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. Compound A contains 8.7% Hydrogen, 74% Carbon and 17.3% Nitrogen. The molecular formula of the compound is,

   Given : Atomic masses of C, H and N are 12, 1 and 14 amu respectively.

   The molar mass of the compound A is 162 g mol^{-1}.

   (A) $C_4H_6N_2$ (B) C_2H_3N

   (C) C_5H_7N (D) $C_{10}H_{14}N_2$

Answer (D)

Sol.

Element	%mass	Moles	Whole number ratio
C	74	6.17	5
H	8.7	8.7	7
N	17.3	1.236	1

Empirical Formula = C_5H_7N

Empirical formula mass = 81 g

$n \times 81 = 162$

$n = 2$

Hence molecular formula is $C_{10}H_{14}N_2$

2. Consider the following statements :

   (A) The principal quantum number 'n' is a positive integer with values of 'n' = 1, 2, 3, ….

   (B) The azimuthal quantum number 'l' for a given 'n' (principal quantum number) can have values as 'l' = 0, 1, 2, …n

   (C) Magnetic orbital quantum number 'm_l' for a particular 'l' (azimuthal quantum number) has (2l + 1) values.

   (D) ±1/2 are the two possible orientations of electron spin.

   (E) For l = 5, there will be a total of 9 orbital

   Which of the above statements are correct?

   (A) (A), (B) and (C)

   (B) (A), (C), (D) and (E)

   (C) (A), (C) and (D)

   (D) (A), (B), (C) and (D)

Answer (C)

Sol. Possible values of l for a given 'n' = 0,1,2 …(n – 1)

For l = 5, total orbitals = 2l + 1

= 2(5) + 1 = 11 orbital

Hence A, C and D are correct statements

3. In the structure of SF_4, the lone pair of electrons on S is in.

   (A) Equatorial position and there are two lone pair - bond pair repulsions at 90º

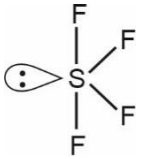
   (B) Equatorial position and there are three lone pair - bond pair repulsions at 90º

   (C) Axial position and there are three lone pair - bond pair repulsion at 90º

   (D) Axial position and there are two lone pair - bond pair repulsion at 90º

Answer (A)

Sol. $SF_4 \rightarrow sp^3d$ hybridisation.



The lone pair of electrons on S is in equatorial position and there are two lone pair-bond pair repulsions at 90°.

4. A student needs to prepare a buffer solution of propanoic acid and its sodium salt with pH 4.

The ratio of $\frac{[CH_3CH_2COO^-]}{[CH_3CH_2COOH]}$ required to make buffer is _____.

Given : $K_a(CH_3CH_2COOH) = 1.3 \times 10^{-5}$

(A) 0.03 (B) 0.13

(C) 0.23 (D) 0.33

Answer (B)

Sol. $CH_3CH_2COOH \rightleftharpoons CH_3CH_2COO^- + H^+$

From Henderson equation

$$pH = pK_a + \log\frac{[CH_3CH_2COO^-]}{[CH_3CH_2COOH]}$$

$$4 = -\log 1.3 \times 10^{-5} + \log\frac{[CH_3CH_2COO^-]}{[CH_3CH_2COOH]}$$

$$-\log 10^{-4} = -\log 1.3 \times 10^{-5} + \log\frac{[CH_3CH_2COO^-]}{[CH_3CH_2COOH]}$$

$$-\log 10^{-4} = -\log 1.3 \times 10^{-5}\frac{[CH_3CH_2COOH]}{[CH_3CH_2COO^-]}$$

$$10^{-4} = 1.3 \times 10^{-5}\frac{[CH_3CH_2COOH]}{[CH_3CH_2COO^-]}$$

$$\frac{[CH_3CH_2COO^-]}{[CH_3CH_2COOH]} = 0.13$$

5. Match List-I with List-II :

List-I	List-II
(A) Negatively charged sol	(I) $Fe_2O_3 \cdot xH_2O$
(B) Macromolecular colloid	(II) CdS sol
(C) Positively charged sol	(III) Starch
(D) Cheese	(IV) a gel

Choose the **correct** answer from the options given below:

(A) (A) – (II), (B) – (III), (C) – (IV), (D) – (I)

(B) (A) – (II), (B) – (I), (C) – (III), (D) – (IV)

