SECTION-A

1. Using the rules for significant figures, the correct answer for the expression $\dfrac{0.02858 \times 0.112}{0.5702}$ will be:

   (A) 0.005613   (B) 0.00561

   (C) 0.0056   (D) 0.006

   Ans. (B)

   Sol. Reported answer should not be more precise than least precise term in calculations, so there should be three significant figures in reported answer.

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 form the nucleus for 2s orbital?

   (A)

   (B)

   (C)

   (D)
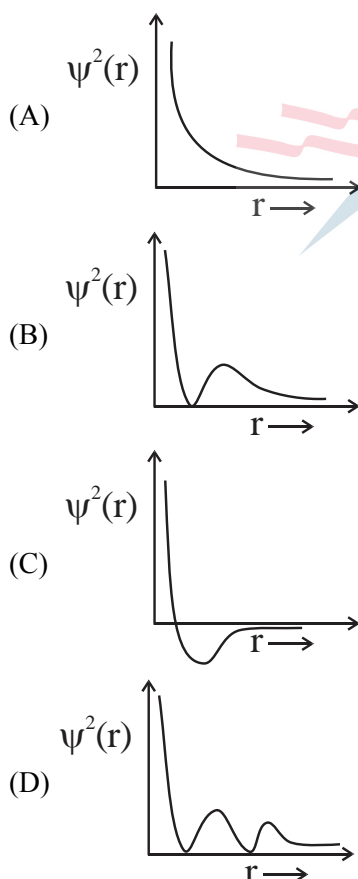
   Ans. (B)

   Sol. For 2s, number of radial nodes = 2 – 0 – 1 = 1 and value of ψ^2 is always positive.

3. Consider the species CH_4, NH_4^+ and BH_4^-. Choose the correct option with respect to the there 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

   Ans. (B)

   Sol.
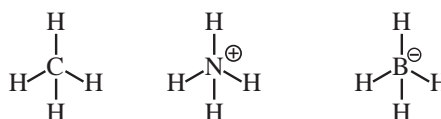
   All are tetrahedral and each have 10 electrons.

4. 4.0 moles of argon and 5.0 moles of 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 : R = 0.082L atm K^{-1} mol^{-1}]
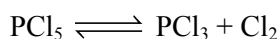
   (A) 2.25   (B) 6.24

   (C) 12.13   (D) 15.24

   Ans. (A)

   Sol. PCl_5 = 5 mole

   Ar = 4 mole

   $$P_{Total} = \frac{9 \times 0.82 \times 610}{100} = 4.5\,atm$$

   $$P_{PCl_5} = \frac{5 \times 4.5}{9} = 2.5 \; ; \; P_{Ar} = \frac{4 \times 4.5}{9} = 2$$

   $$PCl_5 \rightleftharpoons PCl_3 + Cl_2$$

   $$2.5 - P \qquad P \qquad P$$

   $P_{total} = 2.5 - P + P + P + P_{Ar} = 6$

   P = 1.5

   $$K_p = \frac{1.5 \times 1.5}{1} = 2.25$$

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 : Na = 23.0 g mol^{-1}; Cl = 35.5 g mol^{-1}]

(A) 36 mmol L^{-1}

(B) 36 mol L^{-1}

(C) 1440 mol L^{-1}

(D) 1440 mmol L^{-1}

Ans. (Bonus)

Sol. Data 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 2p 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 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

Ans. (A)

Sol. Ionisation energy = N > O.

In oxygen atom, 2 of the 4 2p electrons must occupy the same 2p orbital resulting in an increased electron electron-repulsion.

7. Match List I with List II.

List I Ore	List II Composition
A. Siderite	I. Fe CO$_3$
B. Malachite	II. CuCO$_3$.Cu(OH)$_2$
C. Sphalerite	III. ZnS
D. Calamine	IV. 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

Ans. (A)

Sol. Siderite – FeCO$_3$

Malachite – CuCO$_3$.Cu(OH)$_2$

Calamine – ZnCO$_3$

Sphalerite – ZnS

8. Given below are two statements .

Statement I : In CuSO$_4$.5H$_2$O, Cu–O bonds are present.

