CHEMISTRY

SECTION - A

Multiple Choice Questions: This section contains 20 multiple choice questions. Each question has 4 choices (1), (2), (3) and (4), out of which **ONLY ONE** is correct.

Choose the correct answer:

1. Given below are two statements :

   Statement I : The correct order for radius is Al > Mg > Mg^{2+} > Al^{3+}.

   Statement II : Atomic size always depends on electronegativity.

   In the light of the above statements, choose the correct option.

   (1) Both Statement I and Statement II are correct

   (2) Both Statement I and Statement II are incorrect

   (3) Statement I is correct but Statement II is incorrect

   (4) Statement I is incorrect but Statement II is correct

Answer (3)

Sol. Atomic radius : Mg > Al > Mg^{2+} > Al^{3+}

Atomic radius depends on Z_{eff}, number of shells etc.

2. What will be significant figure of summation of 0.153, 153.2 and 1532?

   (1) 3

   (2) 4

   (3) 5

   (4) 6

Answer (2)

Sol. 1532 + 153.2 + 0.153 = 1685.353 = 1685 (least decimal = 0)

3. Given below are two statements :

   Statement-I : Crystal field stabilisation energy (magnitude) of $[Co(H_2O)_6]^{2+}$ is greater than $[Ni(H_2O)_6]^{2+}$

   Statement-II : Order of bond energy is Cl_2 > Br_2 > F_2 > I_2.

   In the light of above statements choose the correct option.

   (1) Statement-I and Statement-II both are correct

   (2) Statement-I and Statement-II both are incorrect

   (3) Statement-I is correct, Statement-II is incorrect

   (4) Statement-I is incorrect, Statement-II is correct

Answer (4)

Sol. $[Co(H_2O)_6]^{2+}$

H_2O is WFL with Co^{2+}

$3d^7 \Rightarrow t_{2g}^5 e_g^2$

CFSE = $-0.4 \times 5\Delta_o + 2 \times 0.6\ \Delta_o$

$= -2.0\Delta_o + 1.2\Delta_o$

$= -0.8\Delta_o$

$[Ni(H_2O)_6]^{2+}$

$H_2O \Rightarrow$ WFL

$3d^8 \Rightarrow t_{2g}^6 e_g^2$

CFSE = $-0.4 \times 6\Delta_o + 0.6 \times 2\ \Delta_o$

$= -2.4\Delta_o + 1.2\Delta_o$

$= -1.2\ \Delta_o$

(BDE in kJ/mol)

$F_2 \Rightarrow 158.8$

$Cl_2 = 242.6$

$Br_2 = 192.8$

$I_2 = 151.1$

Order of BDE $\Rightarrow Cl_2 > Br_2 > F_2 > I_2$

4. When 8.74 g MnO_2 is treated with HCl, then what will be the weight of $Cl_2(g)$ obtained?

Molar mass of MnO_2 = 87.4 g/mol

(1) 7.1 g

(2) 17.1 g

(3) 14.2 g

(4) 3.55 g

Answer (1)

Sol. $MnO_2 + 4HCl \rightarrow MnCl_2 + Cl_2 + 2H_2O$

$\frac{8.74}{87.4} = 0.1$ $\qquad$ 0.1 mol

$M_{Cl_2} \cong 7.1\,g$

5. Find concentration of X^{2-} at equilibrium in 0.1 M H_2X.

Given $K_{a_1} = 2.5 \times 10^{-7}$

$K_{a_2} = 1 \times 10^{-13}$

(1) 2.5×10^{-7}

(2) 1×10^{-13}

(3) 6×10^{-12}

(4) 5×10^{-10}

Answer (2)

Sol.

	H_2X	$\rightleftharpoons$	H^+	+	HX^-
$t=0$	C		0		0
$t=t_{eq}$	$C(1-\alpha)$		$C\alpha + Y$		$C\alpha$

	HX^-	$\rightleftharpoons$	H^+	+	X^{2-}
	$C\alpha$				
	$C\alpha - Y$		$C\alpha + Y$		Y

$$K_{a_2} = \frac{[H^+][X^{2-}]}{[HX^-]} = \frac{(C\alpha + Y)(Y)}{(C\alpha - Y)}$$

Since K_{a_2} is very small

Hence $Y \approx 0$ $\qquad$ $C\alpha >> Y$

$K_{a_2} = [X^{2-}]$

$[X^{2-}] = 1 \times 10^{-13}$

6. What will be the ratio of wavelength of 3rd line of Paschen Series to 2nd line of Balmer series of H-atom?

(1) $\frac{9}{4}$

(2) $\frac{3}{2}$

(3) $\frac{2}{3}$

(4) $\frac{16}{4}$

Answer (1)

