FINAL JEE–MAIN EXAMINATION – SEPTEMBER, 2020

(Held On Sunday 06th SEPTEMBER, 2020) TIME : 3 PM to 6 PM

CHEMISTRY

TEST PAPER WITH ANSWER & SOLUTION

1. The value of K_C is 64 at 800 K for the reaction

$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$

The value of K_C for the following reaction is :

$$NH_3(g) \rightleftharpoons \frac{1}{2}N_2(g) + \frac{3}{2}H_2(g)$$

(1) $\frac{1}{4}$ (2) $\frac{1}{8}$ (3) 8 (4) $\frac{1}{64}$

Official Ans. by NTA (2)

Sol. $N_2 + 3H_2 \rightleftharpoons 2NH_3 \rightarrow K_C = 64$

$$2NH_3 \rightleftharpoons N_2 + 3H_2 \rightarrow K_C = \frac{1}{64}$$

$$NH_3 \rightleftharpoons \frac{1}{2}N_2 + \frac{3}{2}H_2 \rightarrow K_C = \left(\frac{1}{64}\right)^{1/2} = \frac{1}{8}$$

2. The element that can be refined by distillation is :

(1) nickel (2) zinc

(3) gallium (4) tin

Official Ans. by NTA (2)

Sol. Impure zinc is refined by distillation method.

3. The correct match between **Item-I** and **Item-II** :

Item-I		Item-II
(a) Natural rubber	(I)	1, 3-butadiene + styrene
(b) Neoprene	(II)	1, 3-butadiene + acrylonitrile
(c) Buna-N	(III)	Chloroprene
(d) Buna-S	(IV)	Isoprene

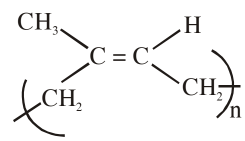
(1) (a) - (III), (b) - (IV), (c) - (I), (d) - (II)

(2) (a) - (IV), (b) - (III), (c) - (II), (d) - (I)

(3) (a) - (IV), (b) - (III), (c) - (I), (d) - (II)

(4) (a) - (III), (b) - (IV), (c) - (II), (d) - (I)

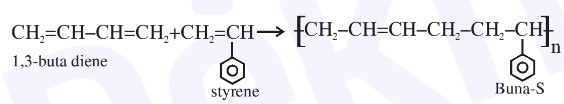
Sol.(a) $nCH_2=C(CH_3)-CH=CH_2$ (isoprene) $\longrightarrow$ Poly cis-isoprene (Natural rubber)



(b) $nCH_2=C(Cl)-CH=CH_2$ (Chloroprene) $\longrightarrow -(CH_2-C(Cl)=CH-CH_2-)_n$ (Neoprene)

(c) $nCH_2=CH-CH=CH_2$ (1,3 buta diene) $+ nCH_2=CH(CN)$ (Acrylonitrile) $\longrightarrow [-CH_2-CH=CH-CH_2-CH_2-CH(CN)]_n$ (Buna-N)

(d)



4. Mischmetal is an alloy consisting mainly of:

(1) lanthanoid metals

(2) actinoid metals

(3) actinoid and transition metals

(4) lanthanoid and actinoid metals

Official Ans. by NTA (1)

Sol. Alloys of lanthanides with Fe are called Misch metal, which consists of a lanthanoid metal (~95%) and iron (~5%) and traces of S, C, Ca and Al.

5. Reaction of an inorganic sulphite X with dilute H_2SO_4 generates compound Y. Reaction of Y with NaOH gives X. Further, the reaction of X with Y and water affords compound Z. Y and Z, respectively, are:

(1) S and Na_2SO_3

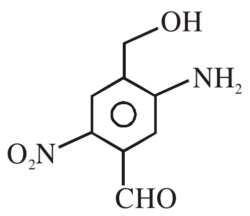
(2) SO_2 and $NaHSO_3$

(3) SO_3 and $NaHSO_3$

(4) SO and Na SO

Sol. $\underset{(X)}{Na_2SO_3} \xrightarrow{\text{dil. } H_2SO_4} \underset{(Y)}{SO_2} \xrightarrow{NaOH} \underset{(X)}{Na_2SO_3} \xrightarrow{SO_2 + H_2O} \underset{(Z)}{NaHSO_3}$

6. The IUPAC name of the following compound is :



(1) 3-amino-4-hydroxymethyl-5-nitrobenzaldehyde

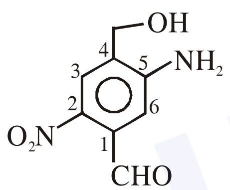
(2) 2-nitro-4-hydroxymethyl-5-aminobenzaldehyde

(3) 4-amino-2-formyl-5-hydroxymethylnitrobenzene

(4) 5-amino-4-hydroxymethyl-2-nitrobenzaldehyde

Official Ans. by NTA (4)

Sol.



