## 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. Using the rules for significant figures, the correct answer for the expression $\frac{0.02858 \times 0.112}{0.5702}$ will be
(A) 0.005613
(B) 0.00561
(C) 0.0056
(D) 0.006

## Answer (B)

Sol. $\frac{0.02858 \times 0.112}{0.5702}=.00561$
Answer expressed in 3 significant figures.
2. Which of the following is the correct plot for the probability density $\psi^{2}(r)$ as a function of distance ' $r$ ' of the electron from the nucleus for $2 s$ orbital?
(A)

(B)

(C)

(D)


## Answer (B)

Sol. 2s
radial node $=n-I-1$

$$
\begin{aligned}
& =2-0-1 \\
& =1
\end{aligned}
$$

It will have one radial node
3. Consider the species $\mathrm{CH}_{4}, \mathrm{NH}_{4}^{+}$and $\mathrm{BH}_{4}^{-}$. Choose the correct option with respect to these species.
(A) They are isoelectronic and only two have tetrahedral structures
(B) They are isoelectronic and all have tetrahedral structures.
(C) Only two are isoelectronic and all have tetrahedral structures.
(D) Only two are isoelectronic and only two have tetrahedral structures.

## Answer (B)

Sol. $\mathrm{CH}_{4}, \quad \mathrm{NH}_{4}^{+}$and $\mathrm{BH}_{4}^{-}$are isoelectronic as well as tetrahedral.
4. 4.0 moles of argon and 5.0 moles of $\mathrm{PCl}_{5}$ are introduced into an evacuated flask of 100 litre capacity at 610 K . The system is allowed to equilibrate. At equilibrium, the total pressure of mixture was found to be 6.0 atm . The $K_{p}$ for the reaction is [Given : $\mathrm{R}=0.082 \mathrm{~L} \mathrm{~atm} \mathrm{~K}^{-1} \mathrm{~mol}^{-1}$ ]
(A) 2.25
(B) 6.24
(C) 12.13
(D) 15.24

## Answer (A)

Sol.

$$
\begin{array}{lll} 
& \mathrm{PCl}_{5} \rightleftharpoons \mathrm{PCl}_{3}+\mathrm{Cl}_{2} \\
\mathrm{t}=0 & 5 & 0
\end{array}
$$

For Argon
$n_{A r}=4$
Total moles $=\mathrm{n}_{\mathrm{Ar}}+\mathrm{nPCl}_{5}+\mathrm{nPCl}_{3}+\mathrm{nPCl}_{2}$

$$
\begin{aligned}
& =4+5+n \\
& =9+n
\end{aligned}
$$

$$
\mathrm{K}_{\mathrm{p}}=\frac{\mathrm{P}_{\mathrm{PCl}_{3}} \cdot \mathrm{PCl}_{2}}{\mathrm{P}_{\mathrm{PCl}_{5}}} \quad \mathrm{PV}=\mathrm{nRT}
$$

$$
6 \times 100=(9+n) \times 0.082 \times 610
$$

$$
\mathrm{n}=3
$$

$$
=\frac{\left(\frac{3}{12} \times 6\right) \times\left(\frac{3}{12} \times 6\right)}{\frac{2}{12} \times 6}
$$

$$
=\frac{27}{12}=\frac{9}{4}=2.25 \mathrm{~atm}
$$

5. A 42.12\% (w, v) solution of NaCl causes precipitation of a certain sol in 10 hours. The coagulating value of NaCl for the sol is
[Given : Molar mass : $\mathrm{Na}=23.0 \mathrm{~g} \mathrm{~mol}^{-1} ; \mathrm{Cl}=35.5$ $\mathrm{g} \mathrm{mol}^{-1}$ ]
(A) $36 \mathrm{mmol} \mathrm{L}^{-1}$
(B) $36 \mathrm{~mol} \mathrm{~L}^{-1}$
(C) $1440 \mathrm{~mol} \mathrm{~L}^{-1}$
(D) $1440 \mathrm{mmol} \mathrm{L}^{-1}$

Answer (Bonus)

Sol. Data is insufficient.
6. Given below are two statements. One is labelled as Assertion A and the other is labelled as Reason R.

Assertion A: The first ionization enthalpy for oxygen is lower than that of nitrogen.
Reason R: The four electrons in $2 p$ orbitals of oxygen experience more electron-electron repulsion.

