FINAL JEE–MAIN EXAMINATION – JANUARY, 2020

(Held On Wednesday 08th JANUARY, 2020) TIME : 2 : 30 PM to 5 : 30 PM

CHEMISTRY

TEST PAPER WITH ANSWER & SOLUTION

1. Among the reactions (a) - (d), the reaction(s) that does/do not occur in the blast furnace during the extraction of iron is/are :

(a) $CaO + SiO_2 \rightarrow CaSiO_3$

(b) $3Fe_2O_3 + CO \rightarrow 2Fe_3O_4 + CO_2$

(c) $FeO + SiO_2 \rightarrow FeSiO_3$

(d) $FeO \rightarrow Fe + \frac{1}{2}O_2$

(1) (c) and (d) (2) (a) and (d)

(3) (d) (4) (a)

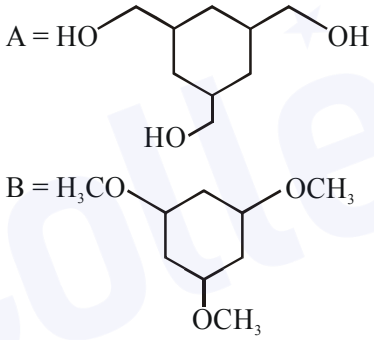
NTA Ans. (1)

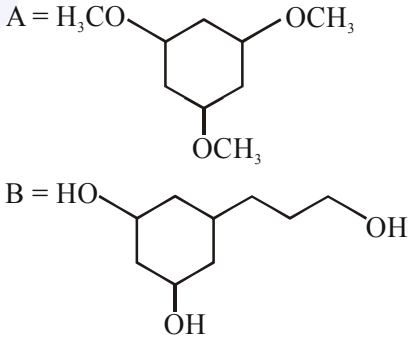
Sol. In blast furnace (metallugy of iron) involved reactions are

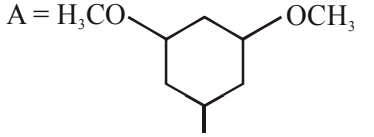
(a) $CaO + SiO_2 \longrightarrow CaSiO_3$

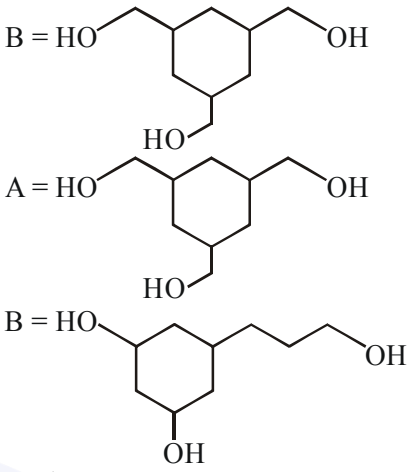
(b) $3Fe_2O_3 + CO \longrightarrow 2Fe_3O_4 + CO_2$

2. Among the compounds A and B with molecular formula $C_9H_{18}O_3$, A is having higher boiling point than B. The possible structures of A and B are :

(1) 

(2) 

(3) 

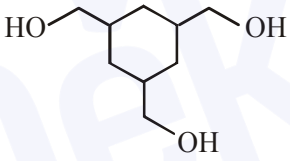


(4)

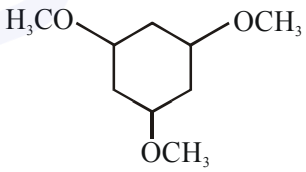
NTA Ans. (1)

Sol. Alcohol has more boiling point than ether (due to hydrogen bonding).

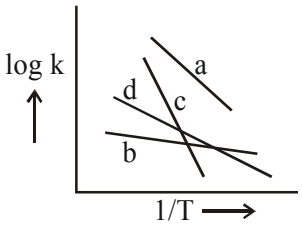
So,



has more boiling point than



3. Consider the following plots of rate constant versus $\frac{1}{T}$ for four different reactions. Which of the following orders is correct for the activation energies of these reactions?



(1) $E_b > E_d > E_c > E_a$ (2) $E_a > E_c > E_d > E_b$

(3) $E_c > E_a > E_d > E_b$ (4) $E_b > E_a > E_d > E_c$

Sol. $\log K = \frac{-Ea}{2.303RT} + \log A$

Acrroding to Arrhenius equation plot of 'log K' Vs. $\frac{1}{T}$ is linear with.

