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. The number of radial and angular nodes in 4d orbital are, respectively

(A) 1 and 2 (B) 3 and 2

(C) 1 and 0 (D) 2 and 1

Answer (A)

Sol. (i) In 4d $n = 4$ $l = 2$

Radial nodes $= n - l - 1$

$= 4 - 2 - 1$

$= 1$

Angular nodes $= l$

$= 2$

2. Match List I with List II

List I Enzyme		List II Conversion of	
A	Invertase	I	Starch into maltose
B	Zymase	II	Maltose into glucose
C	Diastase	III	Glucose into ethanol
D	Maltase	IV	Cane sugar into glucose

Choose the most appropriate answer from the options given below

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

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

Answer (C)

Sol. (A) Invertase $\rightarrow$ Cane sugar into glucose

(B) Zymase $\rightarrow$ Glucose into ethanol

(C) Diastase $\rightarrow$ Starch into maltose

(D) Maltase $\rightarrow$ Maltose into glucose

3. Which of the following elements is considered as a metalloid?

(A) Sc (B) Pb

(C) Bi (D) Te

Answer (D)

Sol. Tellurium is metalloid

4. The role of depressants in 'Froth Floation method' is to

(A) Selectively prevent one component of the ore from coming to the froth

(B) Reduce the consumption of oil for froth formation

(C) Stabilize the froth

(D) Enhance non-wettability of the mineral particles.

Answer (A)

Sol. The role of depressants is to selectively prevent one component of the ore from coming to froth.

5. Boiling of hard water is helpful in removing the temporary hardness by converting calcium hydrogen carbonate and magnesium hydrogen carbonate to

(A) $CaCO_3$ and $Mg(OH)_2$

(B) $CaCO_3$ and $MgCO_3$

(C) $Ca(OH)_2$ and $MgCO_3$

(D) $Ca(OH)_2$ and $Mg(OH)_2$

Answer (A)

Sol. $Ca(HCO_3)_2 \xrightarrow{\Delta} CaCO_3 \downarrow + H_2O + CO_2 \uparrow$

$Mg(HCO_3)_2 \xrightarrow{\Delta} Mg(OH)_2 + 2CO_2 \uparrow$

6. s-block element which **cannot** be qualitatively confirmed by the flame test is

(1) Li (2) Na

(3) Rb (4) Be

Answer (D)

Sol. Beryllium does not give flame test because of its small size and high ionization energy the energy of flame is not sufficient to excite the electrons to higher energy level

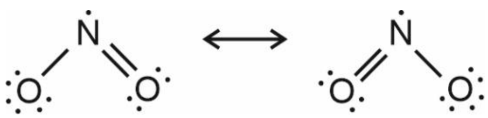
7. The oxide which contains an odd electron at the nitrogen atom is

(A) N_2O (B) NO_2

(C) N_2O_3 (D) N_2O_5

Answer (B)

Sol. The oxide of nitrogen which contains odd electron is NO_2



8. Which one of the following is an example of disproportionation reaction?

(A) $3MnO_4^{2-} + 4H^+ \rightarrow 2MnO_4^- + MnO_2 + 2H_2O$

(B) $MnO_4^- + 4H^+ + 4e^- \rightarrow MnO_2 + 2H_2O$

(C) $10I^- + 2MnO_4^- + 16H^+ \rightarrow 2Mn^{2+} + 8H_2O + 5I_2$

(D) $8MnO_4^- + 3S_2O_3^{2-} + H2O \rightarrow 8MnO_2 + 6SO_4^{2-} + 2OH^-$

Answer (A)

Sol. $\overset{+6}{Mn}O_4^{-2} \rightarrow \overset{+7}{Mn}O_4^-$

$\overset{+6}{Mn}O_4^{-2} \rightarrow \overset{+4}{Mn}O_2$

MnO_4^{-2} is an intermediate oxidation state and is converted into compounds having higher and lower oxidation states.

9. The most common oxidation state of Lanthanoid elements is +3. Which of the following is likely to deviate easily from +3 oxidation state?

(1) Ce(At. No. 58)

(2) La (At. No. 57)

(3) Lu (At. No. 71)

(4) Gd(At. No. 64)

Answer (A)

Sol. $Ce \rightarrow [Xe]4f^1\ 5d^1\ 6s^2$

$Ce^{+4} \rightarrow [xe]\ 4f^\circ\ 5d^\circ\ 6s^\circ$

Cerium in +4 oxidation state acquires inert gas configuration.