Sol. $\frac{\frac{1}{\lambda_P}}{\frac{1}{\lambda_B}} = \frac{\left(\frac{1}{3^2}\right) - \left(\frac{1}{6^2}\right)}{\left(\frac{1}{2^2}\right) - \left(\frac{1}{4^2}\right)} \Rightarrow \frac{4}{9}$

$\frac{\lambda_P}{\lambda_B} = \frac{9}{4}$

7. $K_2Cr_2O_7$ is heated with KCl in pressure of H_2SO_4. Find the correct match of product with their oxidation state.

(1) CrO_2Cl_2, +6

(2) $Cr_2O_2Cl_2$, +6

(3) $Cr_2O_2Cl_2$, +5

(4) CrO_2Cl_2, +5

Answer (1)

Sol. When $K_2Cr_2O_7$ is heated with KCl in pressure of H_2SO_4, deep red vapours of CrO_2Cl_2 is observed. In CrO_2Cl_2, Cr is in +6 state.

8. Osmotic pressure of a solution is 12 atm. What is the concentration of NaCl solution which is isotonic to the given solution at 900 K.

R = 0.082 L-atm K^{-1} mol^{-1}

(Assume 100% dissociation)

(1) 0.4878 M

(2) 0.0243 M

(3) 0.243 M

(4) 0.04878 M

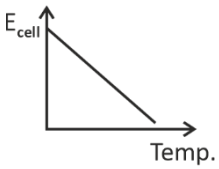
Answer (3)

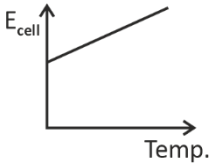
Sol. $12 = i \times C \times 0.082 \times 300$

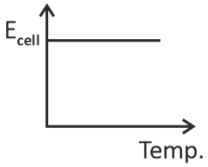
$$\frac{12}{2\times0.082\times300} = C$$

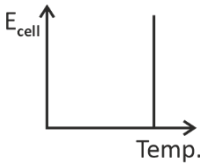
C = 0.243 M

9. Find out correct graph

(1) 

(2) 

(3) 

(4) 

Answer (1)

Sol. $E_{cell} = E^o_{cell} - \frac{RT}{nF}\log q$

Temp ↑ E_{cell} ↓

10. $CH_3Br \xrightarrow{Nu^{\ominus}}$

Order of reactivity of nucleophiles given below,

$^{\ominus}OH$ $CH_3COO^{\ominus}$ $PhO^{\ominus}$ $ClO_4^{\ominus}$

(1) $Ph–O^{\ominus} > {}^{\ominus}OH > ClO_4^{\ominus} > CH_3COO^{\ominus}$

(2) ${}^{\ominus}OH > Ph–O^{\ominus} > CH_3–COO^{\ominus} > ClO_4^{\ominus}$

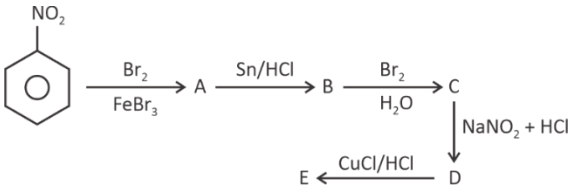
(3) $ClO_4^{\ominus} > {}^{\ominus}OH > Ph–O^{\ominus} > CH_3COO^{\ominus}$

(4) $CH_3COO^{\ominus} > {}^{\ominus}OH > PhO^{\ominus} > ClO_4^{\ominus}$

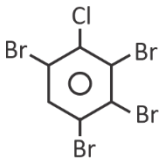
Answer (2)

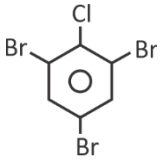
Sol. ${}^{\ominus}OH > Ph–O^{\ominus} > CH_3–COO^{\ominus} > ClO_4^{\ominus}$

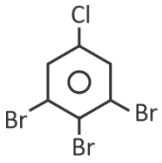
11. Observe the following reaction sequence,