(C) (A) – (II), (B) – (III), (C) – (I), (D) – (IV)

(D) (A) – (I), (B) – (III), (C) – (II), (D) – (IV)

Answer (C)

Sol. (A) Negatively charged sol CdS sol

(B) Macromolecular colloid Starch

(C) Positively charged sol $Fe_2O_3.xH_2O$

(D) Cheese A gel

6. Match **List-I** with **List-II:**

List-I(Oxide)	List-II (Nature)
(A) Cl_2O_7	(I) Amphoteric
(B) Na_2O	(II) Basic
(C) Al_2O_3	(III) Neutral
(D) N_2O	(IV) Acidic

Choose the correct answer from the options given below:

(1) A-IV, B-III, C-I, D-II (2)A-IV, B-II, C-I, D-III

(3) A-II, B-IV, C-III, D-I (4)A-I, B-II, C-III, D-IV

Answer (B)

Sol. (A) $Cl_2O_7 \rightarrow$ Acidic

(B) $Na_2O \rightarrow$ Basic

(C) $Al_2O_3 \rightarrow$ Amphoteric

(D) $N_2O \rightarrow$ Neutral

Oxides of metals are basic in nature whereas oxides of non metals are acidic in nature. N_2O is a neutral oxide.

7. In the metallurgical extraction of copper, following reaction is used :

$FeO + SiO_2 \rightarrow FeSiO_3$

FeO and $FeSiO_3$ respectively are.

(1) Gangue and flux (2) Flux and slag

(3) Slag and flux (4) Gangue and slag

Answer (D)

Sol. $FeO + SiO_2 \rightarrow FeSiO3$

Gangue Slag

8. Hydrogen has three isotopes: protium (^1H), deuterium (^2H or D) and tritium (^3H or T). They have nearly same chemical properties but different physical properties. They differ in

(1) Number of protons

(2) Atomic number

(3) Electronic configuration

(4) Atomic mass

Answer (D)

Sol. ^1H, ^2D and ^3H have same atomic number but their atomic masses are different.

Isotopes have same atomic number i.e. same number of protons

9. Among the following, basic oxide is:

(1) SO_3 (2) SiO_2

(3) CaO (4) Al_2O_3

Answer (C)

Sol. Since, oxides of metals are basic in nature. Hence CaO is a basic oxide

SO_3 and SiO_2 are acidic oxides and Al_2O_3 is a amphoteric oxide

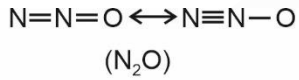
10. Among the given oxides of nitrogen ; N_2O, N_2O_3, N_2O_4 and N_2O_5, the number of compound/(s) having N – N bond is:

(1) 1 (2) 2

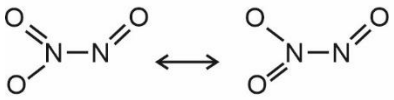
(3) 3 (4) 4

Answer (C)

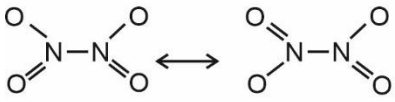
Sol.



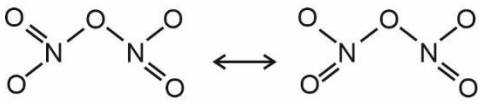
(N_2O)



(N_2O_3)



(N_2O_4)



(N_2O_5)

N_2O, N_2O_3 and N_2O_4 contain N — N bond

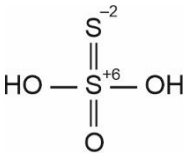
11. Which of the following oxoacids of sulphur contains ''S'' in two different oxidation states?

(A) $H_2S_2O_3$ (B) $H_2S_2O_6$

(C) $H_2S_2O_7$ (D) $H_2S_2O_8$

Answer (A)

Sol. In $H_2S_2O_3$, sulphur exhibits two different oxidation states +6 and –2.



12. Correct statement about photo-chemical smog is:

(A) It occurs in humid climate.

(B) It is a mixture of smoke, fog and SO_2.

(C) It is reducing smog.

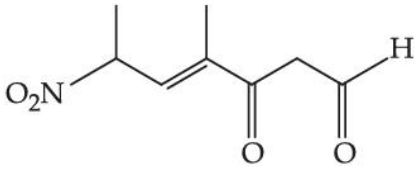
(D) It results from reaction of unsaturated hydrocarbons.