In the light of the above statements, choose the correct answer from the options given below.
(A) Both $A$ and $R$ are correct and $R j$ is the correct explanation of $A$
(B) Both $A$ and $R$ are correct but $R$ is NOT the correct explanation of $A$
(C) A is correct but $R$ is not correct
(D) $A$ is not correct but $R$ is correct

## Answer (B)

Sol. Nitrogen has half filled p-orbitals which is stable. Due to this it's $1^{\text {st }}$ ionization energy is more than oxygen.
7. Match List-I with List-II

| List-I Ore | List-II Composition |
| :--- | :--- |
| A. Siderite | I. $\mathrm{FeCO}_{3}$ |
| B. Malachite | II. $\mathrm{CuCO}_{3} . \mathrm{Cu}(\mathrm{OH})_{2}$ |
| C. Sphalerite | III. ZnS |
| D. Calamine | IV. $\mathrm{ZnCO}_{3}$ |

Choose the correct answer from the options given below:
(A) A-I, B-II, C-III, D-IV
(B) A-III, B-IV, C-II, D-I
(C) A-IV, B-III, C-I, D-II
(D) A-I, B-II, C-IV, D-III

## Answer (A)

Sol. Siderite $\rightarrow \mathrm{FeCO}_{3}$

$$
\begin{aligned}
& \text { Malachite } \rightarrow \mathrm{CuCO}_{3} . \mathrm{Cu}(\mathrm{OH})_{2} \\
& \text { Sphalerite } \rightarrow \mathrm{ZnS} \\
& \text { Calamine } \rightarrow \mathrm{ZnCO}_{3}
\end{aligned}
$$

8. Given below are two statements.

Statement-I: In $\mathrm{CuSO}_{4} .5 \mathrm{H}_{2} \mathrm{O}, \mathrm{Cu}-\mathrm{O}$ bonds are present.
Statement-II: In $\mathrm{CuSO}_{4} .5 \mathrm{H}_{2} \mathrm{O}$, ligands coordinating with $\mathrm{Cu}(\mathrm{II})$ ion are O -and S -based ligands.

In the light of the above statements, choose the correct answer from the options given below:
(A) Both Statement-I and Statement-II are correct
(B) Both Statement-I and Statement-II are incorrect
(C) Statement-I is correct but Statement-II is incorrect
(D) Statement-I is incorrect but Statement-II is correct.

## Answer (C)

Sol. Statement I is true but statement II is false. Only oxygen atom forms Co -ordinate bond with $\mathrm{Cu}^{+2}$ in $\mathrm{CuSO}_{4} .5 \mathrm{H}_{2} \mathrm{O}$
9. Amongst baking soda, caustic soda and washing soda, carbonate anion is present in
(A) Washing soda only
(B) Washing soda and caustic soda only
(C) Washing soda and baking soda only
(D) Baking soda, caustic soda and washing soda

## Answer (A)

Sol. $\mathrm{CO}_{3}^{-2}$ ion is present only in washing soda.
10. Number of lone pair(s) of electrons on central atom and the shape of $\mathrm{BrF}_{3}$ molecule respectively, are
(A) 0, triangular planar
(B) 1, pyramidal
(C) 2, bent T-shape
(D) 1, bent T-shape

## Answer (C)

Sol. : $\ddot{B r F}_{3}$ Shape is bent T-shape

## $\longrightarrow 2$ Lone pairs


11. Aqueous solution of which of the following boron compounds will be strongly basic in nature?
(A) $\mathrm{NaBH}_{4}$
(B) $\mathrm{LiBH}_{4}$
(C) $\mathrm{B}_{2} \mathrm{H}_{6}$
(D) $\mathrm{Na}_{2} \mathrm{~B}_{4} \mathrm{O}_{7}$

## Answer (D)

Sol. $\mathrm{Na}_{2} \mathrm{~B}_{4} \mathrm{O}_{7}+7 \mathrm{H}_{2} \mathrm{O} \longrightarrow 2 \mathrm{H}_{3} \mathrm{BO}_{3}+2 \mathrm{Na}\left[\mathrm{B}(\mathrm{OH})_{4}\right]$
Aqueous solution of borax is buffer whose $\mathrm{pH} \simeq 9$
Other compounds are less basic than this.
12. Sulphur dioxide is one of the components of polluted air. $\mathrm{SO}_{2}$ is also a major contributor to acid rain. The correct and complete reaction to represent acid rain caused by $\mathrm{SO}_{2}$ is
(A) $2 \mathrm{SO}_{2}+\mathrm{O}_{2} \rightarrow 2 \mathrm{SO}_{3}$
(B) $\mathrm{SO}_{2}+\mathrm{O}_{3} \rightarrow \mathrm{SO}_{3}+\mathrm{O}_{2}$
(C) $\mathrm{SO}_{2}+\mathrm{H}_{2} \mathrm{O}_{2} \rightarrow \mathrm{H}_{2} \mathrm{SO}_{4}$
(D) $2 \mathrm{SO}_{2}+\mathrm{O}_{2}+2 \mathrm{H}_{2} \mathrm{O} \rightarrow 2 \mathrm{H}_{2} \mathrm{SO}_{4}$

