FINAL JEE–MAIN EXAMINATION – MARCH, 2021

(Held On Wednesday 17th March, 2021) TIME : 9 : 00 AM to 12 : 00 NOON

CHEMISTRY

TEST PAPER WITH ANSWER & SOLUTION

SECTION-A

1. With respect to drug-enzyme interaction, identify the wrong statement:

(1) Non-Competitive inhibitor binds to the allosteric site

(2) Allosteric inhibitor changes the enzyme's active site

(3) Allosteric inhibitor competes with the enzyme's active site

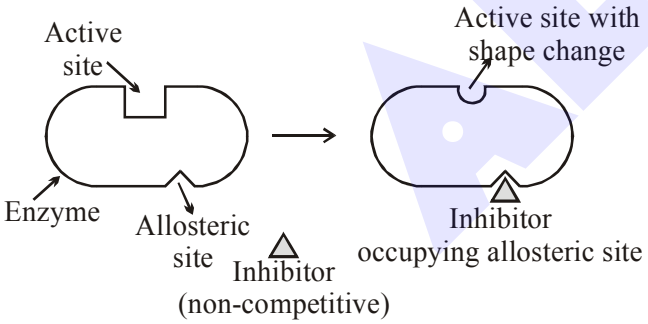
(4) Competitive inhibitor binds to the enzyme's active site

Official Ans. by NTA (3)

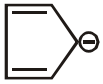
Sol. Some durg do not bind to the Enzyme's active site. These bind to a different site of enzyme which called **allosteric site**.

This binding of inhibitor at allosteric site changes the shape of the active site in such a way that substrate can not recognise it.

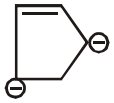
Such inhibitor is known as **Non-competitive inhibitor**.



2. Which of the following is an aromatic compound?

(1) 

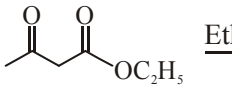
(2) 

(3) 

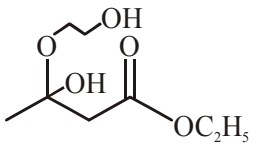
(4) 

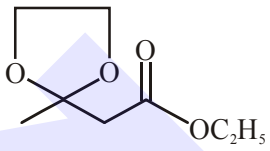
Official Ans. by NTA (1)

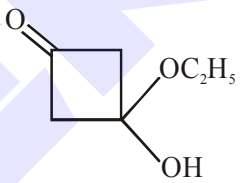
Sol.  → Aromatic compound

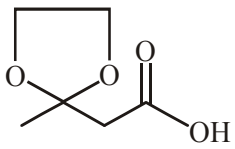
3. 

The product "A" in the above reaction is:

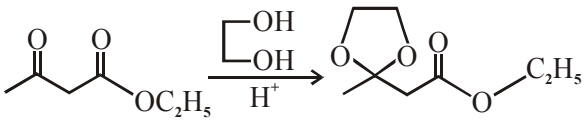
(1) 

(2) 

(3) 

(4) 

Official Ans. by NTA (2)

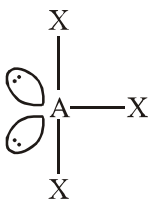
Sol. 

4. A central atom in a molecule has two lone pairs of electrons and forms three single bonds. The shape of this molecule is:

(1) see-saw (2) planar triangular

(3) T-shaped (4) trigonal pyramidal

Official Ans. by NTA (3)

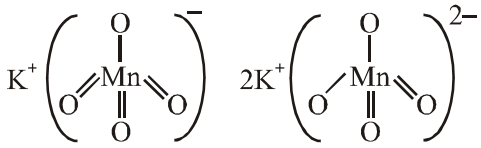
Sol. 

sp^3d hybridised

T-shaped

5. Given below are two statements:
Statement I : Potassium permanganate on heating at 573 K forms potassium manganate.
Statement II : Both potassium permanganate and potassium manganate are tetrahedral and paramagnetic in nature.
In the light of the above statements, choose the most appropriate answer from the options given below:
(1) Statement I is true but statement II is false
(2) Both statement I and statement II are true
(3) Statement I is false but statement II is true
(4) Both statement I and statement II are false
Official Ans. by NTA (1)

