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.

1. Which of the following is correct order of basic strength of amines in aqueous medium

   (1) $CH_3NH_2 > (CH_3)_2NH > (CH_3)_3N > NH_3$

   (2) $(CH_3)_2NH > CH_3NH_2 > (CH_3)_3N > NH_3$

   (3) $CH_3NH_2 > NH_3 > (CH_3)_2NH > (CH_3)_3N$

   (4) $(CH_3)_3N > (CH_3)_2NH > CH_3NH_2 > NH_3$

Answer (2)

Sol. Basic strength of methyl amine follows the order

$2° > 1° > 3° > NH_3$ (In aqueous medium)

2. Which of the following statement(s) is/are correct for the adiabatic process?

   A. Molar heat capacity is zero.

   B. Molar heat capacity is infinite.

   C. Work done on gas is equal to increase in internal energy

   D. The increase in temperature results in decrease in internal energy

   (1) A & C only (2) B & C only

   (3) A & D only (4) C and D only

Answer (1)

Sol. A and C statements are correct $\Delta U = q + w$

For adiabatic process $q = 0$

$\therefore \Delta U = w$

3. In group 17, which property does not follow regular trend?

   (1) Electron affinity (2) Ionisation energy

   (3) Covalent radii (4) Ionic radii

Answer (1)

Sol. 'F' despite having smaller size, has smaller electron affinity than Cl. It is due to $e^- - e^-$ repulsion in F.

4. Out of the following species, which one is anti-aromatic?

   (1) 

   (2) 

   (3) 

   (4) 

Answer (2)

Sol. A species is antiaromatic if it has $(4n)\pi$ electrons delocalised over the entire cyclic ring, where n = 1, 2, 3...

 is anti-aromatic as it has 4π electrons delocalised over five membered cyclic ring.

5. In following reaction sequence product C is

$$But-2-ene + Br_2 \xrightarrow{CCl_4} A \xrightarrow[excess]{NaNH_2} B \xrightarrow{Hg^{2+}/H_2SO_4} C$$

Identity C:

(1) $CH_3-\overset{\overset{O}{\|}}{C}-CH_2-CH_3$

(2) $CH_3-CH_2-CH_2-CHO$

(3) $CH_3-CH_2-CH_2-CH_2-OH$

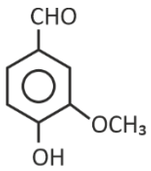
(4) $HC(=O)-CH_2-CH_2-C(=O)-H$

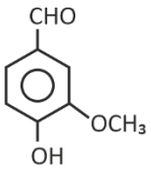
Answer (1)

Sol. $CH_3–CH = CH–CH_3 \xrightarrow[CCl_4]{Br_2} CH_3–\underset{Br}{CH}–\underset{Br}{CH}–CH_3$ (A)

$\xrightarrow{NaNH_2(excess)}$ $CH_3–C\equiv C–CH_3$ (B)

$\xrightarrow[H_2SO_4]{Hg^{2+}}$ $CH_3–\overset{O}{\overset{\|}{C}}–CH_2–CH_3$ (C)

6. Statement-I :  reacts with NaOH to give a compound which gives positive Tollens test.

Statement-II :  reacts with NaOH to give self aldol condensation reaction.

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

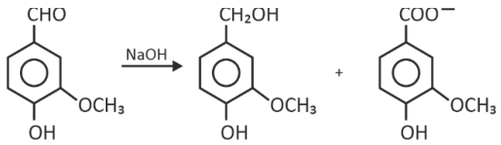
(1) Statement-I and Statement-II both are correct

(2) Statement-I is correct and Statement-II is incorrect

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

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

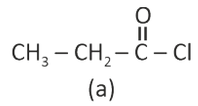
Answer (4)

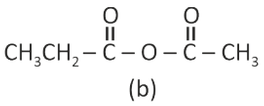
Sol. 

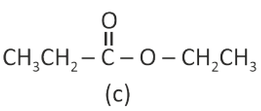
It gives Cannizarro reaction.