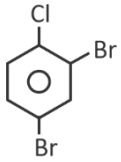


The final product 'E' is

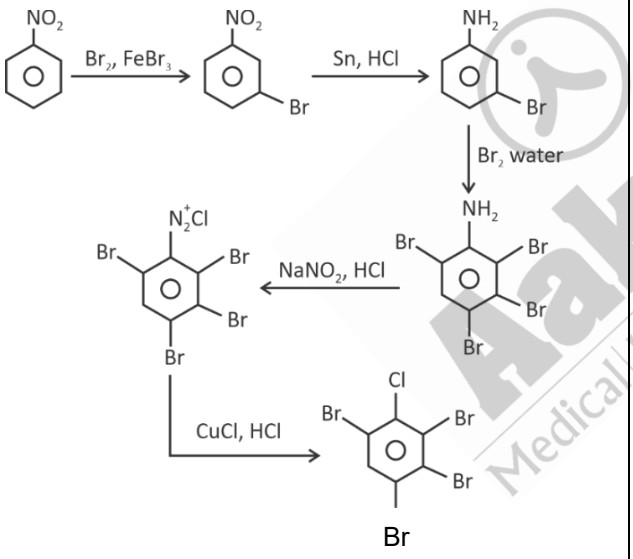
(1) 

(2) 

(3) 

(4) 

Answer (1)

Sol. 

12. For first order kinetics reaction,

$A \rightarrow B + C$

If initial pressure of A is 1 bar and at time 100 s, the total pressure is 1.5 bar, then find the rate constant of the reaction.

(1) $6.93 \times 10^{-3}\ s^{-1}$

(2) $6.93 \times 10^{-2}\ s^{-1}$

(3) $0.693\ s^{-1}$

(4) $6.93\ s^{-1}$

Answer (1)

Sol.

	A	$\rightarrow$	B	+	C
$t = 0$	P_0		–		–
$t = 100\ s$	$P_0 - x$		x		x

$P_t = P_0 + x$

$x = P_t - P_0$

$$k = \frac{2.303}{100}\log\frac{P_0}{P_0 - P_t + P_0}$$

$$k = \frac{2.303}{100}\log\frac{P_0}{2P_0 - P_t}$$

$$k = \frac{2.303}{100}\log\frac{1}{2 - 1.5}$$

$$k = \frac{2.303}{100}\log 2 = \frac{2.303\log 2}{100}$$

$= 0.693 \times 10^{-2}$

$= 6.93 \times 10^{-3}\ s^{-1}$

13. Energy of first line of Lyman series – A

Energy of second line of Balmer series – B

Energy of first line of Balmer series – C

Energy of second line of Lyman series – D

What will be the correct decreasing order of energies of photons?

(1) C > A > B > D

(2) D < A > B > C

(3) D > A > C > B

(4) D > A > B > C

Answer (4)

Sol. A . Lyman/1st line $\Delta E = 13.6 - 3.4 = 10.2$ eV

B. Balmer/2nd line $\Delta E = 3.4 - 0.85 = 2.55$ eV

C. Balmer/1st line $\Delta E = 3.4 - 1.51 = 1.89$ eV

D. Lyman/2nd line $\Delta E = 13.6 - 1.51 = 12.09$ eV

14. Which compound is optically inactive out of following

n-propyl chloride (I), secondary butyl chloride (II),

tert butyl chloride (III), isopropyl chloride (IV).

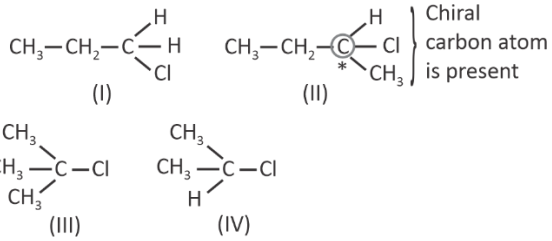
(1) Only I, III, IV

(2) Only IV

(3) Only I, II, III

(4) Only II, III, IV

Answer (1)

Sol. 

15. Which of the following statements are true?

(i) Mn has highest oxidation state in Mn_2O_7

(ii) MnO is more Ionic than Mn_2O_7

(iii) Mn_2O_7 has one bridging O atom

(iv) Oxidation state of Mn is generally maximum in oxo compounds

(1) Only (i), (ii), (iii) are correct

(2) All (i), (ii), (iii) and (iv) are correct

(3) Only (i), (iii) and (iv) are correct

(4) Only (i) and (iv) are correct

Answer (2)

Sol. (i) $Mn_2O_7 \rightarrow$ Mn is +7 (oxidation state)

(ii) MnO is more Ionic than Mn_2O_7.