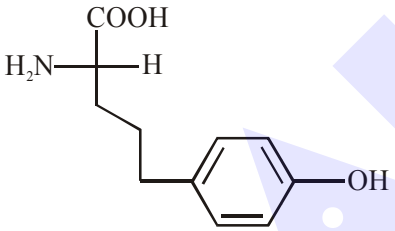
Sol. $2KMnO_4 \xrightarrow{573K} K_2MnO_4 + MnO_2 + O_2$
Potassium permanganate — Potassium manganate

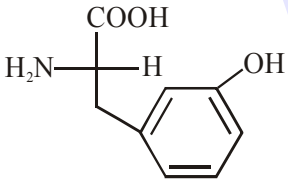


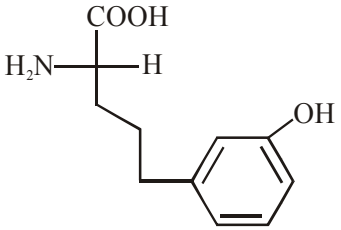
Tetrahedral unit diamagnetic — Tetrahedral unit paramagnetic

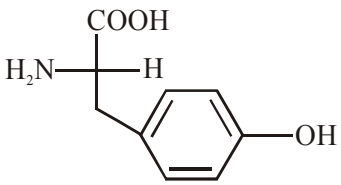
Statement-I is correct.
Statement-II is incorrect.

6. Which of the following is correct structure of tyrosine?

(1) 

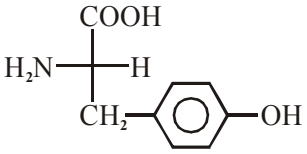
(2) 

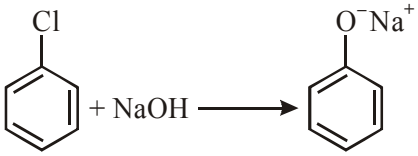
(3) 

(4) 

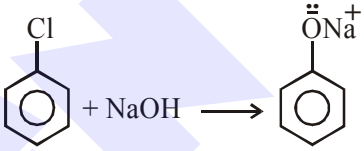
Official Ans. by NTA (4)

Sol. The structure of Tyrosine amino acid is



7. 

The above reaction requires which of the following reaction conditions?
(1) 573 K, Cu, 300 atm
(2) 623 K, Cu, 300 atm
(3) 573 K, 300 atm
(4) 623 K, 300 atm
Official Ans. by NTA (4)

Sol.  Dow process

Temperature = 623 K
Pressure = 300 atm

8. The absolute value of the electron gain enthalpy of halogens satisfies:
(1) I > Br > Cl > F (2) Cl > Br > F > I
(3) Cl > F > Br > I (4) F > Cl > Br > I
Official Ans. by NTA (3)

Sol. Order of electron gain enthalpy (Absolute value)
Cl > F > Br > I

9. Which of the following compound CANNOT act as a Lewis base?
(1) NF_3 (2) PCl_5 (3) SF_4 (4) ClF_3
Official Ans. by NTA (2)

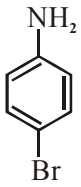
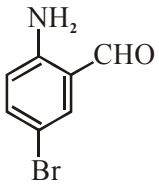
Sol. Lewis base : Chemical species which has capability to donate electron pair.
In NF_3, SF_4, ClF_3 central atom (i.e. N, S, Cl) having lone pair therefore act as lewis base.

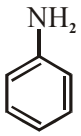
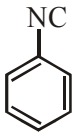
In PCl_5 central atom (P) does not have lone pair therefore does not act as lewis base.

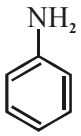
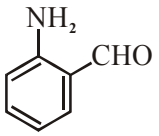
10. Reducing smog is a mixture of:
(1) Smoke, fog and O_3
(2) Smoke, fog and SO_2
(3) Smoke, fog and CH_2=CH–CHO
(4) Smoke, fog and N_2O_3
Official Ans. by NTA (2)

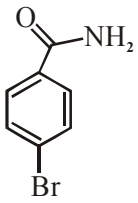
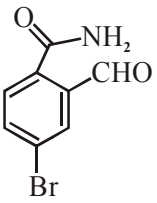
Sol. Reducing or classical smog is the combination of smoke, fog and SO_2.

