FINAL JEE–MAIN EXAMINATION – SEPTEMBER, 2020

(Held On Saturday 05th SEPTEMBER, 2020) TIME : 9 AM to 12 PM

CHEMISTRY TEST PAPER WITH ANSWER & SOLUTION

1. The equation that represents the water-gas shift reaction is :

(1) $CO(g) + H_2O(g) \xrightarrow[\text{Catalyst}]{673K} CO_2(g) + H_2(g)$

(2) $CH_4(g) + H_2O(g) \xrightarrow[Ni]{1270K} CO(g) + 3\,H_2(g)$

(3) $C(s) + H_2O(g) \xrightarrow{1270K} CO(g) + H_2(g)$

(4) $2C(s)+O_2(g)+4N_2(g) \xrightarrow{1273K} 2CO(g)+4N_2(g)$

Official Ans. by NTA (1)

Sol. (1) Water gas shift reaction

$$CO_{(g)} + H_2O_{(g)} \xrightarrow[\text{catalyst}]{673K} CO_{2(g)} + H_{2(g)}$$

(2) Water gas is produced by this reaction.

$$CH_{4(g)} + H_2O_{(g)} \xrightarrow[Ni]{1270K} CO_{(g)} + 3H_{2(g)}$$

(3) Water gas is produced by this reaction

$$C_{(s)} + H_2O_{(g)} \xrightarrow{1270K} CO_{(g)} + H_{2(g)}$$

(4) producer gas is produced by this reaction.

$$2C_{(s)} + O_{2(g)} + 4N_{2(g)} \xrightarrow{1270K} 2CO_{(g)} + 4N_{2(g)}$$

2. Consider the following reaction

$N_2O_4(g) \rightleftharpoons 2NO_2(g)$; $\Delta H^0 = +58$ kJ

For each of the following cases (a, b), the direction in which the equilibrium shifts is:

(a) Temperature is decreased

(b) Pressure is increased by adding N_2 at constant T

(1) (a) towards reactant, (b) no change

(2) (a) towards product, (b) towards reactant

(3) (a) towards product, (b) no change

(4) (a) towards reactant, (b) towards product

Official Ans. by NTA (1)

Sol. $\Delta H^o > 0$ $T\downarrow$ equation shifts back ward.

N_2 is treated as inert gas in this case hence no effect on equilibrium.

3. The values of the crystal field stabilization energies for a high spin d^6 metal ion in octahedral and tetrahedral fields, respectively, are :

(1) $-0.4\ \Delta_0$ and $-0.27\ \Delta_t$

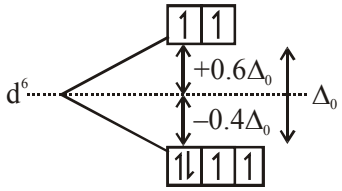
(2) $-1.6\ \Delta_0$ and $-0.4\ \Delta_t$

(3) $-0.4\ \Delta_0$ and $-0.6\ \Delta_t$

(4) $-2.4\ \Delta_0$ and $-0.6\ \Delta_t$

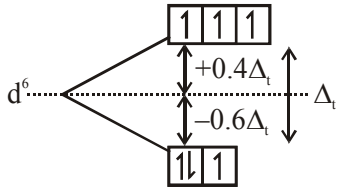
Official Ans. by NTA (3)

Sol. For high spin octahedral field



CFSE = (4) $(-0.4\Delta_0)$ + 2(0.6 Δ_0) = – 0.4 Δ_0

For high spin tetrahedral field



CFSE = $3(-0.6\Delta_t)$ + $3(0.4\ \Delta_t)$ = – 0.6 Δ_t

4. Which of the following is not an essential amino acid :

(1) Valine

(2) Leucine

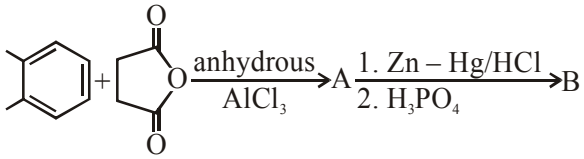
(3) Lysine

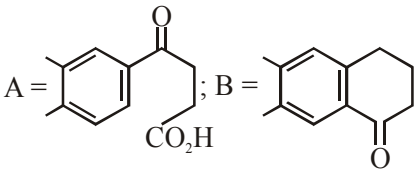
(4) Tyrosine

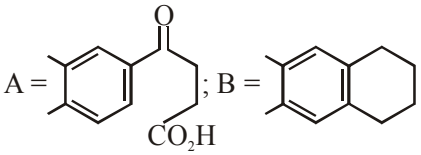
Official Ans. by NTA (4)

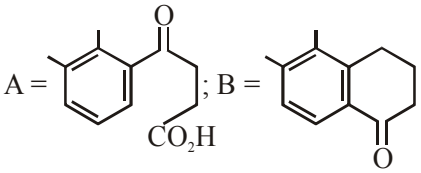
Sol. Tyrosine is not an essential amino acid.