10. The measured BOD values for four different water samples (A-D) are as follows:

A = 3 ppm; B = 18 ppm; C = 21 ppm; D = 4 ppm;. The water samples which can be called as highly polluted with organic wastes, are

(A) A and B (B) A and D

(C) B and C (D) B and D

Answer (C)

Highly polluted water should have BOD value of 17 ppm or more

11. The correct order of nucleophilicity is

(A) $F^- > OH^-$ (B) $H_2\ddot{\underset{\cdot\cdot}{O}} > OH^-$

(C) $R\ddot{\underset{\cdot\cdot}{O}}H > RO^-$ (D) $NH_2^- > NH_3$

Answer (D)

Sol. $\underset{\text{Acid}}{NH_3} \longrightarrow \underset{\text{Conjugate base}}{NH_2^-} + H^+$

Conjugate base of acid is always a stronger nucleophile.

12. Oxidation of toluene to benzaldehyde can be easily carried out with which of the following reagents?

(A) CrO_3/acetic acid, H_3O^+

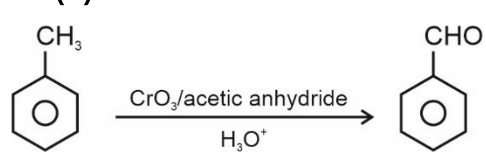
(B) CrO_3/acetic anhydride, H_3O^+

(C) $KMnO_4$/HCl, H_3O^+

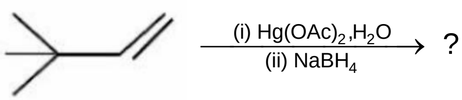
(D) CO/HCl, anhydrous $AlCl_3$

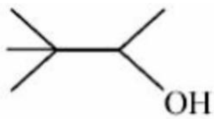
Answer (B)

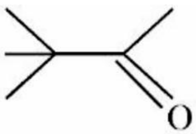
Sol.

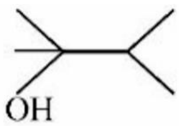


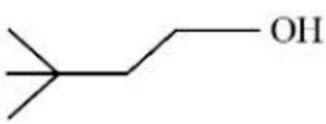
13. The major product in the following reaction



(A) 

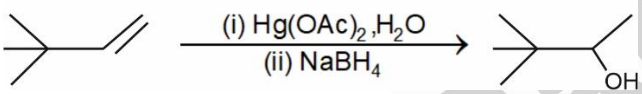
(B) 

(C) 

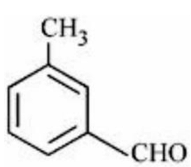
(D) 

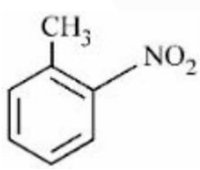
Answer (A)

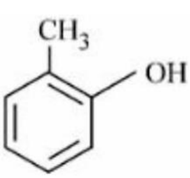
Sol. Oxymercuration-demercuration follows Markovnikov's addition of water without rearrangement.

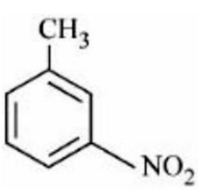


14. Halogenation of which one of the following will yield m-substituted product with respect to methyl group as a major product?

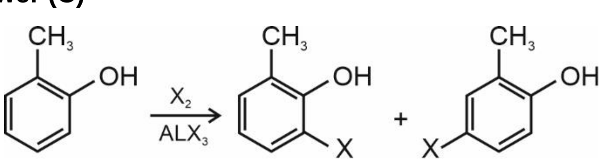
(A) 

(B) 

(C) 

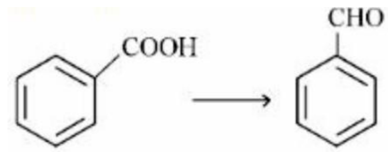
(D) 

Answer (C)

Sol. 

Both products are meta with respect to $-CH_3$.

15. The reagent, from the following, which converts benzoic acid to benzaldehyde in one step is



(A) $LiAlH_4$ (B) $KMnO_4$

(C) MnO (D) $NaBH_4$

Answer (C)

Sol. Benzoic acid can be converted to benzaldehyde in presence of MnO.