11. Hoffmann bromomide degradation of benzamide gives product A, which upon heating with $CHCl_3$ and NaOH gives product B. The structures of A and B are :

(1) A -  B - 

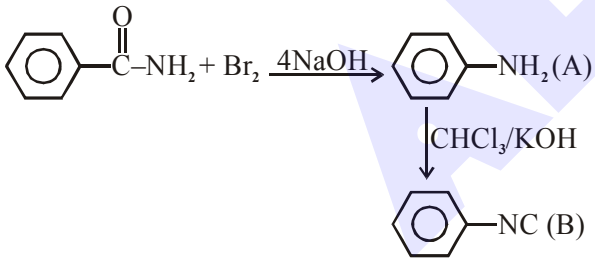
(2) A -  B - 

(3) A -  B - 

(4) A -  B - 

Official Ans. by NTA (2)

Sol. Hoffmann bromamide degradation reaction :



Carbylamine reaction :

12. Mesityl oxide is a common name of :

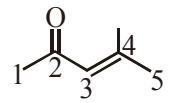
(1) 2,4-Dimethyl pentan-3-one

(2) 3-Methyl cyclohexane carbaldehyde

(3) 2-Methyl cyclohexanone

(4) 4-Methyl pent-3-en-2-one

Official Ans. by NTA (4)

Sol. 

Mesityloxide

IUPAC [4-Methylpent-3-en-2-one]

13. Which of the following reaction is an example of ammonolysis?

(1) $C_6H_5COCl + C_6H_5NH_2 \longrightarrow C_6H_5CONHC_6H_5$

(2) $C_6H_5CH_2CN \xrightarrow{[H]} C_6H_5CH_2CH_2NH_2$

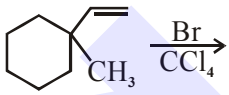
(3) $C_6H_5NH_2 \xrightarrow{HCl} C_6H_5\overset{+}{N}H_3Cl^-$

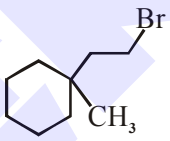
(4) $C_6H_5CH_2Cl + NH_3 \longrightarrow C_6H_5CH_2NH_2$

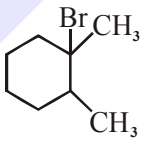
Official Ans. by NTA (4)

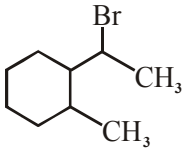
Sol. The process of cleavage of the C–X bond by Ammonia molecule is known as ammonolysis.

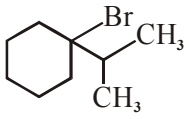
Ex : $R{-}CH_2{-}Cl + \ddot{N}H_3 \longrightarrow R{-}CH_2{-}NH_2$

14.  A (Major product)

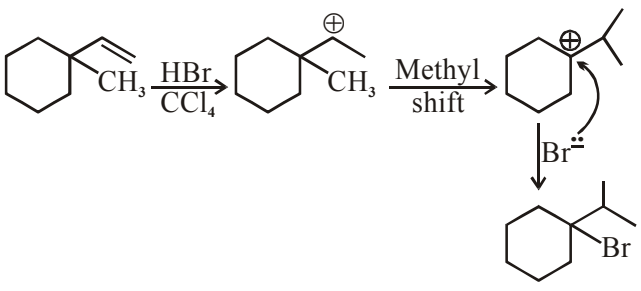
(1) 

(2) 

(3) 

(4) 

Official Ans. by NTA (4)

Sol. 

15. A colloidal system consisting of a gas dispersed in a solid is called a/an :

(1) solid sol (2) gel

(3) aerosol (4) foam

Official Ans. by NTA (1)

Sol. Colloid of gas dispersed in solid is called solid sol.

16. The INCORRECT statement(s) about heavy water is (are)

(A) used as a moderator in nuclear reactor

(B) obtained as a by-product in fertilizer industry.