Answer (D)

Sol. Photochemical smog occurs in warm, dry and sunny climate. The main components of photochemical smog result from the action of unsaturated hydrocarbons and nitrogen oxides.

This is an oxidising smog.

13. The correct IUPAC name of the following compound is:



(A) 4-methyl-2-nitro-5-oxohept-3-enal

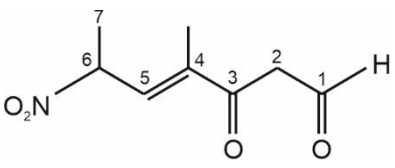
(B) 4-methyl-5-oxo-2-nitrohept-3-enal

(C) 4-methyl-6-nitro-3-oxohept-4-enal

(D) 6-formyl-4-methyl-2-nitrohex-3-enal

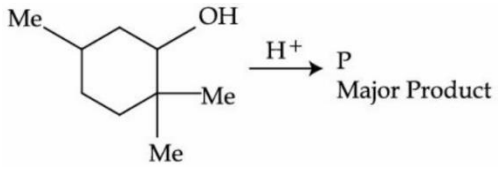
Answer (C)

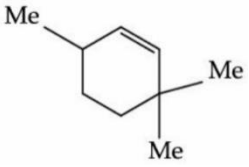
Sol.

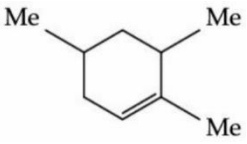


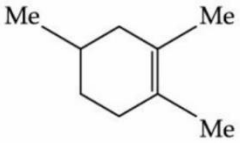
4-methyl-6-nitro-3-oxohept-4-enal

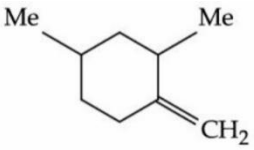
14. The major product (P) of the given reaction is (where, Me is $-CH_3$)



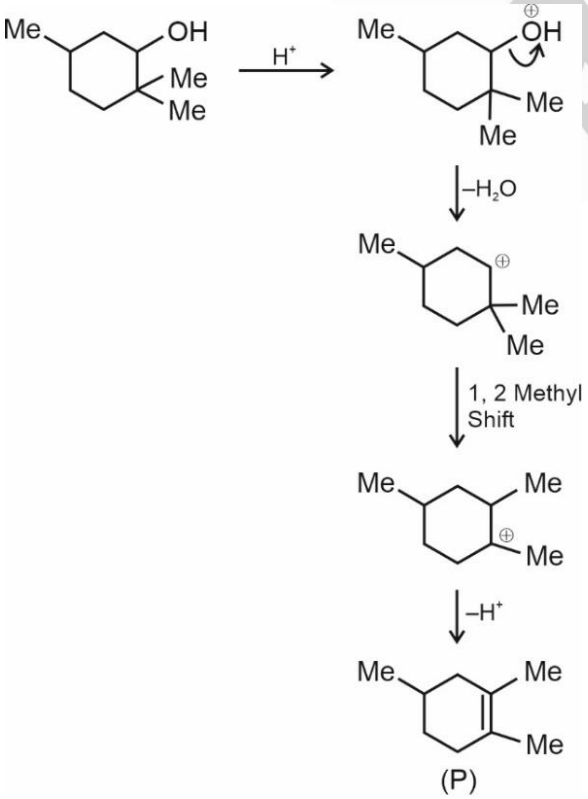
(A) 

(B) 

(C) 

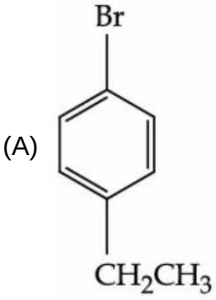
(D) 

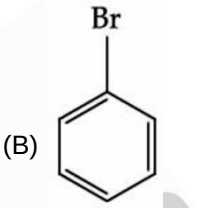
Answer (C)

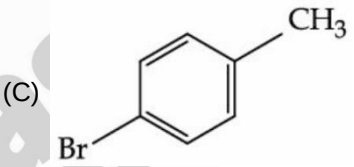
Sol. 

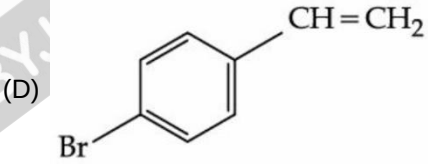
15. A $\xrightarrow[\text{(ii) } CN^-]{\text{(i) } Cl_2,\ \Delta}$ 4-Bromophenyl acetic acid.