5-amino-4-hydroxymethyl-2-nitrobenzaldehyde

7. Dihydrogen of high purity (> 99.95%) is obtained through:

(1) the electrolysis of warm $Ba(OH)_2$ solution using Ni electrodes.

(2) the reaction of Zn with dilute HCl

(3) the electrolysis of brine solution.

(4) the electrolysis of acidified water using Pt electrodes.

Official Ans. by NTA (1)

Sol. High purity (>99.95%) dihydrogen is obtained by electrolysing warm aqueous barium

8. Match the following :

	Test/Method		**Reagent**
(i)	Lucas Test	(a)	$C_6H_5SO_2Cl$/aq. KOH
(ii)	Dumas method	(b)	$HNO_3/AgNO_3$
(iii)	Kjeldahl's method	(c)	CuO/CO_2
(iv)	Hinsberg Test	(d)	Conc. HCl and $ZnCl_2$
		(e)	H_2SO_4

(1) (i)-(d), (ii)-(c), (iii)-(e), (iv)-(a)

(2) (i)-(b), (ii)-(d), (iii)-(e), (iv)-(a)

(3) (i)-(d), (ii)-(c), (iii)-(b), (iv)-(e)

(4) (i)-(b), (ii)-(a), (iii)-(c), (iv)-(d)

Official Ans. by NTA (1)

Sol. **Test** — **Correct reagent**

(i) Lucas test $\longrightarrow$ conc. HCl + $ZnCl_2$

(ii) Dumas method $\longrightarrow$ CuO / CO_2

(iii) Kjeldahl's method $\longrightarrow$ H_2SO_4

(iv) Hinsberg Test $\longrightarrow$ $C_6H_5SO_2Cl$ + aq. KOH

9. The reaction of NO with N_2O_4 at 250 K gives :

(1) N_2O_5 (2) NO_2

(3) N_2O (4) N_2O_3

Official Ans. by NTA (4)

Sol. $2NO + N_2O_4 \xrightarrow{250K} \underset{\text{blue solid}}{2N_2O_3}$

10. For the given cell ;

$Cu(s)|Cu^{2+}(C_1M)||Cu^{2+}(C_2M)|Cu(s)$ change in Gibbs energy (ΔG) is negative, if :

(1) $C_1 = 2C_2$ (2) $C_2 = \frac{C1}{\sqrt{2}}$

(3) $C_1 = C_2$ (4) $C_2 = \sqrt{2}C_1$

Official Ans. by NTA (4)

Sol. $\Delta G = -n F E_{cell}$

ΔG is negative, if E_{cell} is positive

Anode : $Cu(s) \longrightarrow Cu^{+2}(C_1) + 2e^- : E°$

Cathode : $Cu^{+2}(C_2) + 2e^- \longrightarrow Cu(S) : -E°$

Cell reaction : $Cu^{+2}(C_2) \longrightarrow Cu^{+2}(C_1)$ $E^\circ_{cell} = 0$

$$E_{cell} = E^\circ_{cell} - \frac{2.303RT}{nF}\log Q$$

$$E_{cell} = 0 - \frac{2.303RT}{nF}\log\left(\frac{C_1}{C_2}\right)$$

$\underline{C_1}$

11. A crystal is made up of metal ions 'M_1' ana 'M_2' and oxide ions. Oxide ions form a ccp lattice structure. The cation 'M_1' occupies 50% of octahedral voids and the cation 'M_2' occupies 12.5% of tetrahedral voids of oxide lattice. The oxidation numbers of 'M_1' and 'M_2' are, respectively :

(1) +2, +4 (2) +3, +1

(3) +1, +3 (4) +4, +2

Official Ans. by NTA (1)

Sol. O^{-2} ions form ccp. O_4 $\downarrow$ (–8 charge)

$$M_1 = 50\% \text{ of O.V.} \Rightarrow \frac{50}{100}\times 4 = 2 : (M_1)_2$$

$$M_2 = 12.5\% \text{ of T.V.} \Rightarrow \frac{12.5}{100}\times 8 = 1 : (M_2)_1$$

So formula is : $(M_1)_2\ (M_2)_1O_4$

This must be neutral. Both metals must have +8 charge in total.

From given options : $\left\{\begin{matrix} \text{O.N. of } M_1 = +2 \\ M_2 = +4 \end{matrix}\right\}$

12. For a d^4 metal ion in an octahedral field, the correct electronic configuration is :

(1) $t_{2g}^4 e_g^0$ when $\Delta_O < P$

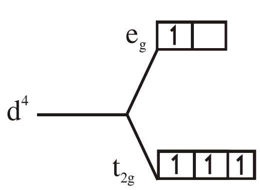
(2) $e_g^2 t_{2g}^2$ when $\Delta_O < P$

(3) $t_{2g}^3 e_g^1$ when $\Delta_O < P$

(4) $t_{2g}^3 e_g^1$ when $\Delta_O > P$

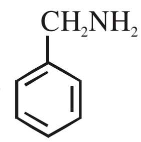
Official Ans. by NTA (3)

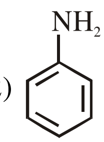
Sol.