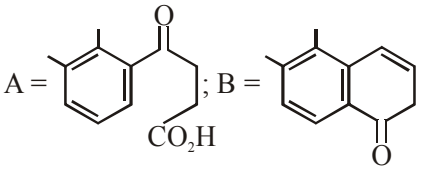
5. In the following reaction sequence the major products A and B are :



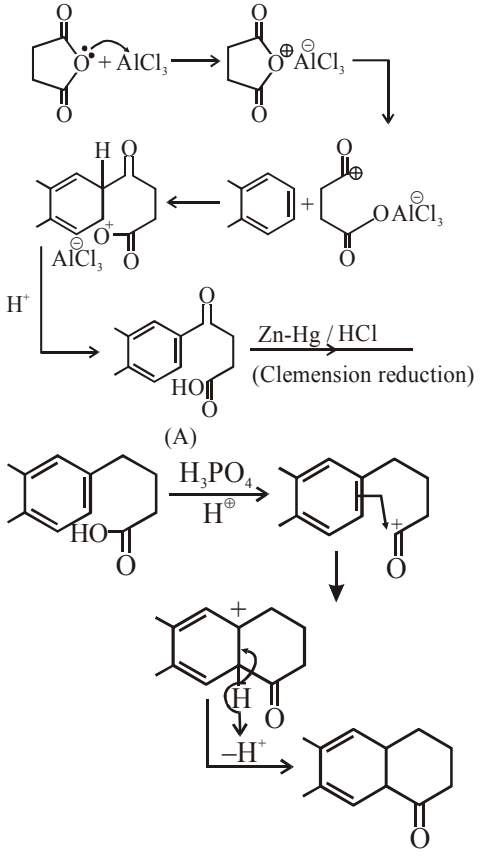
(1) 

(2) 

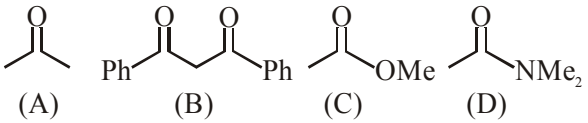
(3) 

(4) 

Official Ans. by NTA (1)

Sol. 

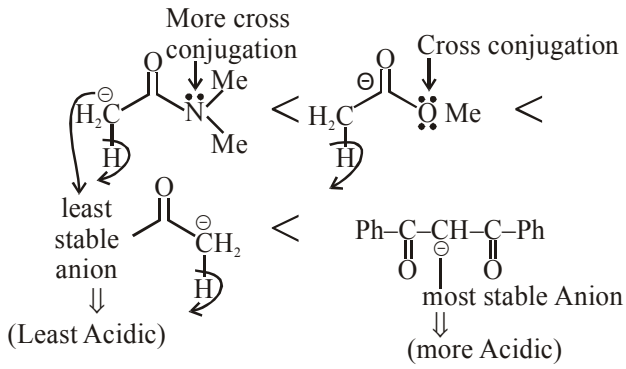
6. The increasing order of the acidity of the α-hydrogen of the following compounds is :



(1) (C) < (A) < (B) < (D)
(2) (B) < (C) < (A) < (D)
(3) (A) < (C) < (D) < (B)
(4) (D) < (C) < (A) < (B)

Official Ans. by NTA (4)

Sol. $\boxed{D < C < A < B}$



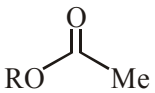
7. An Ellingham diagram provides information about :

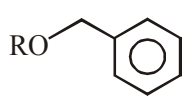
(1) the pressure dependence of the standard electrode potentials of reduction reactions involved in the extraction of metals.
(2) the kinetics of the reduction process.
(3) the temperature dependence of the standard Gibbs energies of formation of some metal oxides.
(4) the conditions of pH and potential under which a species is thermodynamically stable.