(C) used for the study of reaction mechanism

(D) has a higher dielectric constant than water

Choose the correct answer from the options given below :

(1) (B) only (2) (C) only

(3) (D) only (4) (B) and (D) only

Official Ans. by NTA (3)

Sol. The dielectric constant of H_2O is greater than heavy water.

17. The correct order of conductivity of ions in water is :

(1) $Na^+ > K^+ > Rb^+ > Cs^+$

(2) $Cs^+ > Rb^+ > K^+ > Na^+$

(3) $K^+ > Na^+ > Cs^+ > Rb^+$

(4) $Rb^+ > Na^+ > K^+ > Li^+$

Official Ans. by NTA (2)

Sol. $Li^+ \; Na^+ \; K^+ \; Rb^+ \; Cs^+$

$\longrightarrow$ Hydration energy $\uparrow$

$\longrightarrow$ Ionic mobility $\downarrow$

$\longrightarrow$ Conductivity $\downarrow$

$\therefore$ Correct option is $Na^+ > K^+ > Rb^+ > Cs^+$.

OR

Sol. As the size of gaseous ion decreases, it get more hydrated in water and hence, the size of aqueous ion increases. When this bulky ion move in solution, it experience greater resistance and hence lower conductivity.

Size of gasesous ion : $Cs^+ > Rb^+ > K^+ > Na^+$

Size of aqueous ion : $Cs^+ < Rb^+ < K^+ < Na^+$

Conductivity : $Cs^+ > Rb^+ > K^+ > Na^+$

18. What is the spin-only magnetic moment value (BM) of a divalent metal ion with atomic number 25, in it's aqueous solution?

(1) 5.92

(2) 5.0

(3) zero

(4) 5.26

Official Ans. by NTA (1)

Sol. Electronic configuration of divalent metal ion having atomic number 25 is

$Mn^{+2}_{(aq)} \Rightarrow$ $1s^2$ $2s^2$ $2p^6$ $3s^2$ $3p^6$ $3d^5$

Total number of unpaired electrons = 5

μ (Magnetic moment) = $\sqrt{n(n+2)}$ BM

where n = number of unpaired e^-

$\therefore \; \mu = \sqrt{5(5+2)} = \sqrt{35}$ BM $= 5.92$ BM

19. Given below are two statements :

Statement-I : Retardation factor (R_f) can be measured in meter/centimeter.

Statement-II : R_f value of a compound remains constant in all solvents.

Choose the most appropriate answer from the options given below:

(1) Statement-I is true but statement-II is false

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

(3) Both statement-I and statement-II are false

(4) Statement-I is false but statement-II is true

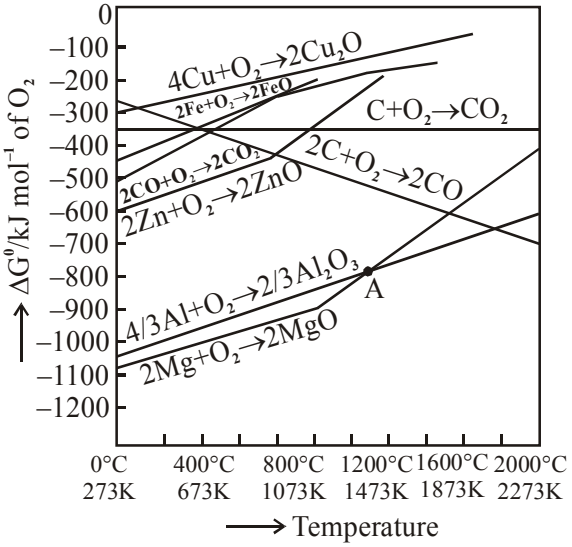
Official Ans. by NTA (3)

Sol. R_f = retardation factor

$$R_f = \frac{\text{Distance travelled by the substance from reference line (c.m)}}{\text{Distance travelled by the solvent from reference line (c.m)}}$$

Note : R_f value of different compounds are different.

20. The point of intersection and sudden increase in the slope, in the diagram given below, respectively, indicates :



(1) $\Delta G = 0$ and melting or boiling point of the metal oxide
(2) $\Delta G > 0$ and decomposition of the metal oxide
(3) $\Delta G < 0$ and decomposition of the metal oxide
(4) $\Delta G = 0$ and reduction of the metal oxide

Official Ans. by NTA (1)

Official Ans. by **ALLEN (Bonus)**

Sol. At intersection point $\Delta G = 0$ and sudden increase in slope is due to melting or boiling point of the metal.