16. The final product 'A' in the following reaction sequence

$$CH_3CH_2-\underset{\underset{O}{||}}{C}-CH_3 \xrightarrow{HCN} ? \xrightarrow[\text{Heat}]{95\%H_2SO_4} A$$

(A) $CH_3-CH=\overset{\overset{CH_3}{|}}{C}-COOH$

(B) $CH_3-CH=\underset{\underset{CH_3}{|}}{C}-CN$

(C) $CH_3-CH_2-\overset{\overset{OH}{|}}{\underset{\underset{CH_3}{|}}{C}}-COOH$

(D) $CH_3-CH=\underset{\underset{CH_3}{|}}{C}-CONH_2$

Answer (A)

Sol.

$$CH_3-CH_2-\overset{\overset{O}{||}}{C}-CH_3 \xrightarrow{HCN}$$

$$CH_3-CH_2-\overset{\overset{OH}{|}}{\underset{\underset{CN}{|}}{C}}-CH_3$$

$$\Big\downarrow \frac{95\%H_2SO_4}{\Delta}$$

$$CH_3-CH=\overset{\overset{CH_3}{|}}{C}-COOH$$

[A]

17. Which statement is NOT correct for p-toluenesulphonyl chloride?

(A) It is known as Hinsberg's reagent

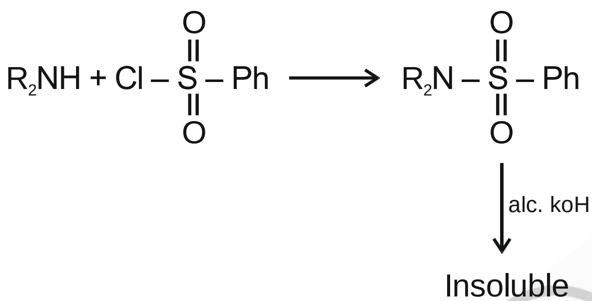
(B) It is used to distinguish primary and secondary amines

(C) On treatment with secondary amine, it leads to a product, that is soluble in alkali

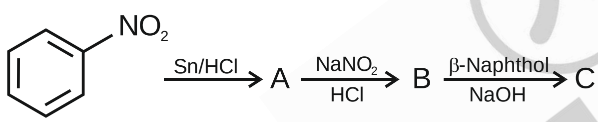
(D) It doesn't react with tertiary amines

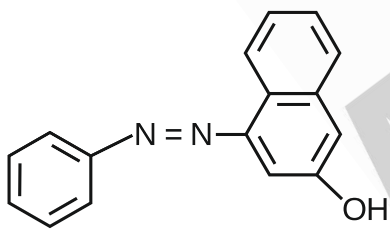
Answer (C)

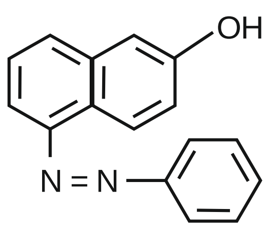
Sol.

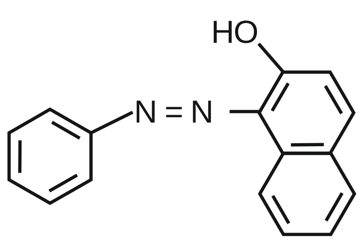


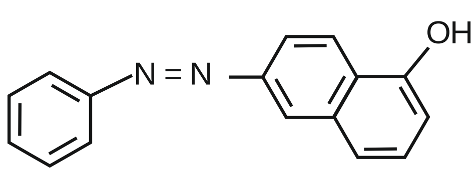
18. The final product 'C' in the following series of reactions



(A) 

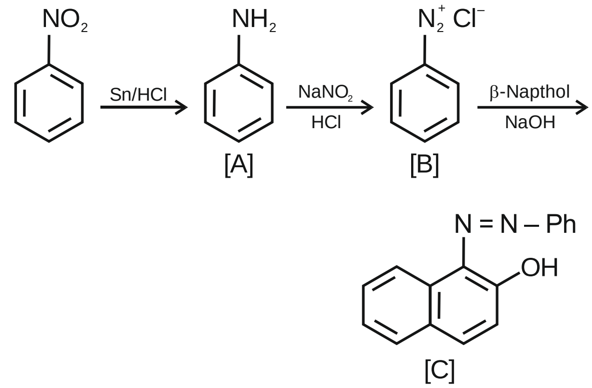
(B) 

(C) 

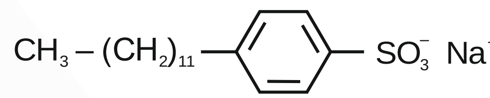
(D) 

Answer (C)

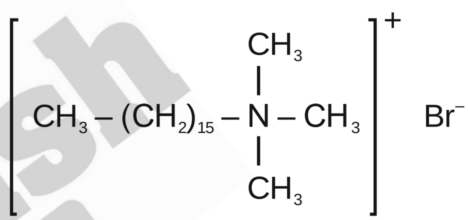
Sol.