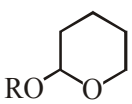
Official Ans. by NTA (3)

Sol. Ellingham diagram provides information about temperature dependence of the standard gibbs energies of formation of some metal oxides.

8. Which of the following derivatives of alcohols is unstable in an aqueous base ?

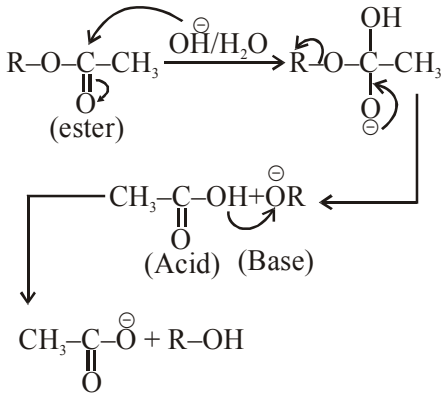
(1) RO – CMe_3 (2) 

(3) 

(4) 

Official Ans. by NTA (2)

Sol.



It is a hydrolysis of ester in basic medium.

9. The structure of PCl_5 in the solid state is

(1) square pyramidal

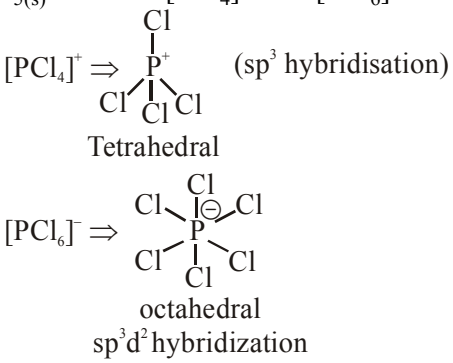
(2) tetrahedral $[PCl_4]^+$ and octahedral $[PCl_6]^-$

(3) square planar $[PCl_4]^+$ and octahedral $[PCl_6]^-$

(4) trigonal bipyramidal

Official Ans. by NTA (2)

Sol. $PCl_{5(s)}$ exist as $[PCl_4]^+$ and $[PCl_6]^-$



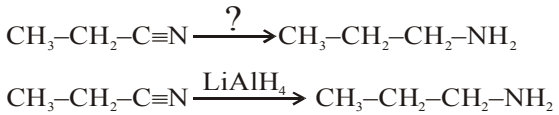
10. The most appropriate reagent for conversion of C_2H_5CN into $CH_3CH_2CH_2NH_2$ is :

(1) $Na(CN)BH_3$ (2) $LiAlH_4$

(3) $NaBH_4$ (4) CaH_2

Official Ans. by NTA (2)

Sol.



11. The difference between the radii of 3rd and 4th orbits of Li^{2+} is ΔR_1. The difference between the radii of 3rd and 4th orbits of He^+ is ΔR_2. Ratio $\Delta R_1 : \Delta R_2$ is :

(1) 8 : 3 (2) 3 : 2

(3) 3 : 8 (4) 2 : 3

Official Ans. by NTA (4)

Sol. $$\frac{\Delta R_1}{\Delta R_2} = \frac{(r_4 - r_3)_{4^{2+}}}{(r_4 - r_3)_{He^+}} = \frac{\frac{4^2}{3} - \frac{3^2}{3}}{\frac{4^2}{2} - \frac{3^2}{2}} = \frac{7/3}{7/2} = \frac{2}{3}$$

12. A flask contains a mixture of compounds A and B. Both compounds decompose by first-order kinetics. The half-lives for A and B are 300 s and 180 s, respectively. If the concentrations of A and B are equal initially, the time required for the concentration of A to be four times that of B(in s) : (Use ln 2 = 0.693)

(1) 180 (2) 120

(3) 300 (4) 900

Official Ans. by NTA (4)

Sol. $[A]_t = 4[B]_t$

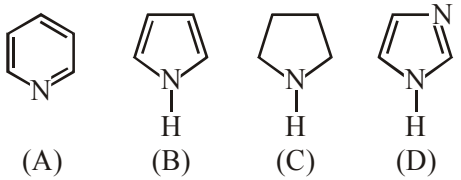
$$[A]_0\ e^{-(\ln^2/300)t} = 4[B]_0 e^{(-\ln 2/180)t}$$

$$e^{\left(\frac{\ln^2}{180} - \frac{\ln^2}{300}\right)} = 4$$

$$\left(\frac{\ln^2}{180} - \frac{\ln^2}{300}\right)t = \ln 4$$

$$\left(\frac{1}{180} - \frac{1}{300}\right)t = 2 \Rightarrow t = \frac{2 \times 180 \times 300}{120} = 900\,\text{sec}.$$