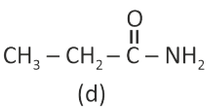
None of the products gives Tollens test

7. Arrange the following compounds in the decreasing order of their rate of hydrolysis in presence of acid as a catalyst.


(a)


(b)


(c)


(d)

(1) a > b > c > d (2) b > a > c > d

(3) c > a > b > d (4) d > c > b > a

Answer (1)

Sol. The rate of acid catalysed hydrolysis of acid derivatives is decided by leaving group ability. Lower the basic strength greater the leaving group ability, higher will be the rate of hydrolysis.

$R–\overset{O}{\overset{\|}{C}}–L + H_2O \rightleftharpoons R–\overset{O}{\overset{\|}{C}}–OH + L^- + H^+$

Acid derivative	Leaving group
(a) $CH_3–CH_2–\overset{O}{\overset{\|}{C}}–Cl$	Cl^-
(b) $CH_3CH_2–\overset{O}{\overset{\|}{C}}–O–\overset{O}{\overset{\|}{C}}–CH_3$	$CH_3–\overset{O}{\overset{\|}{C}}–O^-$
(c) $CH_3CH_2–\overset{O}{\overset{\|}{C}}–O–CH_2CH_3$	$CH_3CH_2O^-$
(d) $CH_3–CH_2–\overset{O}{\overset{\|}{C}}–NH_2$	NH_2^-

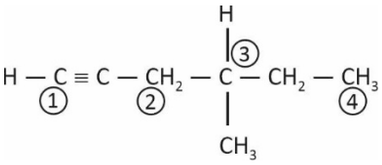
Order of basic strength of leaving groups

$Cl^- < CH_3–\overset{O}{\overset{\|}{C}}–O^- < CH_3CH_2O^- < NH_2^-$

$\therefore$ Decreasing order rate of hydrolysis of the given acid derivatives

a > b > c > d

8. Which of the following carbon atom, forms the least stable and most stable free radical, respectively.



(1) 1, 3 (2) 1, 4

(3) 1, 2 (4) 3, 4

Answer (1)

Sol.

- Least stable free radical formed on carbon marked as (1), because that carbon is sp hybridised.
- Most stable free radical formed on carbon marked as (3) because it has 7 α H atoms available for hyperconujugation

9. Given below are two statements.

Statement I : All naturally occurring amino acids are optically active except glycine.

Statement : All amino acids are optically active. In light of the above statements, choose the most appropriate option

(1) Statement I is true, Statement II is false

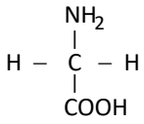
(2) Both statement I and statement II are true

(3) Both statement I and statement II are false

(4) Statement I is false while statement II is true

Answer (1)

Sol. Glycine is the only optically inactive naturally occurring amino acid.



10. Consider the following statements

Statement-1 : Metallic radius of Al is less than that of Ga.

Statement-2 : Ionic radius of Al^{3+} is less than that of Ga^{3+}

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

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

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

(4) Statement-I and Statement-II, both one incorrect

Answer (3)

Sol. Metallic radius of Ga is less than that of Al. This can be understood from the variation in the inner core of the electronic configuration. The presence of additional 10 *d*-electrons offer only poor screening effect for the outer electrons from the increased nuclear charge in gallium.

Ga(135 pm) < Al (143 pm)

Ga^{3+} (62 pm) > Al^{3+} (53.5 pm)

11. Out of the following, XeF_2, NH_3, NF_3, ClF_3, SF_4 and SO_2 Compound having non zero dipole moment and central atom having maximum lone pair of electrons, respectively are :-

(1) ClF_3 and SF_4 (2) XeF_2 and SO_2

(3) ClF_3 and XeF_2 (4) NH_3 and NF_3

Answer (3)