## Answer (D)

Sol. $2 \mathrm{SO}_{2}+\mathrm{O}_{2}+2 \mathrm{H}_{2} \mathrm{O} \longrightarrow 2 \mathrm{H}_{2} \mathrm{SO}_{4}$
Acid rain occurs due to increased concentration of oxides of sulphur and Nitrogen.
13. Which of the following carbocations is most stable?
(A)

(B)

(C)

(D)


## Answer (D)

Sol.


14.


The stable carbocation formed in the above reaction is
(A)

(B) $\mathrm{CH}_{3} \stackrel{\oplus}{\mathrm{C}} \mathrm{H}_{2}$
(C)

(D)


## Answer (C)

Sol. Initially
$\mathrm{CH}_{3}-\mathrm{CH}_{2}-\mathrm{CH}_{2}^{+}$is formed.
On rearrangement

stable carbocation is formed.
15. Two isomers $(A)$ and (B) with Molar mass $184 \mathrm{~g} / \mathrm{mol}$ and elemental composition C, 52.2\%; H, $4.9 \%$ and $\mathrm{Br} 42.9 \%$ gave benzoic acid and p-bromobenzoic acid, respectively on oxidation with $\mathrm{KMnO}_{4}$. Isomer ' $A$ ' is optically active and gives a pale yellow precipitate when warmed with alcoholic $\mathrm{AgNO}_{3}$. Isomers ' $A$ ' and ' $B$ ' are, respectively
(A) $\mathrm{H}_{3} \mathrm{C}-\mathrm{CHBr}-\mathrm{C}_{6} \mathrm{H}_{5}$ and

(B)
 and

(C)

and

(D)
 and $\mathrm{H}_{3} \mathrm{C}-\mathrm{CHBr}-\mathrm{C}_{6} \mathrm{H}_{5}$

## Answer (C)

Sol. moles relative ratio simplest ratio
C $52.2=52.2 / 12=4.35 \rightarrow 8.7$
H $4.9=4.9 / 1=4.9 \rightarrow 9.8$
$\mathrm{Br} 42.9=42.9 / 80=0.5 \quad \rightarrow \quad 1$
$\mathrm{C}_{8} \mathrm{H}_{9} \mathrm{Br}$
A is optically active


B forms para bromo benzoic acid on reaction with $\mathrm{KMnO}_{4}$.

16. In Friedel-Crafts alkylation of aniline, one gets
(A) Alkylated product with ortho and para substitution.
(B) Secondary amine after acidic treatment.
(C) An amide product.
(D) Positively charged nitrogen at benzene ring.

Answer (D)
Sol.

17. Given below are two statements : one is labelled as Assertion A and the other is labelled as Reason R.

Assertion A : Dacron is an example of polyester polymer.

Reason R : Dacron is made up of ethylene glycol and terephthalic acid monomers.

In the light of the above statements, choose the most appropriate answer from the options given below.
(A) Both $\mathbf{A}$ and $\mathbf{R}$ are correct and $\mathbf{R}$ is the correct explanation of $\mathbf{A}$.
(B) Both $\mathbf{A}$ and $\mathbf{R}$ are correct but $\mathbf{R}$ is NOT the correct explanation of $\mathbf{A}$.
(C) $\mathbf{A}$ is correct but $\mathbf{R}$ is not correct.
(D) $\mathbf{A}$ is not correct but $\mathbf{R}$ is correct.

## Answer (A)

Sol.