In the above reaction 'A' is

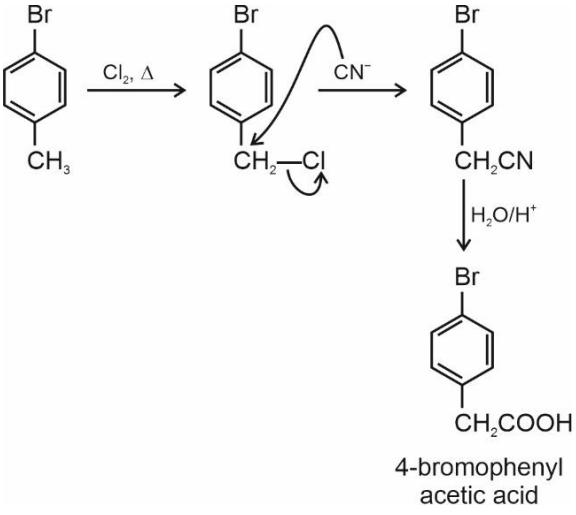
(A) 

(B) 

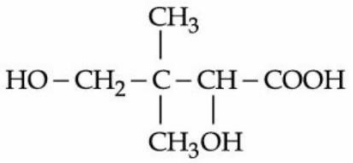
(C) 

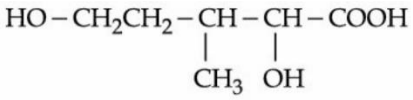
(D) 

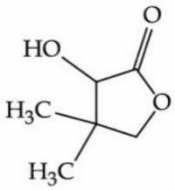
Answer (C)

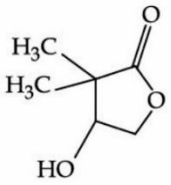
Sol. 

16. Isobutyraldehyde on reaction with formaldehyde and K_2CO_3 gives compound 'A'. Compound 'A' reacts with KCN and yields compound 'B', which on hydrolysis gives a stable compound 'C'. The compound 'C' is

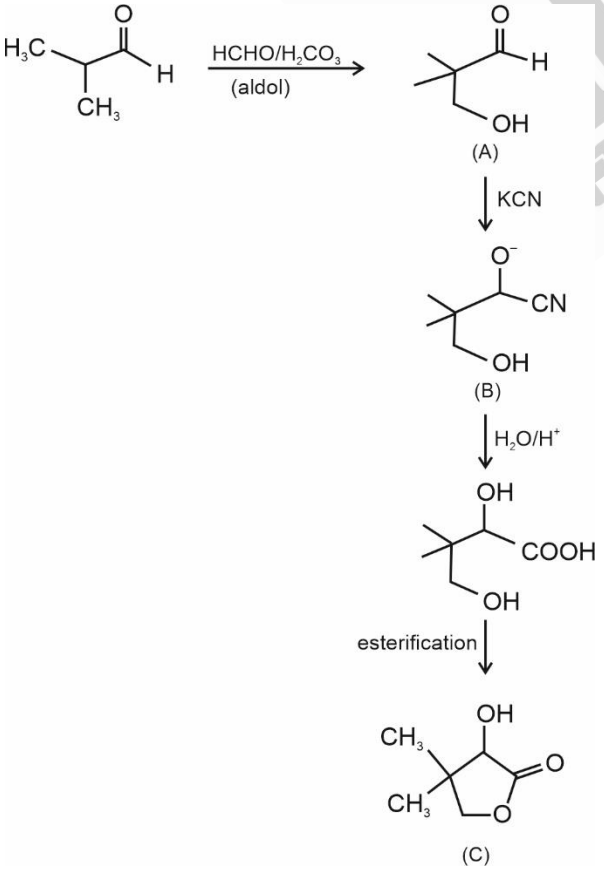
(A) 

(B) 

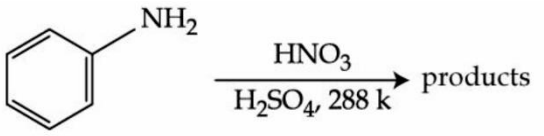
(C) 

(D) 

Answer (C)

Sol. 

17. With respect to the following reaction, consider the given statements:



(A) o-Nitroaniline and p-nitroaniline are the predominant products.

