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. In Kjeldahl's estimation of nitrogen, $CuSO_4$ act as
   (1) Oxidizing agent
   (2) Reducing agent
   (3) Catalyst
   (4) Reagent

Answer (3)

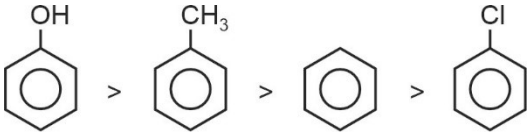
Sol. $CuSO_4$ acts as catalyst in Kjeldahl's method of estimation of nitrogen.

2. Which of the following is most likely attacked by electrophile?

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

Answer (2)

Sol. Order of reactivity towards electrophile



Strength of +M/+R : –OH > $–CH_3$ > –Cl

In case of halogens, their –I effect dominates over +M hence –Cl is deactivating and  is lesser reactive than  for incoming electrophile.

3. **Statement-I:** PH_3 will have low boiling point than NH_3.

   Statement-II: There are strong van der Wall forces in NH_3 and strong hydrogen-bonding in PH_3.

   (1) Statement-I and statement-II both are true
   (2) Statement-I and statement-II both are false
   (3) Statement-I is true but statement-II is false
   (4) Statement-I is false but statement-II is true

Answer (3)

Sol. Boiling point: $\overset{(239.7)}{NH_3} > \overset{(185.5)}{PH_3}$ due to hydrogen bonding in NH_3.

4. Which of the following have trigonal bipyramidal shape?

   PF_5, PBr_5, $[PtCl_4]^{2-}$, SF_6, BF_3, BrF_5, PCl_5, $[Fe(CO)_5]$

   (1) PF_5, PBr_5, PCl_5 and $Fe(CO)_5$ only
   (2) BrF_5, PF_5, PCl_5 and PBr_5 only
   (3) PF_5, PCl_5 and $[Fe(CO)_5]$ only
   (4) $[Fe(CO)_5]$, BrF_5, PF_5, PBr_5, PCl_5 only

Answer (1)

Sol. PF_5, PCl_5, PBr_5, $Fe(CO)_5 \Rightarrow$ Trigonal bipyramidal

$BrF_5 \Rightarrow$ Square pyramidal

$[PtCl_4]^{2-} \Rightarrow$ Square planar

$SF_6 \Rightarrow$ Octahedral

5. Which of the following is correct for adiabatic free expansion against vacuum

   (1) $q = 0, \Delta U = 0, W = 0$ (2) $q \neq 0, W = 0, \Delta U = 0$
   (3) $q = 0, \Delta U \neq 0, W = 0$ (4) $q = 0, \Delta U \neq 0, W \neq 0$

Answer (1)

Sol. $q = 0$ as adiabatic process is given

$W = 0$ as $p_{ext} = 0$

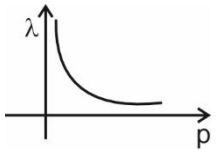
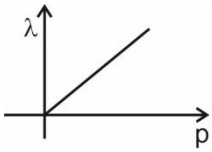
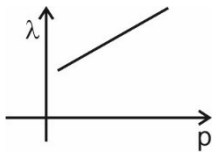
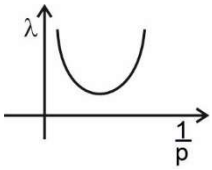
$q + W = \Delta U$

$q = 0$

$W = 0$

$\Rightarrow \Delta U = 0$

6. Which of the following is the correct plot between λ (de Broglie wavelength) and p(momentum)?

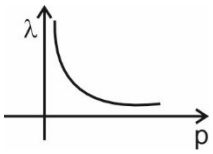
(1) 
(2) 
(3) 
(4) 

Answer (1)

Sol. $\lambda = \frac{h}{p}\left[\lambda \propto \frac{1}{p}\right]$

$\Rightarrow \lambda p = h$ (constant)

So, the plot is a rectangular hyperbola.



7. $Cr_2O_7^{2-} + xH^+ + ye^- \rightarrow 2Cr^{3+} + AH_2O$

Balance the above reaction and find x, y and A.