Statement II : In CuSO$_4$.5H$_2$O, ligands coordinating with Cu(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

Ans. (C)

Sol.
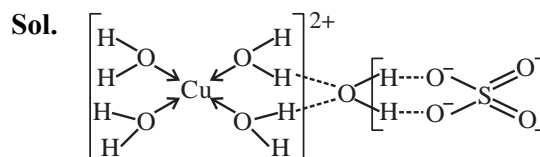
9. Amongst baking soda, caustic soda and washing soda carbonate anion is present in :

(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.
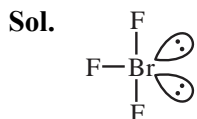
Ans. (A)

Sol. Baking soda → $NaHCO_3$

Washing soda → $Na_2CO_3.10H_2O$

Caustic soda → $NaOH$

10. Number of lone pair (s) of electrons on central atom and the shape of BrF_3 molecule respectively, are :

(A) 0, triangular planar.

(B) 1, pyramidal.

(C) 2, bent T-shape.

(D) 1, bent T-shape

Official Ans. by NTA (C)

Ans. (C)

Sol.

$$F-\overset{\overset{\displaystyle F}{|}}{\underset{\underset{\displaystyle F}{|}}{Br}} \,\,\ddot{}\ddot{}$$

Steric no. = 5 (sp^3d), lone pair = 2

Bent T shape.

11. Aqueous solution of which of the following boron compounds will be strongly basic in nature?

(A) $NaBH_4$ (B) $LiBH_4$

(C) B_2H_6 (D) $Na_2B_4O_7$

Ans. (D)

**Sol.** $Na_2B_4O_7$ gives H_3BO_3 and $NaOH$ (strong base) in water.

12. Sulphur dioxide is one of the components of polluted air. SO_2 is also a major contributor to acid rain. The correct and complete reaction to represent acid rain caused by SO_2 is :

(A) $2\,SO_2 + O_2 \rightarrow 2\,SO_3$

(B) $SO_2 + O_3 \rightarrow SO_3 + O_2$

(C) $SO_2 + H_2O_2 \rightarrow H_2SO_4$

(D) $2\,SO_2 + O_2 + 2\,H_2O \rightarrow 2\,H_2SO_4$

Ans. (D)

Sol. $2SO_2 + O_2 + 2H_2O \rightarrow 2H_2SO_4$ (Acid rain)

13. Which of the following carbocations is most stable :

(A)

(B)

(C)

(D)

Ans. (D)

Sol.
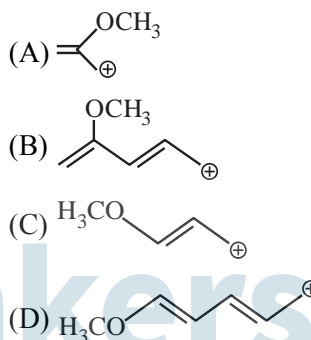
Is most stable carbocation

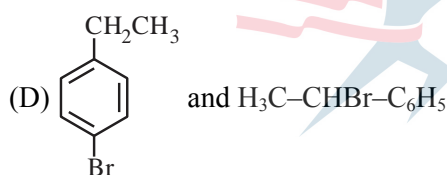**14.** $+ CH_3CH_2CH_2Cl \xrightarrow[\text{Major Product}]{\text{Anhydrous, } AlCl_3} \text{'A'}$

The stable carbocation formed in the above reaction is :

(A) $CH_3CH_2\overset{\oplus}{C}H_2$ (B) $CH_3\overset{\oplus}{C}H_2$

(C) $CH_3 - \overset{\oplus}{C}H - CH_3$ (D)