(B) p-Nitroaniline and m-nitroaniline are the predominant products.

(C) HNO_3 acts as an acid.

(D) H_2SO_4 acts as an acid.

Choose the **correct** option.

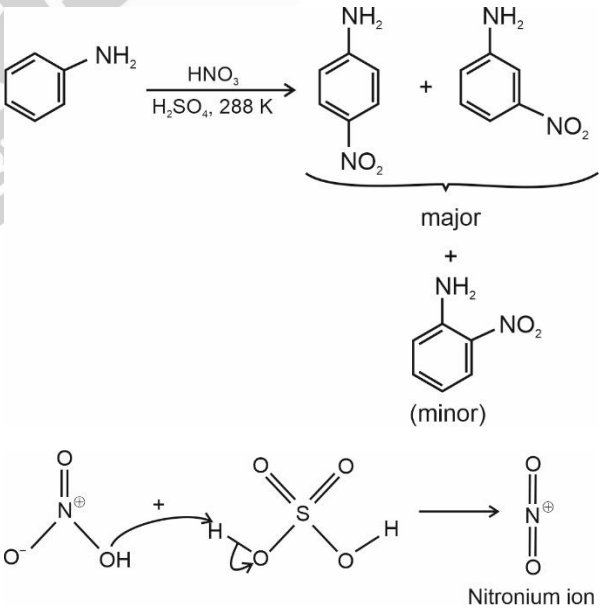
(A) (A) and (C) are correct statements.

(B) (A) and (D) are correct statements.

(C) (B) and (D) are correct statements.

(D) (B) and (C) are correct statements.

Answer (C)

Sol. 

Hence H_2SO_4 acts as an acid

18. Given below are two statements, one is **Assertion (A)** and other is **Reason (R)**.

Assertion (A): Natural rubber is a linear polymer of isoprene called *cis*-polyisoprene with elastic properties.

Reason (R): The *cis*-polyisoprene molecules consist of various chains held together by strong polar interactions with coiled structure.

In the light of the above statements, choose the **correct** one from the options given below:

(A) Both **(A)** and **(R)** are true and **(R)** is the correct explanation of **(A)**.

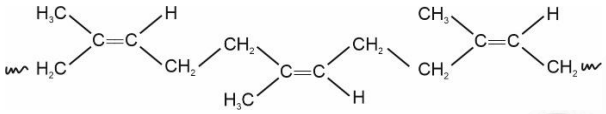
(B) Both **(A)** and **(R)** are true but **(R)** is not the correct explanation of **(A)**.

(C) **(A)** is true but **(R)** is false.

(D) **(A)** is false but **(R)** is true.

Answer (C)

Sol.



The cis-polyisoprene molecule consists of various chains held together by weak van der Waals interactions and has a coiled structure.

Hence assertion is true but reason is false.

19. When sugar 'X' is boiled with dilute H_2SO_4 in alcoholic solution, two isomers 'A' and 'B' are formed. 'A' on oxidation with HNO_3 yields saccharic acid whereas 'B' is laevorotatory. The compound 'X' is :

(A) Maltose

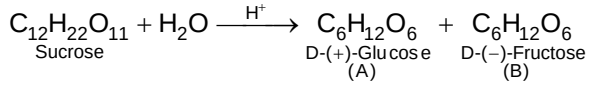
(B) Sucrose

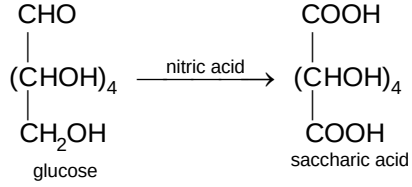
(C) Lactose

(D) Starch

Answer (B)

Sol.

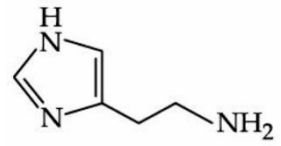




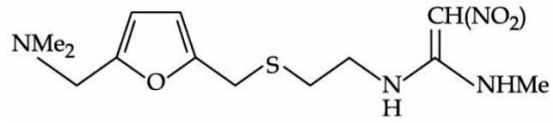
D-(–)-Fructose is a laevorotatory compound.