(iii) Each Mn is tetrahedrally surrounded by 4 oxygen atom and one oxygen is bridging (Mn-O-Mn)

(iv) In Mn_2O_7 the Mn is in +7 oxidation state (Maximum)

16. Match the two columns

	List-I (Name reaction)		**List-II Reagent(s)**
(A)	Etard reaction	(i)	$H_2/Pd\text{-}BaSO_4$
(B)	Gattermann Koch reaction	(ii)	(a) $SnCl_2$ + HCl (b) H_3O^+
(C)	Stephen reaction	(iii)	CO + $HCl/AlCl_3$(anhy)
(D)	Rosenmund reduction	(iv)	(a) CrO_2Cl_2/CS_2 (b) H_3O^+

Choose the correct answer:

(1) A – iv, B – ii, C – iii, D – i

(2) A – iv, B – iii, C – ii, D – i

(3) A – iv, B – iii, C – i, D – ii

(4) A – iv, B – i, C – iii, D – ii

Answer (2)

Sol. Etard reaction CrO_2Cl_2/H^+

Gattermann Koch CO + $HCl/AlCl_3$

Stephen reaction $SnCl_2$ + HCl

Rosenmund reduction H_2, Pd–$BaSO_4$

17. In which of the following pairs first compound have more covalent nature than second compound?

(a) $SnCl_2$, $SnCl_4$

(b) $PbCl_4$, $PbCl_2$

(c) UF_6, UF_4

(1) Only (a) and (b)

(2) Only (b) and (c)

(3) Only (a) and (c)

(4) Only (c)

Answer (2)

Sol. More the charge on cation more will be polarising power and more will be covalent character.

18. Solubility product of MX(s) is 10^{-10} and $E^{o}_{M^+/M} = 0.71\,V$. Find out $E^{o}_{M/MX/X^-}$.

(1) 0.119 V (2) –0.119 V

(3) 1.301 V (4) –1.301 V

Answer (2)

Sol. $E^{o}_{M/MX/X^-} = -E^{o}_{M^+/M} - \frac{0.0591}{1}\log K_{sp}$

= –0.71 – 0.0591(–10)

= –0.71 + 0.591

= –0.119 V

19. 5 g of a solute X (M. wt = 200 g/mol) is dissolved in 250 g benzene. If ΔT_f = 0.5 K and relative lowering of vapour pressure is 'P' find P × 10^4

K_f = 5.5 K kg mol^{-1}, solute dimerises in benzene.

(1) 253.6 (2) 0.1636

(3) 70 (4) 23.36

Answer (3)

Sol. $0.5 = i \times 5.5 \times \frac{5}{200} \times \frac{1000}{250}$

$i = \frac{0.5 \times 10}{5.5}$

= 0.91

$1 - \frac{\alpha}{2} = 0.91 \qquad 1 - 0.91 = \frac{\alpha}{2}$

0.09 × 2 = α

0.18 = α

$\frac{P^o - P_s}{P^o} = \frac{i \times n_{solute}}{i \times n_{solute} + n_{solvents}}$

$= \frac{i \times 5/200}{i \times \frac{5}{200} + \frac{250}{78}} = \frac{0.91 \times 0.025}{0.91 \times 0.025 + 3.20}$

= 70 × 10^{-4}

20.

SECTION - B

Numerical Value Type Questions: This section contains 5 Numerical based questions. The answer to each question should be rounded-off to the nearest integer.

21. 1 g of an organic compound produce 1.49g of $Mg_2P_2O_7$. Determine % of P

Answer (42)

Sol. Mass of P in organic compound

$= \frac{1.49}{222} \times 31 \times 2$

= 0.4161 g

% of P in organic compound

$= = \frac{0.4161}{1} \times 100$

= 41.61%

≈ 42%

22. Some species are given

Ni^{2+}, Fe^{2+}, Co^{2+}, V^{3+} and Ti^{2+}

How many species has magnetic moment (spin only) less than 3 BM.

Answer (3)

Sol. $\mu_{spinonly} = \sqrt{n(n+2)}$ BM

$Ni^{2+} \Rightarrow 3d^8 \Rightarrow$ ↿⇂ ↿⇂ ↿⇂ | 1 | 1 (n = 2)

$\mu = \sqrt{2(2+2)}\,BM = \sqrt{8} = 2.83\,BM$

$Fe^{2+} \Rightarrow 3d^6 \Rightarrow$ ↿⇂ | 1 | 1 | 1 | 1 (n = 4)

μ = 4.90

$Co^{2+} \Rightarrow 3d^7 \Rightarrow$ ↿⇂ ↿⇂ | 1 | 1 | 1 (n = 3)

μ = 3.87

$V^{3+} \Rightarrow \mu = 2.83$ BM

$Ti^{2+} \Rightarrow \mu = 2.83$ BM

23.

24.

25.