(1) x = 7, y = 6, A = 14 (2) x = 14, y = 6, A = 7

(3) x = 14, y = 3, A = 7 (4) x = 8, y = 2, A = 1

Answer (2)

Sol. The balanced reaction is,

$Cr_2O_7^{2-} + 14H^+ + 6e^- \rightarrow 2Cr^{3+} + 7H_2O$

x = 14

y = 6

A = 7

8. Complementary strand of DNA

ATGCTTCA is:

(1) TACGAAGA

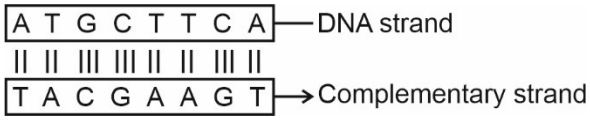
(2) TACGAAGT

(3) TAGCAACA

(4) TAGCTACT

Answer (2)

Sol. Adenine base pairs with thymine with 2 hydrogen bonds and cytosine base pairs with guanine with 3 hydrogen bonds.



9. What is the pH of $CH_3COO^-NH_4^+$ salt?

Given K_a of $CH_3COOH = 1.8 \times 10^{-6}$

K_b of $NH_4OH = 1.8 \times 10^{-6}$

(At 25°C)

(1) 7

(2) 9

(3) 8.9

(4) 7.8

Answer (1)

Sol. $pH = \frac{pK_w + pK_a - pK_b}{2}$

$pK_a = pK_b$

$\Rightarrow pH = \frac{pK_w}{2} = 7$

10. We are given with 3 NaCl samples and their van't Hoff factors

Sample	van't Hoff factor
Sample-1 (0.1M)	i_1
Sample-2 (0.01M)	i_2
Sample-3 (0.001M)	i_3

Choose the correct answer.

(1) $i_1 = i_2 = i_3$ (2) $i_1 > i_2 > i_3$

(3) $i_3 > i_2 > i_1$ (4) $i_1 > i_3 > i_2$

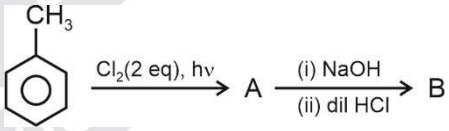
Answer (1)

Sol. As NaCl is strong electrolyte, its degree of dissociation (α) will remain same.

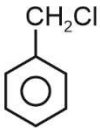
i = 2

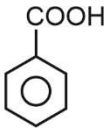
For each sample,

$i_1 = i_2 = i_3$

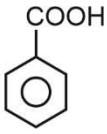
11. 

A and B in above reaction is

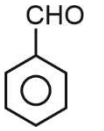
(1) (A) 

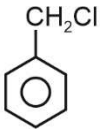
(B) 

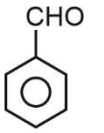
(2) (A) 

(B) 

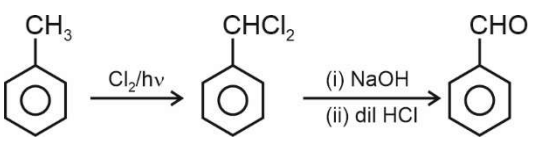
(3) (A) 

(B) 

(4) (A) 

(B) 

Answer (3)

Sol. 

12. We have a mixture of gases having 2 moles of monoatomic gas $\left(C_{v,m}=\frac{3R}{2}\right)$ and 6 moles of diatomic gas $\left(C_{v,m}=\frac{5R}{2}\right)$. Find out molar heat capacity (C_{vm}) of the mixture.

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

(2) $\frac{9R}{2}$

(3) 3R

(4) 4R

Answer (1)

Sol. $C_{vm}=\frac{2\left(\frac{3R}{2}\right)+6\left(\frac{5R}{2}\right)}{2+6}$

$=\frac{3R+15R}{8}=\frac{18R}{8}$

$=\frac{9R}{4}$ (option (1))

13. **Assertion (A):** KCN react with R–X to give cyanide and AgCN reacts with R – X to give isocyanide mainly.

Reason (R): KCN and AgCN both are ionic compounds

(1) Both Assertion and Reason are true and Reason explains Assertion

(2) Both Assertion and Reason is true but Reason does not explains Assertion

(3) Assertion is true and Reason is false

(4) Assertion is false but reason is true

Answer (3)

Sol. $KCN \longrightarrow \overset{+}{K} + CN^-$

$R - X + KCN \longrightarrow R - CN + KX$

$R - X + AgCN \longrightarrow R - NC + AgX$

KCN is ionic therefore ionised and attack occurs through carbon.