Sol. $XeF_2 \rightarrow$ dipole moment = 0

NH_3, NF_3, ClF_3, SF_4, SO_2 $\rightarrow$ Non-zero dipole moment

Number of lone pairs on central atom

$XeF_2 \Rightarrow 3$

$NH_3 \Rightarrow 1$

$NF_3 \Rightarrow 1$

$ClF_3 \Rightarrow 2$

$SF_4 \Rightarrow 1$

$SO_2 \Rightarrow 1$

$\therefore$ XeF_2 has maximum number of lone pairs

12. In AX_4B, if A is p-block group-18 element, X is most electronegative element and B is second most electronegative element, then shape of compound will be

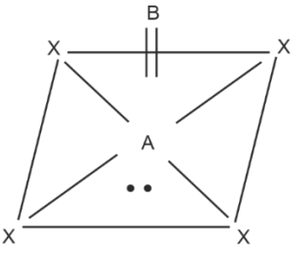
(1) Square pyramidal

(2) Trigonal bipyramidal

(3) Pentagonal Planar

(4) Distorted pentagonal pyramidal

Answer (1)

Sol. 

e.g., $XeOF_4$

Oxygen is second most electronegative element

13. Among Fe, Mn, Co and Cr, element having highest value of $E^{o}_{M^{3+}/M^{2+}}$ form a complex $[M(CN)_6]^{3-}$, then find the number of electrons in e_g set of orbital

(1) 0 (2) 1

(3) 2 (4) 4

Answer (1)

Sol. $E^{o}_{Fe^{3+}/Fe^{2+}} = 0.77$ V

$E^{o}_{Co^{3+}/Co^{2+}} = 1.97$ V

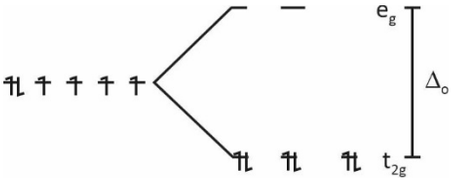
$E^{o}_{Cr^{3+}/Cr^{2+}} = -0.41$ V

$E^{o}_{Mn^{3+}/Mn^{2+}} = 1.57$ V

Cobalt having maximum value of $E^{o}_{Co^{3+}/Co^{2+}}$ i.e. 1.97 V

Complex compound should be $[Co(CN)_6]^{3-}$

$Co^{3+} \Rightarrow [Ar]3d^6 4s^0$



$\Delta_o > P$ as CN^- is a SFL with Co^{3+} ion

$t_{2g}^6 e_g^0$

Number of electrons in e_g set of orbitals = 0

14. Statement I : If paring energy (P) is greater than Δ_o then high spin complex is formed and if $P < \Delta_o$, then low spin complex is formed.
Statement II : If $\Delta_t < P$, then high spin complex is formed.
(Δ_0 – CFSE in octahedral field, Δ_t – CFSE in tetrahedral field)

(1) Both statements I and II are correct
(2) Statement I is correct Statement II is incorrect
(3) Statement I is incorrect Statement II is correct
(4) Both statements I and II are incorrect

Answer (1)

Sol. If pairing energy is higher, then electrons do not pair- results in high spin complex. In tetrahedral field $\Delta_t < P$.

15.

16.

17.

18.

19.

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. Vapour pressure of pure liquid A is 200 mm Hg. If 1 mol of A and 3 mol of B are mixed. Assuming solution to be ideal, find the vapour pressure of pure liquid 'B', if total vapour pressure of solution is 500 mm Hg

Answer (600)

Sol. For an ideal solution $P_S = P_A^{\circ} X_A + P_B^{\circ} X_B$

$X_A = \frac{1}{4}$

$X_B = \frac{3}{4}$

$500 = 200 \times \frac{1}{4} + P_B^{\circ} \times \frac{3}{4}$

$P_B^{\circ} \times \frac{3}{4} = 450$

$P_B^{\circ} = \frac{450 \times 4}{3} = 600$ mm Hg

22. 100 g $CaCO_3$ when reacted with 0.19 mole of HCl then the moles of $CaCl_2$ formed is $P \times 10^{-3}$ mol. Find P?