19. Which of the following is NOT an example of synthetic detergent?

(A) 

(B) $CH_3 – (CH_2)_{16} – COO^– Na^+$

(C) 

(D) $CH_3(CH_2)_{16}COO(CH_2CH_2O)nCH_2CH_2OH$

Answer (B)

Sol. $CH_3 – (CH_2)_{16} – COO^– Na^+$

Sodium stearate is example of soap.

20. Which one of the following is a water soluble vitamin, that is not excreted easily?

(A) Vitamin B_2 (B) Vitamin B_1

(C) Vitamin B_6 (D) Vitamin B_{12}

Answer (D)

Sol. Vitamin B_{12} is water soluble and not excreted easily.

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. CNG is an important transportation fuel. When 100 g CNG is mixed with 208 g oxygen in vehicles, it leads to the formation of CO_2 and H_2O and produced large quantity of heat during this combustion, then the amount of carbon dioxide, produced in grams is _____. [nearest integer]

[Assume CNG to be methane]

Answer (143)

Sol. $CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$

wt. of $CH_4 = 100$ g

wt. of $O_2 = 208$ g $\qquad n_{O_2} = \frac{208}{32}$

In this reaction O_2 is limiting reagent

2 moles of $O_2 \longrightarrow$ 1 mole of CO_2

1 mole of $O_2 \longrightarrow \frac{1}{2}$ mole of CO_2

$\frac{208}{32}$ mole of $O_2 \longrightarrow \frac{208}{32}\times\frac{1}{2}$ mole of CO_2

$\longrightarrow \frac{208}{32}\times\frac{1}{2}\times 44$ gm of CO_2

$\longrightarrow$ 143 gm of CO_2

2. In a solid AB, A atoms are in ccp arrangement and B atoms occupy all the octahedral sites. If two atoms from the opposite faces are removed, then the resultant stoichiometry of the compound is A_xB_y. The value of x is _____. [nearest integer]

Answer (3)

Sol. A atoms are in CCP contribution of A is

A = 4

If atoms from opposite faces are removed

then $\quad A = 4 - x\times\frac{1}{x}$

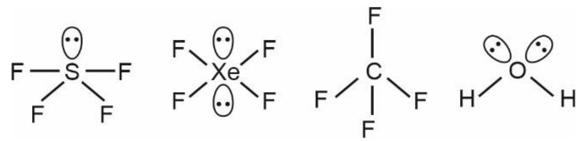
A = 3

Value of x = 3

3. Amongst SF_4, XeF_4, CF_4 and H_2O, the number of species with two lone pair of electrons is _____.

Answer (2)

Sol.



XeF_4 and H_2O have 2 lone pairs.

4. A fish swimming in water body when taken out from the water body is covered with a film of water of weight 36 g. When it is subjected to cooking at 100 °C, then the internal energy for vaporization in kJ mol^{-1} is ________. [nearest integer]

[Assume steam to be an ideal gas. Given $\Delta_{vap}H^\ominus$ for water at 373 K and 1 bar is 41.1 kJ mol^{-1}; R = 8.31 J K^{-1} mol^{-1}]

Answer (38)

Sol. $\underset{36\,g}{H_2O(\ell)} \longrightarrow \underset{36\,g}{H_2O(g)}$ (evaporation)

$n_{H_2O} = \frac{36}{18} = 2 \qquad \Delta n_g = 1 - 0 = 1$

$\Delta U_{vap} = \Delta H_{vap} - \Delta n_g RT$

$= 41.1 - (1) \times 8.31 \times 10^{-3} \times 373$

$= 41.1 - 3.099$

$= 38$ kJ/mol

5. The osmotic pressure exerted by a solution prepared by dissolving 2.0 g of protein of molar mass 60 kg mol^{-1} in 200 mL of water at 27°C is _________ Pa. [Integer value]

