Y \rightleftharpoons \text{HNO}_3 \rightleftharpoons Z$$

$$\begin{array}{c}
\text{NO}_2 \\
\text{Br} \\
\text{Br}
\end{array}$$

$$\begin{array}{c}
\text{Br} \\
\text{NO}_2
\end{array}$$

$$\begin{array}{c}
\text{Br} \\
\text{O}_2\text{N} \\
\text{Br}
\end{array}$$

$$\begin{array}{c}
\text{Br} \\
\text{NO}_2 \\
\text{Br}
\end{array}$$

(1)  (2)  (3)  (4)
Q.16 Which of these will produce the highest yield in Friedel Crafts reaction?

![Chemical Structures](image)

Ans. [2]
Sol. Aniline react lewis acid form anilinium complex.
So phenol is most reactive among for nucleophilic substitution reaction.

Q.17 B has a smaller first ionization enthalpy than Be. Consider the following statements:
(i) it is easier to remove 2p electron than 2s electron
(ii) 2p electron of B is more shielded from the nucleus by the inner core of electrons than the 2s electrons of Be
(iii) 2s electron has more penetration power than 2p electron
(iv) atomic radius of B is more than Be
(atomic number B = 5, Be = 4)
The correct statements are:
(1) (i), (iii) and (iv)  (2) (i), (ii) and (iii)  (3) (i), (ii) and (iv)  (4) (ii), (iii) and (iv)

Ans. [4]
Sol. Radius of Boron is less than Radius of Be Hence IV statement is false. Rest are True. Statement

Q.18 The correct order of heat of combustion for following alkadienes is:

(i)  
(ii)  
(iii)  

(1) (i) < (ii) < (iii)  (2) (i) < (iii) < (ii)  (3) (iii) < (ii) < (i)  (4) (ii) < (iii) < (i)

Ans. [1]
Stability a > b > c
Heat of combustion c > b > a
Q.19 If enthalpy of atomisation for Br$_2$(l) is $x$ kJ/mol and bond enthalpy for Br$_2$ is $y$ kJ/mol, the relation between them:

1. $x = 7y$
2. $x > y$
3. does not exist
4. $x < y$

**Ans.** [2]

**Sol.**

\[
\text{Br}_2(l) \xrightarrow{\Delta H \text{ atomisation}} 2\text{Br}(g) \\
\Delta H \text{ atomisation} = \Delta H \text{ vap} + \text{Bond Energy}
\]

Hence.

$x > y$

Q.20 According to the following diagram, A reduces BO$_2$ when the temperature is:

1. $> 1400$ °C
2. $< 1400$ °C
3. $< 1200$ °C
4. $> 1200$ °C but $< 1400$ °C

**Ans.** [1]

**Sol.**

\[A + \text{BO}_2 \rightarrow B + \text{AO}_2\]  
$\Delta G = -\text{ve}$

Only above 1400 °C.

Q.21 The molarity of HNO$_3$ in a sample which has density 1.4 g/mL and mass percentage of 63% is \_________.

(Molecular Weight of HNO$_3$ = 63)

**Ans.** [14.00]

**Sol.**

\[d = 1.4 \text{ g/ml}\]

\[\text{63/w/w} \]

Molarity = \[\frac{63 \times 1.4}{63 \times 100} \times 1000 \text{ mole/litre}\]

= 14 mole/L.

Q.22 The mass percentage of nitrogen In histamine is \_________.

**Ans.** [37.84]

**Sol.**

Structure of Histamine is

\[
\begin{array}{c}
\text{N} \\
\text{NH} \\
\text{NH}_2 \\
\text{NH}
\end{array}
\]

Molecular formula = C$_5$H$_9$N$_3$

Molecular mass = 111

% of N = \[\frac{42}{111} \times 100\]

= 37.84 %
Q.23  How much amount of NaCl should be added to 600 g of water (ρ = 1.00 g/mL) to decrease the freezing point of water to −0.2°C ? __________. (The freezing point depression constant for water = 2 K kg mol⁻¹)

Ans.  [01.76]

Sol.  

\[ ΔT_f = i K_f m \]

\[ i = 2 \text{ for NaCl} \]

\[ 0.2 = 2 \times 2 \times m \]

\[ m = \frac{w \times 1000}{58.5 \times 600} \]

\[ 0.2 = 2 \times 2 \times \frac{w \times 1000}{58.5 \times 600} \]

\[ w = \frac{0.2 \times 58.5 \times 600}{4 \times 1000} = \frac{1.2 \times 58.5}{40} = 01.76 \text{ g} \]

Q.24  108 g of silver (molar mass 108 g mol⁻¹) is deposited at cathode from AgNO₃(aq) solution by a certain quantity of electricity. The volume (in L) of oxygen gas produced at 273 K and 1 bar pressure from water by the same quantity of electricity is __________.

Ans.  [0.568]

Sol.  

\[ [n_{Ag}]_{depot} = \frac{108}{108} \]

= 1 mole.

\[ \text{Ag}^{+} + e^{-} \rightarrow \text{Ag} \]

1F charge is required for 1 mole of Ag

\[ \text{H}_2\text{O} \rightarrow \frac{1}{2} \text{O}_2 + 2\text{H}^+ + 2e^- \]

2F charge deposit _______ \( \frac{1}{2} \) mole

1F charge deposit _______ \( \frac{1}{4} \) mole

\[ PV = n \cdot R \cdot T \]

\[ V = \frac{1}{4} \times \frac{0.83 \times 273}{1} \]

\[ V = 5.675 \text{ L} \]

Q.25  The hardness of a water sample containing 10⁻³ M MgSO₄ expressed as CaCO₃ equivalents (in ppm) is __________.

(molar mass of MgSO₄ is 120.38 g/mol)

Ans.  [100.00]

Sol.  Given: 10⁻³ M MgSO₄

i.e. 10⁻³ mole MgSO₄ present in 1 litre solution

\[ n_{MgSO_4} = n_{CaCO_3} \]

Mass of CaCO₃ = 10⁻³ \times 100

ppm (in terms of CaCO₃) = \( \frac{10^{-3} \times 100}{1000} \times 10^6 \)

= 100 ppm