13. The increasing order of basicity of the following compounds is



(1) (A) < (B) < (C) < (D)

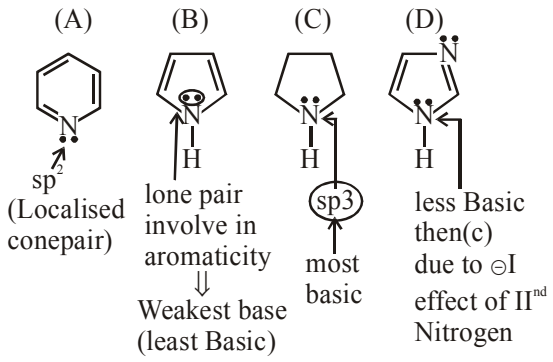
(2) (B) < (A) < (C) < (D)

(3) (D) < (A) < (B) < (C)

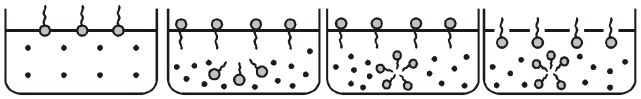
(4) (B) < (A) < (D) < (C)

Official Ans. by NTA (4)

Sol.



14. Identify the correct molecular picture showing that happens at the critical micellar concentration (CMC) of an aqueous solution of a surfactant (○ polar head; ∽ non-polar tail; • water).



(A) (B) (C) (D)

(1) (B) (2) (A) (3) (D) (4) (C)

Official Ans. by NTA (3)

Sol.

Polar head
more compatible
with polar aq. solution

Micelles formed at CMC.

15. If a person is suffering from the deficiency of nor-adrenaline, what kind of drug can be suggested ?

(1) Anti-inflammatory (2) Analgesic
(3) Antihistamine (4) Antidepressant

Official Ans. by NTA (4)

Sol. Anti depressant → drug which enhance the mood. Non adrenaline is neurotransmitter and its level is low in body due to some reason then person suffers from depression and in that situation anti depressant drug is required.

16. The correct electronic configuration and spin-only magnetic moment (BM) of Gd^{3+} (Z = 64), respectively, are

(1) $[Xe]5f^7$ and 8.9 (2) $[Xe]4f^7$ and 7.9
(3) $[Xe]5f^7$ and 7.9 (4) $[Xe]4f^7$ and 8.9

Official Ans. by NTA (2)

Sol. Electronic configuration of Gd^{3+} is

$_{64}Gd^{3+} = [Xe]4f^7$

[Xe] 1 1 1 1 1 1 1

Gd^{3+} having 7 unpaired electrons.

Magnetic moment (μ) = $\sqrt{n(n+2)}$B.M.

$\mu = \sqrt{7(7+2)}$B.M.

= 7.9 B.M.

n ⇒ Number of unpaired electrons.

17. The condition that indicates a polluted environment is

(1) BOD value of 5 ppm
(2) eutrophication
(3) 0.03% of CO_2 in the atmosphere
(4) pH of rain water to be 5.6

Official Ans. by NTA (2)

Sol. In Eutrophication nutrient enriched water bodies support a dense plant population, which kills animal life by depriving it of oxygen and results in subsequent loss of biodiversity. If indicates polluted environment.

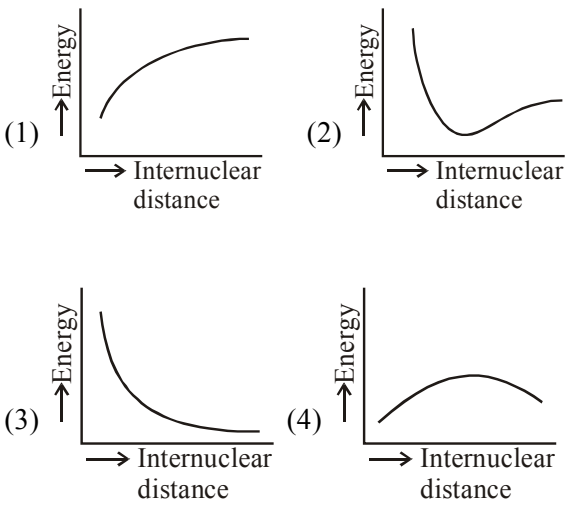
18. In the sixth period, the orbitals that are filled are

(1) 6s, 5f, 6d, 6p (2) 6s, 6p, 6d, 6f
(3) 6s, 5d, 5f, 6p (4) 6s, 4f, 5d, 6p

Official Ans. by NTA (4)

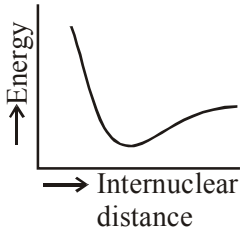
Sol. As per (n + ℓ) rule in 6th period, order of orbitals filling is 6s, 4f, 5d, 6p.