SECTION-B

1. The reaction of white phosphorus on boiling with alkali in inert atmosphere resulted in the formation of product 'A'. The reaction 1 mol of 'A' with excess of $AgNO_3$ in aqueous medium gives _____ mol(s) of Ag. (Round off to the Nearest Integer).

Official Ans. by NTA (4)

Sol. $P_4 + 3OH^- + 3H_2O \rightarrow PH_3 + \underset{(A)}{3H_2PO_2^-}$

$$\underset{1\text{ mole}}{H_2PO_2^-} + \underset{\text{excess}}{4Ag^+} + 2H_2O \rightarrow \underset{4\text{ mole}}{4Ag} + H_3PO_4 + 3H^+$$

2. 0.01 moles of a weak acid HA($K_a = 2.0 \times 10^{-6}$) is dissolved in 1.0 L of 0.1 M HCl solution. The degree of dissociation of HA is _____ $\times 10^{-5}$ (Round off to the Nearest Integer).
[Neglect volume change on adding HA. Assume degree of dissociation <<1]

Official Ans. by NTA (2)

Sol.

	HA	$\rightleftharpoons$	H^+	+	A^-
Initial conc.	0.01M		0.1M		0
Equ. conc.	(0.01 – x)		(0.1 + x)		xM
	≈ 0.01M		≈ 0.1M		

$$\text{Now, } K_a = \frac{[x^+][A^-]}{[HA]} \Rightarrow 2\times10^{-6} = \frac{0.1\times x}{0.01}$$

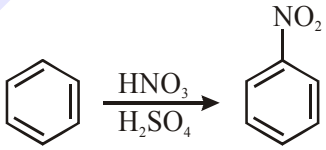
$\therefore \quad x = 2 \times 10^{-7}$

$$\text{Now, } \alpha = \frac{x}{0.01} = \frac{2\times10^{-7}}{0.01} = 2\times10^{-5}$$

3. A certain orbital has n = 4 and $m_L = -3$. The number of radial nodes in this orbital is _____. (Round off to the Nearest Integer).

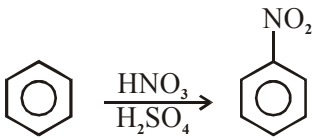
Official Ans. by NTA (0)

Sol. n = 4 and $m_\ell = -3$
Hence, ℓ value must be 3.
Now, number of radial nodes = $n - \ell - 1$
$= 4 - 3 - 1 = 0$

4. 

In the above reaction, 3.9 g of benzene on nitration gives 4.92 g of nitrobenzene. The percentage yield of nitrobenzene in the above reaction is _____ %. (Round off to the Nearest Integer).
(Given atomic mass : C : 12.0 u, H : 1.0u, O : 16.0 u, N : 14.0 u)

Official Ans. by NTA (80)

Sol. 

1 mole 78gm → 1 mole 123gm

3.9gm → $\frac{123}{78} \times 3.9 = 6.15$gm

But actual amount of nitrobenzene formed is 4.92 gm and hence.

$$\text{Percentage yield} = \frac{4.92}{6.15}\times100 = 80\%$$

5. The mole fraction of a solute in a 100 molal aqueous solution _____ $\times 10^{-2}$.
(Round off to the Nearest Integer).
[Given : Atomic masses : H : 1.0 u, O : 16.0 u]
Official Ans. by NTA (64)

Sol. 100 molal aqueous solution means there is 100 mole solute in 1 kg = 1000 gm water.
Now,

$$\text{mole-fraction of solute} = \frac{n_{solute}}{n_{solute} + n_{solvent}}$$

$$= \frac{100}{100 + \frac{1000}{18}} = \frac{1800}{2800} = 0.6428$$

$$= 64.28 \times 10^{-2}$$

6. For a certain first order reaction 32% of the reactant is left after 570 s. The rate constant of this reaction is _____ $\times 10^{-3}$ s^{-1}. (Round off to the Nearest Integer).
[Given : $\log_{10}2 = 0.301$, $\ln 10 = 2.303$]
Official Ans. by NTA (2)