Ans. (C)
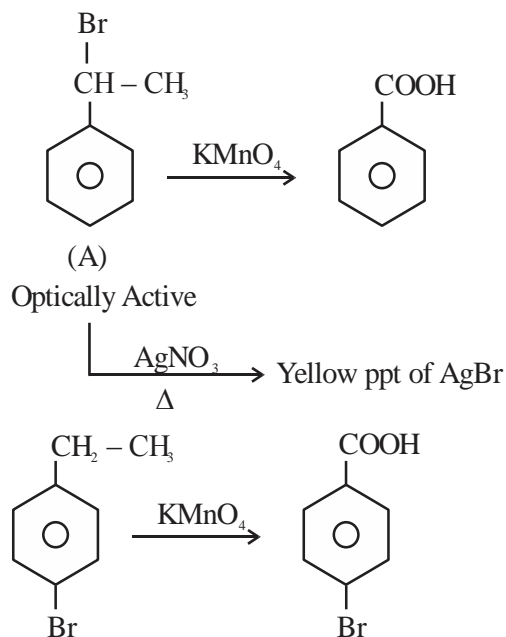
Sol. $CH_3-\overset{\oplus}{C}H-CH_3$ is formed in the above reaction

15. Two isomers (A) and (B) with Molar mass 184 g/mol and elemental composition C, 52.2%; H, 4.9% and Br 42.9% gave benzoic acid and p-bromobenzoic acid, respectively on oxidation with $KMnO_4$. Isomer 'A' is optically active and gives a pale yellow precipitate when warmed with alcoholic $AgNO_3$. Isomer 'A' and 'B' are, respectively :

(A) $H_3C–CHBr–C_6H_5$ and

(with CH_2Br, CH_3 substituents on benzene)

(B)

(CH_2Br, CH_3 substituents) and (CH_2CH_3, Br substituents)

(C) $H_3C–CHBr–C_6H_5$ and

(CH_2CH_3, Br substituents on benzene)

(D)

(CH_2CH_3, Br) and $H_3C–CHBr–C_6H_5$

Ans.   (C)

Sol.

(A)
Optically Active

$$\xrightarrow[\Delta]{AgNO_3} \text{Yellow ppt of AgBr}$$
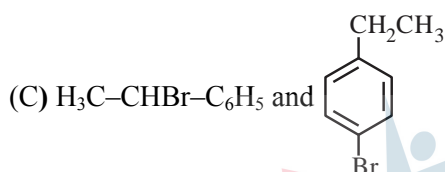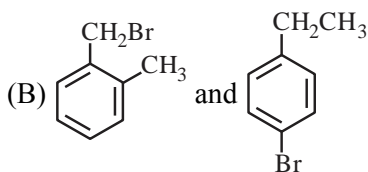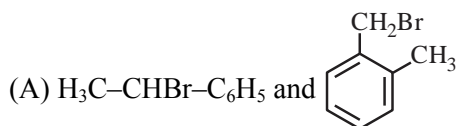
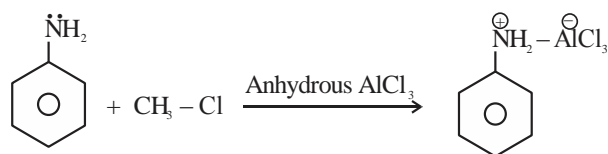**16.** In Friedel-Crafts alkylation of aniline, one gets :

(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.

Ans. (D)

Sol.

$$+ \; CH_3 – Cl \xrightarrow{\text{Anhydrous } AlCl_3}$$

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 **A** and **B** are correct and **R** is the correct explanation of **A**.

(B) Both **A** and **B** 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.

Ans. (A)

Sol.
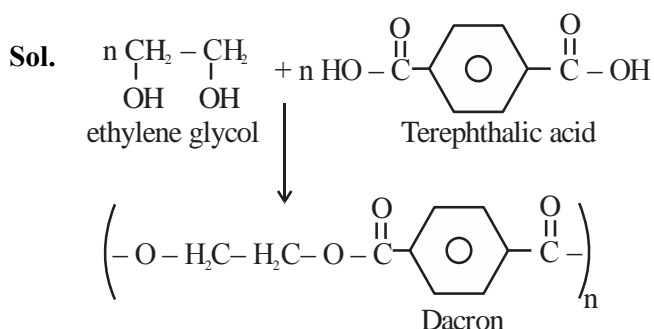
18. The structure of protein that is unaffected by heating is :

(A) secondary structure   (B) tertiary structure

(C) primary structure   (D) quaternary structure

Ans. (C)

Sol. Primary structure of protein is unaffected by physical 'or' chemical changes.