AgCN is covalent therefore attack starts with Nitrogen.

14. Consider the following two statements.

Statement I: $[Ni(H_2O)_6]^{2+}$ is of green colour

Statement II : $[Ni(CN)_4]^{2-}$ is colourless

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

(2) Statement I is true, statement II is true

(3) Statement I is false, statement II is true

(4) Statement I is false, statement II is false

Answer (2)

Sol. $[Ni(H_2O)_6]^{2+}$ is octahedral and $[Ni(CN)_4]^{2-}$ is square planar.

In $[Ni(H_2O)_6]^{2+} \Rightarrow Ni^{2+}$ has two unpaired electrons and in $[Ni(CN)_4]^{2-} \Rightarrow Ni^{2+}$ has no unpaired electrons.

$[Ni(H_2O)_6]^{2+}$ is coloured as it absorbs red light due to suitable d-d transition and complementary light emitted is green.

$[Ni(CN)_4]^{2-}$ has strong field ligand so the electrons of Ni^{2+} pair up and it is colourless as it cannot absorb light from visible region.

15. **Statement-I:** Potassium hydrogen phthalate is primary standard for NaOH solution.

Statement-II: Phenolphthalein is used to detect completion of titration.

(1) Both statement-I and statement-II are correct

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

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

(4) Both statement-I and statement-II are incorrect

Answer (1)

Sol. Potassium hydrogen phthalate is used to standardize NaOH solutions.

Phenolphthalein is used as an indicator to detect completion of titrations.

16. **Statement-I:** In aniline, $-NH_2$ group is strong deactivating group for all ESR.

Statement-II: Aniline does not show Friedel-Craft alkylation reaction.

(1) Both statement-I and statement-II are correct

(2) Both statement-I and statement-II are incorrect

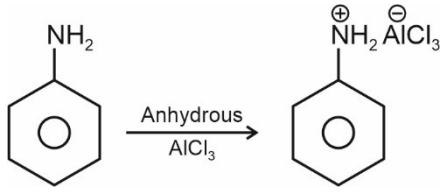
(3) Statement-I is correct and statement-II is incorrect

(4) Statement-I is incorrect and statement-II is correct

Answer (4)

Sol. In aniline $-NH_2$ is strong activating group due to presence of lone pair in nitrogen.

Aniline does not show Friedel-Craft alkylation reaction, because anhydrous $AlCl_3$ and aniline form salt together



17. Which of the following is homoleptic complex?

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

(2) $[Cu(H_2O)_3Cl_3]$

(3) $[PtCl2Br_2]^{2-}$

(4) $[Cu(NH_3)_5Cl]Cl_2$

Answer (1)

Sol. Homoleptic complexes in which a metal is bound to only one kind of donor groups/ligands.

18. For ionic reaction in organic compound which type of bond cleavage occur?

(1) Heterolytic cleavage

(2) Homolytic cleavage

(3) Free radical

(4) No cleavage of bond

Answer (1)

Sol. In heterolytic bond cleavage ions are formed. hence for ionic reaction in organic compound heterolytic bond cleavage takes place.

19. Ka values of three acids A, B and C are 10^{-3}, 5×10^{-9}, 9×10^{-11} respectively. The acidic strength order of these acids is

(1) A > B > C

(2) B > A > C

(3) C > B > A

(4) C > A > B

Answer (1)

Sol. Higher the value of K_a, more is the acidic strength.

20. Which of the following is a disproportionation reaction?

A. $Cu^{+} \longrightarrow Cu^{2+} + Cu$

B. $MnO_4^{2-} \longrightarrow MnO_4^{-} + MnO_2$

C. $H_2O_2 \longrightarrow O_2 + H_2O$

D. $CrO_4^{2-} \longrightarrow Cr^{3+} + H_2O$

(1) All A, B, C and D (2) A and B only

(3) A and C only (4) A, B and C only

Answer (4)

Sol. Disproportionation reaction is a reaction in which a substance (element) is simultaneously oxidised and reduced.