Dacron
18. The structure of protein that is unaffected by heating is
(A) Secondary Structure
(B) Tertiary Structure
(C) Primary Structure
(D) Quaternary Structure

## Answer (C)

Sol. Primary structure is unaffected by heating
19. The mixture of chloroxylenol and terpineol is an example of
(A) Antiseptic
(B) Pesticide
(C) Disinfectant
(D) Narcotic analgesic

## Answer (A)

Sol. Mixture of chloroxylenol and terpineol is known as Dettol. It acts as Antiseptic
20. A white precipitate was formed when $\mathrm{BaCl}_{2}$ was added to water extract of an inorganic salt. Further, a gas ' X ' with characteristic odour was released when the formed white precipitate was dissolved in dilute HCl . The anion present in the inorganic salt is
(A) $\mathrm{I}^{-}$
(B) $\mathrm{SO}_{3}^{2-}$
(C) $\mathrm{S}^{2-}$
(D) $\mathrm{NO}_{2}^{-}$

## Answer (B)

Sol. Anion is $\mathrm{SO}_{3}^{-2}$


Gas is released with smell of burning sulphur.

## SECTION - B

Numerical Value Type Questions: This section contains 10 questions. In Section B, attempt any five questions out of 10. The answer to each question is a NUMERICAL VALUE. For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the second decimal place; e.g. $06.25,07.00,-00.33,-00.30,30.27,-27.30$ ) using the mouse and the on-screen virtual numeric keypad in the place designated to enter the answer.

1. A box contains 0.90 g of liquid water in equilibrium with water vapour at $27^{\circ} \mathrm{C}$. The equilibrium vapour pressure of water at $27^{\circ} \mathrm{C}$ is 32.0 Torr. When the volume of the box is increased, some of the liquid water evaporates to maintain the equilibrium pressure. If all the liquid water evaporates, then the volume of the box must be $\qquad$ litre. [nearest integer]
(Given : $\mathrm{R}=0.082 \mathrm{~L} \mathrm{~atm} \mathrm{~K}^{-1} \mathrm{~mol}^{-1}$ ]
(Ignore the volume of the liquid water and assume water vapours behave as an ideal gas.
Answer (29)
Sol. $\quad \mathrm{H}_{2} \mathrm{O}(\mathrm{I}) \rightleftharpoons \mathrm{H}_{2} \mathrm{O}(\mathrm{g})$
$t=t_{\text {eq }} \quad \frac{0.90}{18}-x \quad x$
$P V=n R T$
$\frac{32}{760} \times V=.082 \times(x) \times 300$
$x=\frac{0.90}{18}$

$$
\begin{aligned}
V & =.082 \times \frac{0.90}{18} \times \frac{300 \times 760}{32} \\
& \approx 29.21 \mathrm{~L} \\
& \approx 29 \mathrm{~L}
\end{aligned}
$$

2. 2.2 g of nitrous oxide $\left(\mathrm{N}_{2} \mathrm{O}\right)$ gas is cooled at a constant pressure of 1 atm from 310 K to 270 K causing the compression of the gas from 217.1 mL to 167.75 mL . The change in internal energy of the process, $\Delta U$ is ' $-x$ ' $J$. The value of ' $x$ ' is $\qquad$ -. [nearest integer]
(Given : atomic mass of $\mathrm{N}=14 \mathrm{~g} \mathrm{~mol}^{-1}$ and of $\mathrm{O}=16 \mathrm{~g} \mathrm{~mol}^{-1}$

Molar heat capacity of $\mathrm{N}_{2} \mathrm{O}$ is $100 \mathrm{~J} \mathrm{~K}^{-1} \mathrm{~mol}^{-1}$ )
Answer (195)
Sol. $\Delta T=-40 \mathrm{~K}$

$$
\begin{aligned}
\Delta U & =q+w \\
& =\frac{100 \times 2.2}{44}(-40)-(-49.39) \times 10^{-3} \times 101.325
\end{aligned}
$$

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$$
\begin{aligned}
& =-200+5 \\
& =-195 \mathrm{~J} \\
x= & 195
\end{aligned}
$$

3. Elevation in boiling point for 1.5 molal solution of glucose in water is 4 K . The depression in freezing point for 4.5 molal solution of glucose in water is 4 K . The ratio of molal elevation constant to molal depression constant $\left(\mathrm{K}_{\mathrm{b}} / \mathrm{K}_{\mathrm{f}}\right)$ is $\qquad$ -.