20. The drug tegamet is:

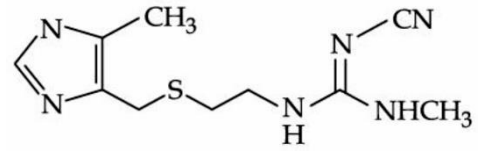
(A)



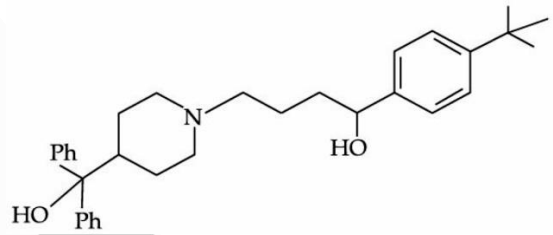
(B)



(C)

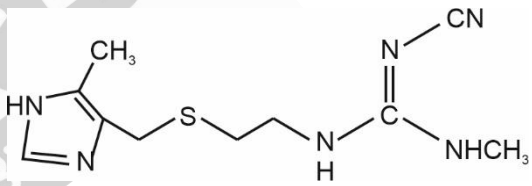


(D)



Answer (C)

Sol. Tegamet (cimetidine) is



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. 100 g of an ideal gas is kept in a cylinder of 416 L volume at 27°C under 1.5 bar pressure. The molar mass of the gas is _____ g mol^{-1}. (Nearest integer).

(Given : R = 0.083 L bar K^{-1} mol^{-1})

Answer (4)

Sol. From combined gas law,

$PV = nRT$

$PV = \frac{W}{M}RT$

$1.5 \times 416 = \frac{100}{M} \times 0.083 \times 300$

$M = 4$ g/mol

2. For combustion of one mole of magnesium in an open container at 300 K and 1 bar pressure, $\Delta_C H^{\ominus} = -601.70$ kJ mol^{-1}, the magnitude of change in internal energy for the reaction is _____ kJ. (Nearest integer)

(Given : R = 8.3 J K^{-1} mol^{-1})

Answer (600)

Sol. $Mg(s) + \frac{1}{2}O_2(g) \longrightarrow MgO(s)$

$\Delta H = \Delta U + \Delta ngRT$

$\Delta ng = -\frac{1}{2}$

$-601.70 = \Delta U - \frac{1}{2}(8.3)(300) \times 10^{-3}$

$\Delta U = -601.70 + 1.245$

$\Delta U \simeq -600$ kJ

Magnitude of change in internal energy is 600 kJ.

3. 2.5 g of protein containing only glycine ($C_2H_5NO_2$) is dissolved in water to make 500 mL of solution. The osmotic pressure of this solution at 300 K is found to be 5.03×10^{-3} bar. The total number of glycine units present in the protein is _____.

(Given : R = 0.083 L bar K^{-1} mol^{-1})

Answer (330)

Sol. Since,

$\pi = icRT$

$5.03 \times 10^{-3} = \frac{2.5}{M} \times \frac{1000}{500} \times 0.083 \times 300$

Molar mass of protein = 24751.5 g/mol

Number of glycine units in protein = $\frac{24751.5}{75}$

= 330

4. For the given reactions

$Sn^{2+} + 2e^- \rightarrow Sn$

$Sn^{4+} + 4e^- \rightarrow Sn$

the electrode potentials are; $E^o_{Sn^{2+}/Sn} = -0.140$ V and $E^o_{Sn^{4+}/Sn} = 0.010$ V. The magnitude of standard electrode potential for Sn^{4+} / Sn^{2+} i.e. $E^o_{Sn^{4+}/Sn^{2+}}$ is _____ $\times 10^{-2}$ V. (Nearest integer)

Answer (16)

Sol. $Sn \longrightarrow Sn^{2+} + 2e^-$ $\quad E^o_1 = 0.140$ V

$Sn^{4+} + 4e^- \longrightarrow Sn$ $\quad E^o_2 = 0.010$ V

$Sn^{4+} + 2e^- \longrightarrow Sn^{2+}$ $\quad E^o_{cell}$

$E^o_{cell} = \frac{n_2E^o_2 + n_1E^o_1}{n} = \frac{4(0.010) + 2(0.140)}{2}$

$E^o_{cell} = 0.16$ V $= 16 \times 10^{-2}$ V

5. A radioactive element has a half life of 200 days. The percentage of original activity remaining after 83 days is _____. (Nearest integer)

(Given : antilog 0.125 = 1.333,

antilog 0.693 = 4.93)

Answer (75)

Sol. $\lambda = \frac{2.303}{t}\log\frac{A_0}{A}$

$\frac{0.693}{200} = \frac{2.303}{83}\log\frac{A_0}{A}$

$\frac{A}{A_0} = 0.75$

Hence, percentage of original activity remaining after 83 days is 75%

6. $[Fe(CN)_6]^{4-}$

$[Fe(CN)_6]^{3-}$

$[Ti(CN)_6]^{3-}$

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

$[Co(CN)_6]^{3-}$

Among the given complexes, number of paramagnetic complexes is_____.