Slope = $\frac{-Ea}{2.303R}$

From plot we conclude :

$\underset{\text{(magnitude)}}{|\text{slope}|}$: c > a > d > b

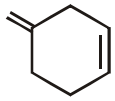
$\therefore\ E_c > E_a > E_d > E_b$

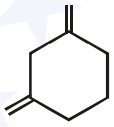
4. An unsaturated hydrocarbon X absorbs two hydrogen molecules on catalytic hydrogenattion, and also gives following reaction :

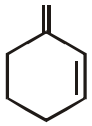
$$X \xrightarrow[Zn/H_2O]{O_3} A \xrightarrow{[Ag(NH_3)_2]^+}$$

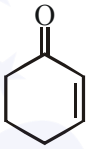
B(3 - oxo - hexanedicarboxylic acid)

X will be :-

(1) 

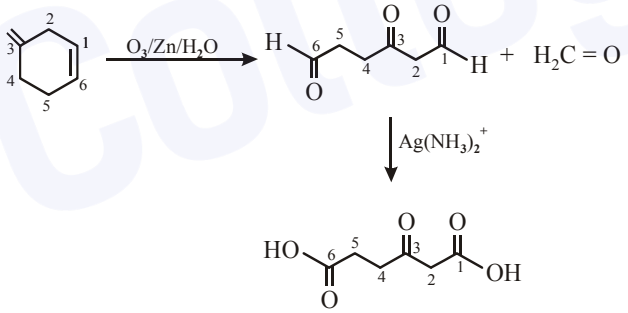
(2) 

(3) 

(4) 

NTA Ans. (1)

Sol.



5. The increasing order of the atomic radii of the following elements is :-

(a) C (b) O (c) F (d) Cl

(e) Br

(1) (b) < (c) < (d) < (a) < (e)

(2) (a) < (b) < (c) < (d) < (e)

(3) (d) < (c) < (b) < (a) < (e)

(4) (c) < (b) < (a) < (d) < (e)

Sol. If the given elements are arranged according to their position in periodic table

Atomic radius

$$\begin{matrix} C > O > F \\ \wedge \\ Cl \\ \wedge \\ Br \end{matrix}$$

Br > Cl > C > O > F

c < b < a < d < e

6. Kjeldahl's method cannot be used to estimate nitrogen for which of the following compounds?

(1) $C_6H_5NO_2$ (2) $C_6H_5NH_2$

(3) $CH_3CH_2-C\equiv N$ (4) $NH_2-\overset{\overset{O}{\|}}{C}-NH_2$

NTA Ans. (1)

Sol. Kjeldahl's method for estimation of nitrogen is not applicable for nitrobenzene $C_6H_5NO_2$. because reaction with H_2SO_4, nitrobenzene can not give ammonia.

7. The major product [B] in the following sequence of reactions is :-

$$CH_3-\underset{\underset{CH(CH_3)_2}{|}}{C}=CH-CH_2CH_3 \xrightarrow[(ii)\ H_2O_2, OH^{\ominus}]{(i)\ B_2H_6} [A] \xrightarrow[\Delta]{\text{dil. } H_2SO_4} [B]$$

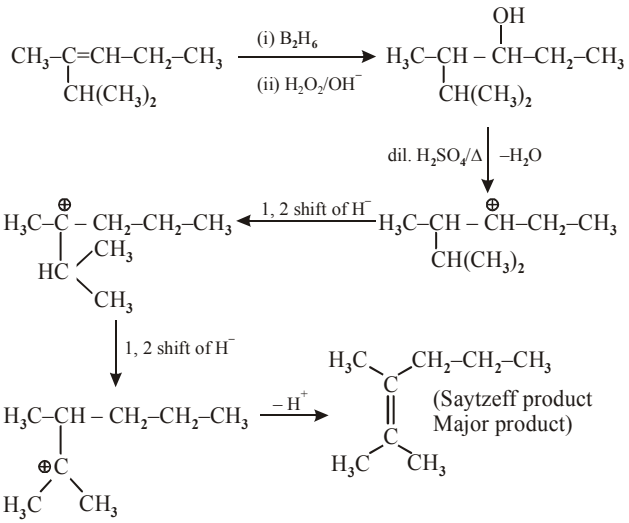
(1) $CH_3-\underset{\underset{C}{\|}}{C}-CH_2CH_2CH_3$ with H_3C and CH_3 on C

(2) $CH_2=\underset{\underset{CH(CH_3)_2}{|}}{C}-CH_2CH_2CH_3$

(3) $CH_3-\underset{\underset{CH(CH_3)_2}{|}}{CH}-CH=CH-CH_3$

(4) $CH_3-\underset{\underset{CH(CH_3)_2}{|}}{C}=CH-CH_2CH_3$

Sol.