19. The potential energy curve for the H_2 molecule as a function of internuclear distance is :



Official Ans. by NTA (2)

Sol. Potential energy curve for H_2 molecule is.



20. A diatomic molecule X_2 has a body-centred cubic (bcc) structure with a cell edge of 300 pm. The density of the molecule is 6.17 g cm^{-3}. The number of molecules present in 200 g of X_2 is
(Avogadro constant (N_A) = 6 × 10^{23} mol^{-1})
(1) 8 N_A
(2) 40 N_A
(3) 4 N_A
(4) 2 N_A

Official Ans. by NTA (3)

Sol. $$p = \frac{2\times\frac{M}{N_A}}{a^3} \Rightarrow 6.17 = \frac{2\times\frac{M}{N_A}}{(3\times10^{-8}\,cm)^3}$$

$$\Rightarrow M \simeq 50\ gm/mol$$

$$No = \frac{w}{M}\times N_A = \frac{200}{50}\times N_A = 4N_A$$

21. an oxidation-reduction reaction in which 3 electrons are transferred has a ΔG^o of 17.37 kJ mol^{-1} at 25°C. The value of E^o_{cell} (in V) is _____ × 10^{-2}
(1 F = 96,500 C mol^{-1})

Official Ans. by NTA (6)

Sol. $$\Delta G^\circ = -AFE^\circ = -3\times96500\times E^\circ$$

$$\Rightarrow\ E^\circ = -6\times10^{-2}\ V$$

22. The minimum number of moles of O_2 required for complete combustion of 1 mole of propane and 2 moles of butane is _____.

Official Ans. by NTA (18)

Sol. $$\underset{1mole}{C_3H_8} + \underset{5mole}{SO_2} \rightarrow 3Co_2 + 4H_2O$$

For 1 mole propane combustion 5 mole O_2 required

$$C_4H_{10} + \frac{13}{2}O_2 \rightarrow 4Co_2 + 5H_2O$$

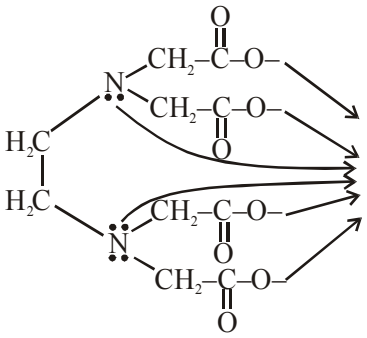
1 mole 6.5 mole
2 mole 13 mole

For 2 moles of butane 13 mole of O_2 is required
total moles = 13 + 5 = 18

23. The total number of coordination sites in ethylenediaminetetraacetate ($EDTA^{4-}$) is _____.

Official Ans. by NTA (6)

Sol. $EDTA^{4-}$ is hexadentate ligand, so its donation sites are six.



24. The number of chiral carbon(s) present in peptide, Ile-Arg-Pro, is _____.

Official Ans. by NTA (4)

25. A soft drink was bottled with a partial pressure of CO_2 of 3 bar over the liquid at room temperature. The partial pressure of CO_2 over the solution approaches a value of 30 bar when 44 g of CO_2 is dissolved in 1 kg of water at room temperature. The approximate pH of the soft drink is _____ × 10^{-1}.

(First dissociation constant of H_2CO_3 = 4.0 × 10^{-7}; log 2 = 0.3; density of the soft drink = 1 g mL^{-1})

Official Ans. by NTA (37)

Sol. $$P_{CO_2} = K_H \times CO_2$$

$$\frac{3}{30} = \frac{K_H.n_{CO_2}}{K_H 1} \Rightarrow n_{CO_2=0.1}\,mol$$

$$pH = \frac{1}{2}(pka_1 - \log c) = \frac{1}{2}(6.4\times1) = 3.7$$

pH = 37 × 10^{-1}