Answer (95)

Sol. $\underset{100\text{ g}}{CaCO_3} + \underset{0.19\text{ mol}}{2HCl} \rightarrow CaCl_2 + H_2CO_3$

= 1 mol

$\therefore$ 1 mol of $CaCO_3$ requires 2 mol HCl

$\therefore$ HCl is limiting request.

$\therefore$ 2 mol HCl $\rightarrow$ 1 mol $CaCl_2$

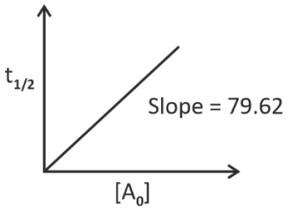
0.19 mol HCl $\rightarrow \frac{1}{2} \times 0.19$ mol $CaCl_2$

= 0.095 mol

= 95×10^{-3} mol

P = 95

23. In the following graph between $t_{1/2}$ and initial concentration $[A_0]$. If slope of the graph is 79.62 M^{-1} min. and initial concentration is 2.5 M. Find the concentration of A after 10 min.



Answer (2)

Sol. As $t_{1/2}$ is directly proportional to initial concentration, the reaction follows zero order kinetics.

$$t_{1/2} = \frac{[A_0]}{2k}$$

$$\text{Slope} = \frac{1}{2k}$$

$$\frac{1}{2k} = 79.62$$

$$k = \frac{1}{2 \times 79.62} = 6.28 \times 10^{-3}$$

$$k = \frac{[A_0] - [A_t]}{t}$$

t = 10 min.

$6.28 \times 10^{-3} \times 10 = 2.5 - [A_t]$

$[A_t] = 2.5 - 6.28 \times 10^{-2}$

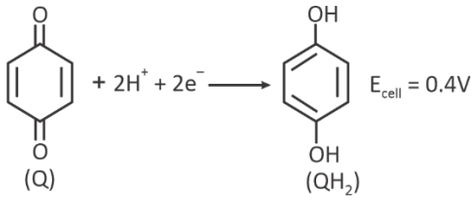
= 2.4372

≈ 2

24. Consider the following electrochemical cell

$Pt|QH_2$, Q, $H^+(0.1\ M)\ ||\ Ag^+(1\ M)|Ag$

Given that



$E°(Q|QH_2) = 0.7V$; $E°(Ag^+|Ag) = 0.8V$;

$$\frac{2.303\,RT}{F} = 0.06$$

Answer (5)

Sol. Overall cell reaction is

$2Ag^+ + QH_2 \rightarrow 2Ag + Q + 2H^+$

According to Nernst equation

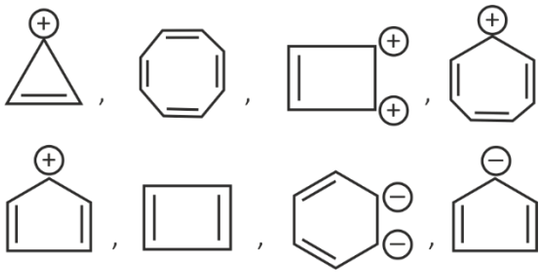
$$E_{cell} = E^\circ_{cell} - \frac{0.06}{2} \log \frac{[H^+]^2}{[Ag^+]^2}$$

$0.4 = 0.1 - 0.06 \log[H^+]$

$$\frac{0.3}{0.06} = pH$$

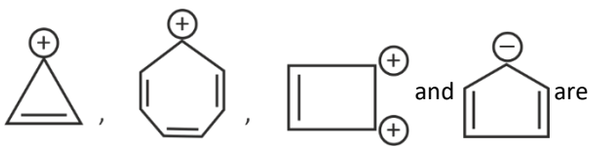
pH = 5

25. Find the total number of aromatic compounds among the following compounds



Answer (4)

Sol. Compound which are cyclic, planar, having cyclic conjugation and follow $(4n + 2)\pi$ electrons rule are aromatic compounds.



aromatic compounds