8. A metal (A) on heating in nitrogen gas gives compound B. B on treatment with H_2O gives a colourless gas which when passed through $CuSO_4$ solution gives a dark blue-violet coloured solution. A and B respectively, are :

(1) Mg and Mg_3N_2

(2) Na and $NaNO_3$

(3) Mg and $Mg(NO_3)_2$

(4) Na and Na_3N

NTA Ans. (1)

Sol. $3Mg + N_2 \xrightarrow{\Delta} \underset{(A)}{Mg_3N_2} \xrightarrow[(B)]{6H_2O} 3Mg(OH)_2 + 2NH_3$ (colourless gas)

$CuSO_4 + 4NH_3 \longrightarrow [Cu(NH_3)_4]SO_4$ (deep blue solution)

9. Which of the following compounds is likely to show both Frenkel and Schottky defects in its crystalline form?

(1) AgBr (2) ZnS (3) KBr (4) CsCl

NTA Ans. (1)

Sol. Since AgBr has intermediate radius ratio

$\therefore$ it shows both schottky & Frenkel defects

ZnS $\rightarrow$ Frenkel defects

10. For the following Assertion and Reason, the correct option is :

Assertion : The pH of water increases with increase in temperature.

Reason : The dissociation of water into H^+ and OH^- is an exothermic reaction.

(1) Both assertion and reason are true, but the reason is not the correct explanation for the assertion.

(2) Both assertion and reason are false.

(3) Assertion is not true, but reason is true.

(4) Both assertion and reason are true, and the reason is the correct explanation for the assertion.

NTA Ans. (2)

Sol. $H_2O(\ell) \rightleftharpoons H^+_{(aq)} + OH^-_{(aq)}$

For ionization of H_2O : $\Delta H > O$

$\Rightarrow$ ENDOTHERMIC

On temperature increase reaction shifts forward

$\Rightarrow$ both $[H^+]$ and $[OH^-]$ increase

$\Rightarrow$ pH & pOH decreases.

11. Arrange the following bonds according to their average bond energies in descending order :

C–Cl, C–Br, C–F, C–I

(1) C–I > C–Br > C–Cl > C–F

(2) C–Br > C–I > C–Cl > C–F

(3) C–F > C–Cl > C–Br > C–I

(4) C–Cl > C–Br > C–I > C–F

NTA Ans. (3)

Sol. Bond length order in carbon halogen bonds are in the order of C – F < C – Cl < C – Br < C – I

Hence, Bond energy order

C – F > C – Cl > C – Br > C – I

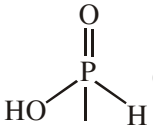
12. White Phosphorus on reaction with concentrated NaOH solution in an inert atmosphere of CO_2 gives phosphine and compound (X). (X) on acidification with HCl gives compound (Y). The basicity of compound (Y) is :

(1) 4 (2) 1 (3) 2 (4) 3

NTA Ans. (2)

Sol. $P_4 + 3NaOH + 3H_2O \longrightarrow \underset{(X)}{3NaH_2PO_2} + PH_3$

$NaH_2PO_2 + HCl \longrightarrow NaCl + \underset{(Y)}{H_3PO_2}$



(mono basic acid)

13. The radius of the second Bohr orbit, in terms of the Bohr radius, a_0, in Li^{2+} is :

(1) $\frac{4a_0}{9}$ (2) $\frac{2a_0}{9}$

(3) $\frac{2a_0}{3}$ (4) $\frac{4a_0}{3}$

NTA Ans. (4)

Sol. $r_n = \frac{n^2 \times a_0}{z}$

For 2nd Bohr orbit of Li^{+2}

n = 2

z = 3

$\Rightarrow r_n = \frac{2^2 \times a_0}{3} = \frac{4a_0}{3}$

14. Among (a) – (d) the complexes that can display geometrical isomerism are :

(a) $[Pt(NH_3)_3Cl]^+$ (b) $[Pt(NH_3)Cl_5]^-$

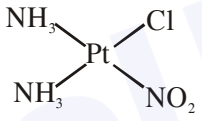
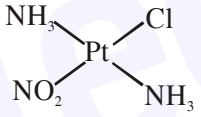
(c) $[Pt(NH_3)_2Cl(NO_2)]$ (d) $[Pt(NH_3)_4ClBr]^{2+}$