Answer (2)

Sol.

	Valence shell configuration	Magnetic nature
$[Fe(CN)_6]^{4-}$	$3d^6$ (Pairing)	Diamagnetic
$[Fe(CN)_6]^{3-}$	$3d^5$ (Pairing)	Paramagnetic
$[Ti(CN)_6]^{3-}$	$3d^1$	Paramagnetic
$[Ni(CN)_4]^{2-}$	$3d^8$ (Pairing)	Diamagnetic
$[Co(CN)_6]^{3-}$	$3d^6$ (Pairing)	Diamagnetic

7. (a) $CoCl_3 \cdot 4\ NH_3$, (b) $CoCl_3 \cdot 5NH_3$, (c) $CoCl_3.6NH_3$ and (d) $CoCl(NO_3)_2 \cdot 5NH_3$. Number of complex(es) which will exist in cis-trans form is/are_____.

Answer (1)

Sol. $CoCl_3 \cdot 4NH_3 \Rightarrow [Co(NH_3)_4Cl_2]Cl$

$CoCl_3 \cdot 5NH_3 \Rightarrow [Co(NH_3)_5Cl]Cl_2$

$CoCl_3 \cdot 6NH_3 \Rightarrow [Co(NH_3)_6]Cl_3$

Only $[Co(NH_3)_4Cl_2]$ can show geometrical isomerism. Hence can exist in cis-trans form.

8. The complete combustion of 0.492 g of an organic compound containing 'C', 'H' and 'O' gives 0.793 g of CO_2 and 0.442 g of H_2O. The percentage of oxygen composition in the organic compound is_____.[nearest integer]

Answer (46)

Sol. $C_xH_yO_z + O_2 \longrightarrow CO_2 + H_2O$

$$\text{weight of carbon} = \frac{0.793}{44} \times 12 = 0.216 \text{ g}$$

$$\text{weight of hydrogen} = \frac{0.442}{18} \times 2 = 0.05 \text{ g}$$

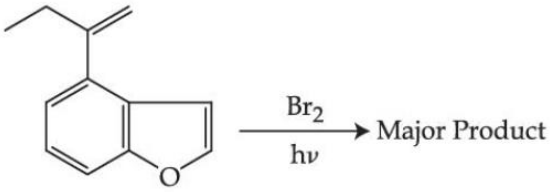
weight of oxygen = 0.492 – (0.216 + 0.05)

= 0.226 g

$$\text{\% by mass of oxygen in compound} = \frac{0.226}{0.492} \times 100$$

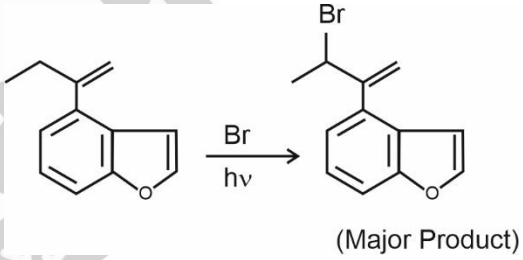
$$\simeq 46\%$$

9. The major product of the following reaction contains_____bromine atom(s).



Answer (1)

Sol.



(Major Product)

10. 0.01 M $KMnO_4$ solution was added to 20.0 mL of 0.05 M Mohr's salt solution through a burette. The initial reading of 50 mL burette is zero. The volume of $KMnO_4$ solution left in burette after the end point is _____ml. [nearest integer]

Answer (30)

Sol. Meq of oxidising agent = Meq of reducing agent

$$(M \times V \times n_F)_{KMnO_4} = (M \times V \times n_F)_{\text{Mohr's salt}}$$

$$0.01 \times 20 \times 5 = 0.05 \times V \times 1$$

Volume required = 20 ml

Since initial volume of $KMnO_4$ in burette is 50 ml. Hence volume of $KMnO_4$ left in the burette after end point is 30 ml.