19. The mixture of chloroxylenol and terpineol is an example of :

(A) antiseptic   (B) pesticide

(C) disinfectant   (D) narcotic analgesic

Ans. (A)

Sol. Antiseptic Dettol is mixture of chloroxylenol and terpineol.

20. A white precipitate was formed when $BaCl_2$ 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) I^- (B) SO_3^{2-}

(C) S^{2-} (D) NO_2^-

Ans. (B)

Sol. $BaCl_2 + SO_3^{2-} \rightarrow \underset{\text{white}}{BaSO_3} \downarrow \xrightarrow{\text{dil.HCl}} \underset{\text{burning sulphur like smell}}{SO_2} \uparrow$

SECTION-B

1. A box contains 0.90 g of liquid water in equilibrium with water vapour at 27°C. The equilibrium vapour pressure of water at 27°C 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_____ litre. [nearest integer]

(Given: R = 0.082 L atm K^{-1} mol^{-1})

(Ignore the volume of the liquid water and assume water vapours behave as an ideal gas.)

Ans. (29)

Sol. $V = \dfrac{nRT}{P} = \dfrac{0.90 \times 0.82 \times 300 \times 760}{18 \times 32} = 29.21$

2. 2.2 g of nitrous oxide (N_2O) 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, ΔU is '–x' J. The value of 'x' is __.

[nearest integer]

(Given: atomic mass of N = 14 g mol^{-1} and of O = 16 g mol^{-1}.

Molar heat capacity of N_2O is 100 JK^{-1} mol^{-1})

Ans. (195)

Sol. $N_2O \text{ moles} = \dfrac{2.2}{44} = \dfrac{1}{20}$

$\Delta H = nC_p\Delta T = \dfrac{1}{20} \times 100(-40) = -200J$

$\Delta U = q_p + w$

$w = -P_{ext.}\Delta V$

$W = -1\dfrac{(167.75 - 217.1)}{1000} \times 101.3J$

$w = +5J$

$\Delta U = -200 + 5 = -195J$

3. Elevation in boiling point for 1.5 molal solution of glucose in water is 4K. The depression in freezing point for 4.5 molal solution of glucose in water is 4K. The ratio of molal elevation constant to molal depression constant (K_b/K_f) is_____.

Ans. (3)
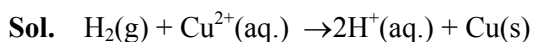
Sol. $\Delta T_b = iK_b m$

$\Delta T_f = iK_f m$

$\dfrac{4}{4} = \dfrac{K_b 1.5}{K_f 4.5}$

$\dfrac{K_b}{K_f} = 3$

4. The cell potential for the given cell at 298 K

Pt | H_2(g,1 bar) | H^+(aq) || Cu^{2+}(aq) | Cu(s)

is 0.31V. The pH of the acidic solution is found to be 3, whereas the concentration of Cu^{2+} is 10^{-x} M. The value of x is _____.

(Given: $E^{\ominus}_{Cu^{2+}/Cu} = 0.34$ V and $\dfrac{2.303RT}{F} = 0.06V$)

Ans. (7)

Sol. H_2(g) + Cu^{2+}(aq.) $\rightarrow$ $2H^+$(aq.) + Cu(s)

$0.31 = 0.34 - \dfrac{0.06}{2} \log \dfrac{[H^+]^2}{[Cu^{2+}]}$

$[Cu^{2+}] = 10^{-7} M$

x = 7

5. The equation

k = ($6.5 \times 10^{12}\, s^{-1}$) $e^{-26000K/T}$

is followed for the decomposition of compound A. The activation energy for the reaction is _____ kJ mol^{-1}. [nearest integer]

(Given: R = 8.314 J K^{-1} mol^{-1})

Ans. (216)
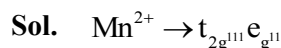
Sol. $K = Ae^{-Ea/RT} = (6.5 \times 10^{12}\, s^{-1})\, e^{-26000K/T}$

$\dfrac{Ea}{8.314} = 26000$

Ea = 216.164 kJ/mol.