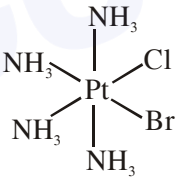
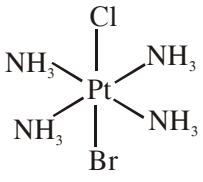
(1) (d) and (a) (2) (a) and (b)

(3) (b) and (c) (4) (c) and (d)

NTA Ans. (4)

Sol. $[Pt(NH_3)_3Cl]^+$ & $[Pt(NH_3)Cl_5]^-$ does not show geometrical isomerism

(c)  cis  trans

(d)  cis  trans

15. Two monomers in maltose are :

(1) α-D-glucose and β-D-glucose

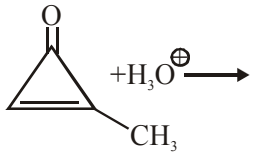
(2) α-D-glucose and α-D-Fructose

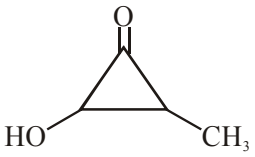
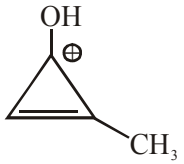
(3) α-D-glucose and α-D-glucose

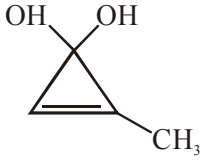
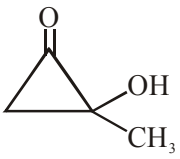
(4) α-D-glucose and α-D-galactose

NTA Ans. (3)

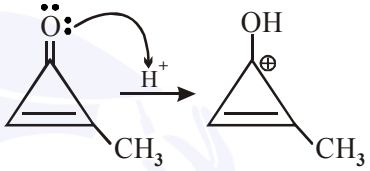
16. The major product in the following reaction is:



(1)  (2) 

(3)  (4) 

NTA Ans. (2)

Sol. 

(Aromatic stable product)

17. Hydrogen has three isotopes (A), (B) and (C). If the number of neutron(s) in (A), (B) and (C) respectively, are (x), (y) and (z), the sum of (x), (y) an (z) is :

(1) 4 (2) 3 (3) 2 (4) 1

NTA Ans. (2)

Sol. Hydrogen has three isotopes

Isotopes	Number of neutrons
Protium ($_1^1H$)	0
Deutrium ($_1^2H$)	1
Tritium ($_1^3H$)	2

Hence the sum of neutrons are 3

18. Preparation of Bakelite proceeds via reactions.

(1) Condensation and elimination

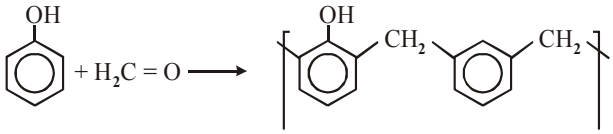
(2) Electrophilic addition and dehydration

(3) Electrophilic substitution and dehydration

(4) Nucleophilic addition and dehydration

NTA Ans. (3)

Sol. Bakelite formation is example of electrophilic substitution and dehydration.



19. For the following Assertion and Reason, the correct option is

Assertion : For hydrogenation reactions, the catalytic activity increases from Group 5 to Group 11 metals with maximum activity shown by Group 7-9 elements.

Reason : The reactants are most strongly adsorbed on group 7-9 elements.

(1) Both assertion and reason are true but the reason is not the correct explanation for the assertion.

(2) Both assertion and reason are false.

(3) Both assertion and reason are true and the reason is the correct explanation for the assertion.

(4) The assertion is true, but the reason is false.

NTA Ans. (4)

20. The correct order of the calculated spin-only magnetic moments of complexs (A) to (D) is:

(A) $Ni(CO)_4$

(B) $[Ni(H_2O)_6]Cl_2$

(C) $Na_2[Ni(CN)_4]$

(D) $PdCl_2(PPh_3)_2$

(1) (A) ≈ (C) ≈ (D) < (B)

(2) (A) ≈ (C) < (B) ≈ (D)

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

(4) (C) ≈ (D) < (B) < (A)

NTA Ans. (1)

Sol. $[Ni(CO)_4]$ μ_m = 0 B.M.