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

Answer (415)

Sol. π = i CRT $\qquad$ (i = 1)

$\pi = \frac{2\times1000}{60\times10^3\times200}\times.083\times300$

π = .00415 atm

π = 415 Pa

6. 40% of HI undergoes decomposition to H_2 and I_2 at 300 K. ΔG^o for this decomposition reaction at one atmosphere pressure is _____ J mol^{-1}. [nearest integer]

(Use R = 8.31 J K^{-1} mol^{-1}; log 2 = 0.3010, ln 10 = 2.3, log 3 = 0.477)

Answer (2735)

Sol. $HI \rightleftharpoons \frac{1}{2}H_2 + \frac{1}{2}I_2$

$1 \quad 0 \quad 0$

$1-\alpha \quad \alpha/2 \quad \alpha/2$

$\Delta G° = -RT\ln K$

$= -RT\ln\frac{\left(\frac{\alpha}{2}\right)^{1/2}\left(\frac{\alpha}{2}\right)^{1/2}}{1-\alpha}$

$= -RT\ln\frac{\alpha}{2(1-\alpha)} \qquad (\alpha = 0.4)$

$= -8.314\times 300\ln\frac{0.4}{2\times 0.6}$

$= +8.314\times 300\ \ln 3$

$= 2735\ J/mol.$

7. $Cu(s) + Sn^{2+}(0.001M) \rightarrow Cu^{2+}(0.01\,M) + Sn(s)$

The Gibbs free energy change for the above reaction at 298 K is x × 10^{-1}kJ mol^{-1}. The value of x is _______.[nearest integer]

[Given

$E^{\ominus}_{Cu^{2+}/Cu} = 0.34V; E^{\ominus}_{Sn^{2+}/Sn} = -0.14\,V; F = 96500\,C\ mol^{-1}$]

Answer (983)

Sol. $Cu + Sn^{+2} \longrightarrow Cu^{+2} + Sn(s)$

$E^{\circ}_{cell} = E^{\circ}_{OX} + E^{\circ}_{Red}$

$= -0.34 - 0.14$

$= -0.48\ V$

$E = E^{\circ} - \frac{0.0591}{2}\log\frac{[Cu^{+2}]}{[Sn^{+2}]}$

$= -0.48 - 0.0295\ \log 10$

$= -0.5095\ V$

$\Delta G = -nFE$

$= -2\times 96500\times -0.5095\ J/mol$

$= 98333.5\times 10^{-3}\ kJ/mol$

$= 983.3\times 10^{-1}\ kJ/mol$

$= 983\times 10^{-1}\ kJ/mol$

8. Catalyst A reduces the activation energy for a reaction by 10 kJ mol^{-1} at 300 K. The ratio of rate constants, $\frac{K', \text{Catalysed}}{K, \text{Uncatalysed}}$ is e^x. The value of x is ____.[nearest integer]

[Assume that the pre-exponential factor is same in both the cases Given R = 8.31 J K^{-1} mol^{-1}]

Answer (4)

Sol. $\ln\frac{K'}{K} = \frac{Ea - Ea'}{RT}$

$= \frac{10\times 10^3}{8.314\times 300}$

$\ln\frac{K'}{K} = \frac{100}{8.314\times 3}$

$\frac{K'}{K} = e^4$

$x = 4$

9. Reaction of $[Co(H_2O)_6]^{2+}$ with excess ammonia and in the presence of oxygen results into a diamagnetic product. Number of electrons present in t_{2g}-orbitals of the product is _______.

Answer (6)

Sol. $[Co(H_2O)_6]^{+2} \xrightarrow[O_2]{NH_3} [Co(NH_3)_6]^{+3} + e^-$

$Co^{+3} \longrightarrow 3d^6$

NH_3 is a strong field ligand.

$3d^6 \longrightarrow t_{2g}^6\ eg^{\circ}$

10. The moles of methane required to produce 81 g of water after complete combustion is _____ × 10^{-2} mol. [nearest integer]

Answer (225)

Sol. $CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$

$1\,mol\ CH_4 \longrightarrow 2\ mole\ H_2O$

$36\,gm\ H_2O \longrightarrow 1\,mole\ CH_4$

$81\,gm\ H_2O \longrightarrow \frac{1}{36}\times 81\,mole\ CH_4$

$\longrightarrow 2.25\ mole$

$\longrightarrow 225\times 10^{-2}$