6. Spin only magnetic moment of $[MnBr_6]^{4-}$ is_____ B.M. (round off to the closest integer)

Ans. (6)

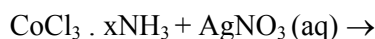**Sol.** $Mn^{2+} \rightarrow t_{2g^{111}} e_{g^{11}}$

$\mu_s = \sqrt{35}$

= 5.91

= 6

7. For the reaction given below:
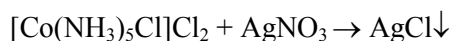
$CoCl_3 . xNH_3 + AgNO_3$ (aq) $\rightarrow$

If two equivalents of AgCl precipitate out, then the value of x will be _____.

Ans. (5)

Sol. $CoCl_3.xNH_3 + AgNO_3 \rightarrow AgCl\downarrow$

$\qquad\qquad\qquad\qquad$ 2 mol
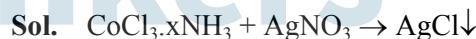
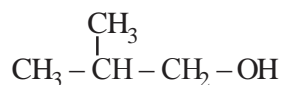$[Co(NH_3)_5Cl]Cl_2 + AgNO_3 \rightarrow AgCl\downarrow$

$\qquad\qquad\qquad\qquad$ 2 mol
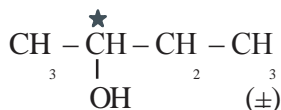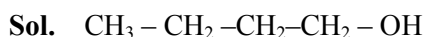
x = 5

8. The number of chiral alcohol(s) with molecular formula $C_4H_{10}O$ is_____.

Ans. (2)

Sol. $CH_3 - CH_2 - CH_2 - CH_2 - OH$

$\overset{\displaystyle \star}{CH_3 - \underset{\underset{\displaystyle OH}{|}}{CH} - CH_2 - CH_3}$ (±)

$CH_3 - \underset{\underset{\displaystyle CH_3}{|}}{CH} - CH_2 - OH$

$CH_3 - \underset{\underset{\displaystyle OH}{|}}{\overset{\overset{\displaystyle CH_3}{|}}{C}} - CH_3$
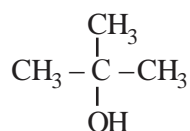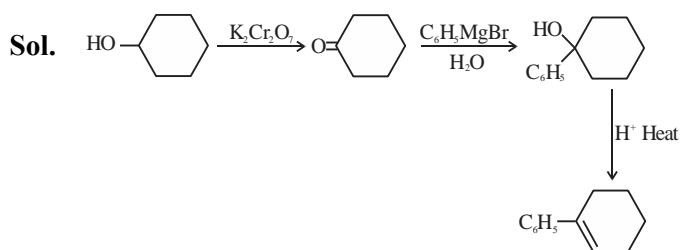
Out of which only two are chiral

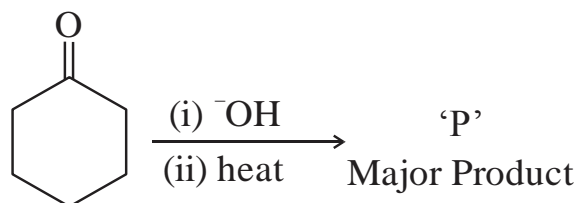**9.** In the given reaction
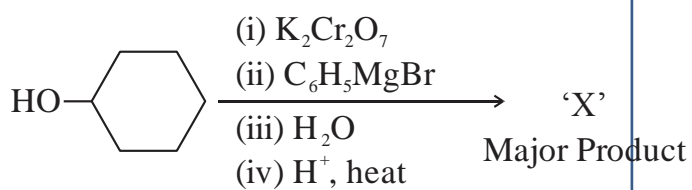
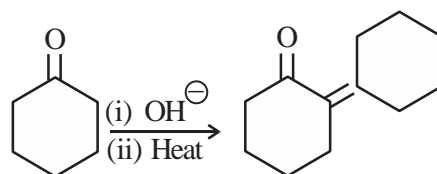the number of sp² hybridised carbon (s) in compound 'X' is_____.

Ans. (8)

Sol.

10. In the given reaction,

The number of π electrons present in the product 'P' is_____.

Ans. (4)

Sol.