Sol. For 1st order reaction,

$$K = \frac{2.303}{t}.\log\frac{[A_0]}{[A_t]} = \frac{2.303}{570\,sec}.\log\left(\frac{100}{32}\right)$$

$$= 1.999 \times 10^{-3}\ sec^{-1} \approx 2 \times 10^{-3}\ sec^{-1}$$

7. The standard enthalpies of formation of Al_2O_3 and CaO are –1675 kJ mol^{-1} and –635 kJ mol^{-1} respectively.
For the reaction
$3CaO + 2Al \rightarrow 3Ca + Al_2O_3$ the standard reaction enthalpy Δ_rH^0= _____ kJ.
(Round off to the Nearest Integer).
Official Ans. by NTA (230)

Sol. Given reaction:
$3CaO + Al \rightarrow Al_2O_3 + 3Ca$
Now, $\Delta_rH° = \Sigma\,\Delta_fH°_{Products} - \Sigma\Delta_fH°_{Reactants}$
$= [1 \times (-1675) + 3 \times 0] - [3 \times (-635) + 2 \times 0]$
$= +\,230$ kJ mol^{-1}

8. 15 mL of aqueous solution of Fe^{2+} in acidic medium completely reacted with 20 mL of 0.03 M aqueous $Cr_2O_7^{2-}$. The molarity of the Fe^{2+} solution is _____ $\times 10^{-2}$ M (Round off to the Nearest Integer).
Official Ans. by NTA (24)

Sol. $n_{eq}\ Fe^{2+} = n_{eq}\ Cr_2O_7^{2-}$

$$\text{or, } \left(\frac{15 \times M_{Fe^{2+}}}{1000}\right) \times 1 = \left(\frac{20 \times 0.03}{1000}\right) \times 6$$

$$\therefore\ M_{Fe^{2+}} = 0.24\ M = 24 \times 10^{-2}\ M$$

9. The oxygen dissolved in water exerts a partial pressure of 20 kPa in the vapour above water. The molar solubility of oxygen in water is _____ $\times 10^{-5}$ mol dm^{-3}.
(Round off to the Nearest Integer).
[Given : Henry's law constant
$= K_H = 8.0 \times 10^4$ kPa for O_2.
Density of water with dissolved oxygen = 1.0 kg dm^{-3}]
Official Ans. by NTA (25)
Official Ans. by ALLEN (1389)

Sol. $P = K_H \cdot x$

$$\text{or, } 20 \times 10^3 = (8 \times 10^4 \times 10^3) \times \frac{n_{O_2}}{n_{O_2} + n_{water}}$$

$$\text{or, } \frac{1}{4000} = \frac{n_{O_2}}{n_{O_2} + n_{water}} = \frac{n_{O_2}}{n_{water}}$$

Means 1 mole water (= 18 gm = 18 ml) dissolves $\frac{1}{4000}$ moles O_2. Hence, molar solubility

$$= \frac{\left(\frac{1}{4000}\right)}{18} \times 1000 = \frac{1}{72}\,mol\,dm^{-3}$$

$$= 1388.89 \times 10^{-5}\ mol\ dm^{-3} \approx 1389\ mol\ dm^{-3}$$

10. The pressure exerted by a non-reactive gaseous mixture of 6.4 g of methane and 8.8 g of carbon dioxide in a 10 L vessel at 27°C is _____ kPa.
(Round off to the Nearest Integer).
[Assume gases are ideal, R = 8.314 J mol^{-1} K^{-1}
Atomic masses : C : 12.0 u, H : 1.0 u, O : 16.0 u]
Official Ans. by NTA (150)

Sol. Total moles of gases, $n = n_{CH_4} + n_{CO_2}$

$$= \frac{6.4}{16} + \frac{8.8}{44} = 0.6$$

$$\text{Now, } P = \frac{nRT}{V} = \frac{0.6 \times 8.314 \times 300}{10 \times 10^{-3}}$$

$$= 1.49652 \times 10^5\ Pa = 149.652\ kPa$$
$$\approx 150\ kPa$$