A. $\overset{\text{Reduction}}{\overset{\frown}{Cu^{+}}} \longrightarrow \overset{\text{Oxidation}}{\underset{\frown}{Cu^{2+}}} + Cu$

B. $\overset{\text{Oxidation}}{\overset{\frown}{\overset{+6}{MnO_4^{2}}}} \longrightarrow \overset{+7}{MnO_4^{-}} + \overset{+4}{MnO_2}$ (Reduction)

C. $\overset{\text{Reduction}}{\overset{\frown}{\overset{-1}{H_2O_2}}} \longrightarrow \overset{0}{O_2} + \overset{-2}{H_2O}$ (Oxidation)

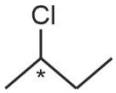
D. $\overset{+6}{CrO_4^{2-}} \longrightarrow Cr^{3+} + H_2O$ (Reduction only)

SECTION - B

Numerical Value Type Questions: This section contains 10 Numerical based questions. The answer to each question should be rounded-off to the nearest integer.

21. Find out total possible optical isomers of 2-chlorobutane.

Answer (2)

Sol. 

There is one chiral centre present in given compound which is unsymmetrical.

Total number of isomers = 2^n

n = number of stereogenic centre

n = 1

$= 2^1$

= 2

Total two optical isomers are possible

22. We are given with following cell reaction :

$$2H^+ + 2e^- \longrightarrow H_2$$

$P_{H_2} = 2$ atm

$[H^+] = 1$ M

$\left(\frac{2.303RT}{F} = 0.06\right)$

If E_{cell} for reaction is given by $-x \times 10^{-3}$ V, find out x.

Answer (9)

Sol. $E_{cell} = 0 - \frac{0.06}{2}\log 2$

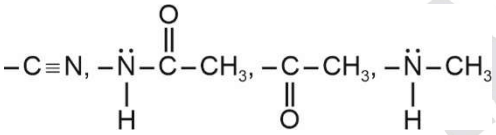
$= -0.03(0.3)$

$= -0.009$

$= -9 \times 10^{-3}$ V

x = 9

23. Total number of deactivating groups among the following



Answer (2)

Sol. $-C\equiv N$, $-\overset{O}{\overset{\|}{C}}-CH_3$ are –R group which is deactivating

$-\ddot{N}H-\overset{O}{\overset{\|}{C}}-CH_3$ and $-\ddot{N}H-CH_3$ due to presence of lone pair in nitrogen atom behaves as activating (+R) group.

24. How many oxides are amphoteric in nature?

SnO_2, PbO_2, SiO_2, P_2O_5, Al_2O_3, CO_2, CO, NO, N_2O

Answer (3)

Sol. Amphoteric oxides are those which can react with both acid and base

SnO_2, PbO_2 and Al_2O_3 are amphoteric oxide

SiO_2, P_2O_5, CO_2 are acidic oxides

CO, NO and N_2O are neutral oxides

25. For carbon dating of a wood sample $\left(\frac{C^{14}}{C^{12}}\right)_t = \frac{1}{8}\left(\frac{C^{14}}{C^{12}}\right)_{t=0}$. If Half life of C^{14} is 1580 years what is the life of wood sample (in yr)

Answer (4740)

Sol. $\left(\frac{C^{14}}{C^{12}}\right)_t = \frac{\left(\frac{C^{14}}{C^{12}}\right)_{t=0}}{(2)^n}$

n = 3

t = 3 × 1580

= 4740 years

26. What is the minimum energy (in eV) required for an electron to excite from ground state to 1st excited state for hydrogen atom?

Answer (10)

Sol. $n_1 = 1$

$n_2 = 2$

$\Delta E = 13.6Z^2\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$

$\Delta E = 13.6\left(\frac{1}{1^2} - \frac{1}{2^2}\right)$

$\Delta E = 13.6\left(1 - \frac{1}{4}\right)$

$\Delta E = 13.6 \times \frac{3}{4}$ eV

= 10.05 eV ≈ 10 eV

27. Find out moles of precipitate product formed when 72 moles of $PbCl_2$ reacts with 50 moles of $(NH_4)_2SO_4$.

Answer (50)

Sol. $PbCl_2 + (NH_4)_2SO_4 \longrightarrow PbSO_4\downarrow + 2NH_4Cl$

72 50

↓ ↓ ↓

22 0 50

Moles of $PbSO_4$ formed = 50 mol

28.

29.

30.