$[Ni(H_2O)_6]Cl_2$ μ_m = 2.8 B.M.

$Na_2[Ni(CN)_4]$ μ_m = 0 B.M.

$[PdCl_2(PPh_3)_2]$ μ_m = 0 B.M.

A ≈ C ≈ D < B

21. For an electrochemical cell

$Sn(s)\,|\,Sn^{2+}\,(aq,1M)||Pb^{2+}\,(aq,1M)|Pb(s)$

the ratio $\frac{[Sn^{2+}]}{[Pb^{2+}]}$ when this cell attains equilibrium is _____.

(Given $E^0_{Sn^{2+}|Sn} = -0.14V$,

$E^0_{Pb^{2+}|Pb} = -0.13V, \frac{2.303RT}{F} = 0.06$)

NTA Ans. (2.13 to 2.17)

Sol. Cell reaction is :

$Sn(s) + Pb^{+2}(aq) \longrightarrow Sn^{+2}(aq) + Pb(s)$

Apply Nernst equation :

$$E_{cell} = E^0_{cell} - \frac{0.06}{2}\log\frac{[Sn^{+2}]}{[Pb^{+2}]} \quad ...(1)$$

$E^0_{cell} = -0.13 + 0.14 = 0.01$ V

At equilibrium : $E_{cell} = 0$

Substituting in (1)

$$0 = 0.01 - \frac{0.06}{2}\log\frac{[Sn^{+2}]}{[Pb^{+2}]}$$

$$\Rightarrow \quad \frac{1}{3} = \log\frac{[Sn^{+2}]}{[Pb^{+2}]}$$

$$\Rightarrow \quad \frac{[Sn^{+2}]}{[Pb^{+2}]} = 2.15$$

22. At constant volume, 4 mol of an ideal gas when heated from 300 K to 500K changes its internal energy by 5000 J. The molar heat capacity at constant volume is _____.

NTA Ans. (6.25)

Sol. For ideal gas :

$$\Delta U = nC_V[T_2 - T_1]$$

$$\Rightarrow \quad 5000 = 4 \times C_V[500 - 300]$$

$$\Rightarrow \quad C_V = \frac{5000}{800} = 6.25 \text{ J mole}^{-1}\text{ K}^{-1}$$

23. $NaClO_3$ is used, even in spacecrafts, to produce O_2. The daily consumption of pure O_2 by a person is 492L at 1 atm, 300K. How much amount of $NaClO_3$, in grams, is required to produce O_2 for the daily consumption of a person at 1 atm, 300 K ?

$NaClO_3(s) + Fe(s) \rightarrow O_2(g) + NaCl(s) + FeO(s)$

R = 0.082 L atm mol^{-1} K^{-1}

NTA Ans. (2120 to 2140)

Sol. Mole of O_2 consumed = $\frac{1\times 492}{0.082\times 300}$ = 20

Mole of $NaClO_3$ required = 20

Mass of $NaClO_3$ = 20 × 106.5 = 2130 gm

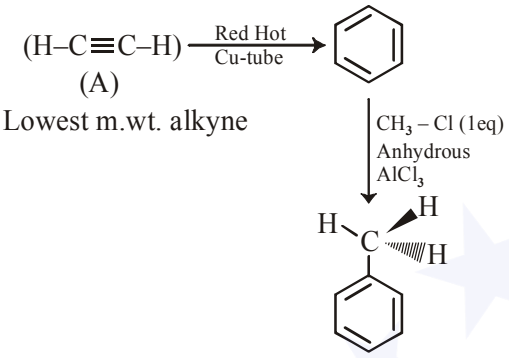
24. In the following sequence of reactions the maximum number of atoms present in molecule 'C' in one plane is _____.

$$A \xrightarrow[Cu\ tube]{Red\ hot} B \xrightarrow[Anhydrous\ AlCl_3]{CH_3Cl(1.eq.)} C$$

(A is a lowest molecular weight alkyne)

NTA Ans. (13)

Sol.



Total 13 atom are present in same plane (7 carbon & 6 hydrogen atoms.)

25. Complexes (ML_5) of metals Ni and Fe have ideal square pyramidal and trigonal bipyramidal grometries, respectively. The sum of the 90°, 120° and 180° L-M L angles in the two complexes is _____.

NTA Ans. (20)