## Answer (3)

Sol. $\Delta \mathrm{T}_{\mathrm{b}}=i \times \mathrm{K}_{\mathrm{b}} \times \mathrm{m}$
$\Delta \mathrm{T}_{\mathrm{f}}=i \times \mathrm{K}_{\mathrm{f}} \times \mathrm{m} \quad i=1$
$4=1 \times K_{b} \times 1.5$
$4=1 \times K_{f} \times 4.5$
$\frac{\mathrm{K}_{\mathrm{b}}}{\mathrm{K}_{\mathrm{f}}}=3$
4. The cell potential for the given cell at 298 K

Pt | $\mathrm{H}_{2}\left(\mathrm{~g}, 1\right.$ bar) | $\mathrm{H}^{+}(\mathrm{aq})| | \mathrm{Cu}^{2+}(\mathrm{aq}) \mid \mathrm{Cu}(\mathrm{s})$
is 0.31 V . The pH of the acidic solution is found to be 3 , whereas the concentration of $\mathrm{Cu}^{2+}$ is $10^{-x} \mathrm{M}$. The value of $x$ is $\qquad$ .
(Given: $\mathrm{E}_{\mathrm{Cu}^{2+} / \mathrm{Cu}}^{\Theta}=0.34 \mathrm{~V}$ and $\frac{2.303 \mathrm{RT}}{\mathrm{F}}=0.06 \mathrm{~V}$ )

## Answer (7)

Sol. $\mathrm{Q}=\frac{\left[\mathrm{H}^{+}\right]^{2}}{\left[\mathrm{Cu}^{+2}\right] \mathrm{pH}_{2}}=\frac{10^{-6}}{\mathrm{C}} \quad \mathrm{pH}_{2}=1$
$E=E_{\text {cell }}^{\circ}-\frac{0.06}{n} \log Q$
$0.31=0.34-\frac{0.06}{2} \log \frac{10^{-6}}{C}$
$\log \frac{10^{-6}}{C}=1$
$C=10^{-7} \mathrm{M}$
$x=7$
5. The equation
$\mathrm{k}=\left(6.5 \times 10^{12} \mathrm{~s}^{-1}\right) \mathrm{e}^{-26000 k T}$ is followed for the decomposition of compound A . The activation energy for the reaction is $\qquad$ $\mathrm{kJ} \mathrm{mol}^{-1}$. [nearest integer]
(Given : $\mathrm{R}=8.314 \mathrm{~J} \mathrm{~K}^{-1} \mathrm{~mol}^{-1}$ ]

## Answer (216)

Sol. $k=A e^{\frac{-E_{a}}{R T}}$

$$
\frac{E_{a}}{R T}=\frac{26000}{T}
$$

$$
E_{a}=26000 \times 8.314
$$

$$
\begin{aligned}
& =216164 \mathrm{~J} \\
& =216 \mathrm{~kJ}
\end{aligned}
$$

6. Spin only magnetic moment of $\left[\mathrm{MnBr}_{6}\right]^{4}$ is ___B.M. [round off to the closest integer]

## Answer (6)

Sol. $\left[\mathrm{MnBr}_{6}\right]^{-4}$

$$
\begin{array}{rl}
x-6=-4 \\
x=+2 & M n=3 d^{5} 4 s^{2} \\
& M n^{+2}=3 d^{5} 4 \mathrm{~s}^{\circ} \\
& n=5
\end{array}
$$

$\mu=\sqrt{\mathrm{n}(\mathrm{n}+2)}$
$=\sqrt{35} \approx 6 \mathrm{~B} . \mathrm{M}$.
7. For the reaction given below:

$$
\mathrm{CoCl}_{3} \cdot \times \mathrm{NH}_{3}+\mathrm{AgNO}_{3}(\mathrm{aq}) \rightarrow
$$

If two equivalents of AgCl precipitate out, then the value of $x$ will be $\qquad$ .

## Answer (5)

Sol. $\left[\mathrm{CoCl}\left(\mathrm{NH}_{3}\right)_{5}\right] \mathrm{Cl}_{2} \xrightarrow{\mathrm{AgNO}_{3}} 2 \mathrm{AgCl} \downarrow$
$x=5$
8. The number of chiral alcohol(s) with molecular formula $\mathrm{C}_{4} \mathrm{H}_{10} \mathrm{O}$ is $\qquad$ —.

## Answer (1)

Sol. $\mathrm{C}-\mathrm{C}-\mathrm{C}-\mathrm{C}-\mathrm{OH}$



9. In the given reaction,

the number of $\mathrm{sp}^{2}$ hybridised carbon(s) in compound ' $X$ ' is $\qquad$ —.
Answer (8)

Sol.

10. In the given reaction,


The number of $\pi$ electrons present in the product ' $P$ ' is $\qquad$ -.

## Answer (4)

Sol.


Total $4 \pi$ electrons are there. Reaction is aldol condensation.