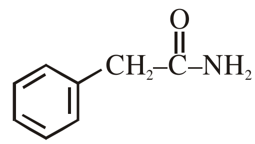


back pairing is not possible because pairing energy $> \Delta$.

13. Which of the following compounds can be prepared in good yield by Gabriel phthalimide synthesis?

(1)


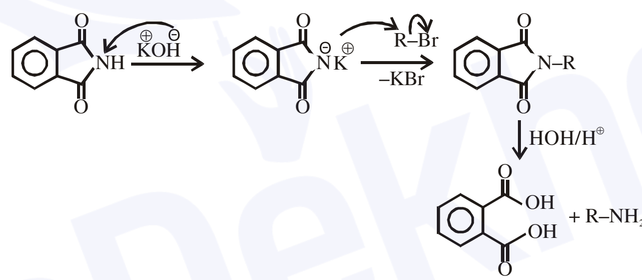
(2)


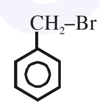
(3)


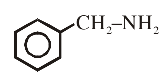
(4) $CH_3–CH_2–NHCH_3$

Official Ans. by NTA (1)

Sol. Gabriel phthalimide synthesis is used for preparation of 1° Aliphatic amine



Here R–Br =


$R–NH_2$ =


14. The correct match between **Item-I** (starting material) and **Item-II** (reagent) for the preparation of benzaldehyde is :

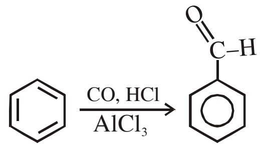
Item-I	Item-II
(I) Benzene	(P) HCl and $SnCl_2, H_3O^+$
(II) Benzonitrile	(Q) H_2, Pd-$BaSO_4$, S and quinoline
(III) Benzoyl Chloride	(R) CO, HCl and $AlCl_3$

(1) (I)-(Q), (II)-(R) and (III)-(P)

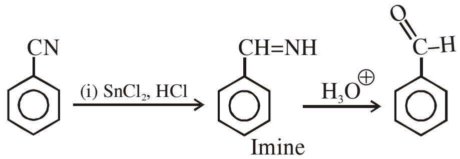
(2) (I)-(R), (II)-(Q) and (III)-(P)

(3) (I)-(R), (II)-(P) and (III)-(Q)

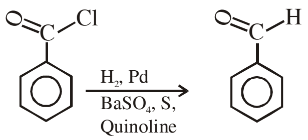
(4) (I)-(P), (II)-(Q) and (III)-(R)

Sol.(i) 

(Gattermann koch reaction)

(ii) 

(Stephen reduction)

(iii) 

(Rosenmund reduction)

15. The average molar mass of chlorine is 35.5 g mol^{-1}. The ratio of ^{35}Cl to ^{37}Cl in naturally occurring chlorine is close to :

(1) 4 : 1

(2) 1 : 1

(3) 2 : 1

(4) 3 : 1

Official Ans. by NTA (4)

Sol.

	^{35}Cl		^{37}Cl	Av. molar mass = 35.5
let mole ratio	x	:	1	

Av. molar mass = $\dfrac{n_1M_1 + n_2M_2}{(n_1 + n_2)}$

$$35.5 = \frac{x \times 35 + 1 \times 37}{x + 1}$$

x = 3

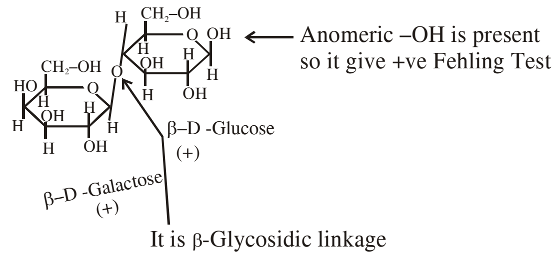
16. Which one of the following statements not true ?

(1) Lactose contains α-glycosidic linkage between C_1 of galactose and C_4 of glucose.

(2) Lactose ($C_{11}H_{22}O_{11}$) is a disaccharide and it contains 8 hydroxyl groups.

(3) On acid hydrolysis, lactose gives one molecule of D(+)-glucose and one molecule of D(+)-galactose.

(4) Lactose is a reducing sugar and it gives

Sol. 

Structure of Lactose

structure of lactose

17. A set of solutions is prepared using 180 g of water as a solvent and 10 g of different non-volatile solutes A, B and C. The relative lowering of vapour pressure in the presence of these solutes are in the order [Given, molar mass of A = 100 g mol^{-1}; B = 200 g mol^{-1}; C = 10,000 g mol^{-1}]

(1) A > B > C

(2) A > C > B

(3) C > B > A

(4) B > C > A

Official Ans. by NTA (1)

Sol. Relative lowering of V.P. = $\dfrac{\Delta P}{P^0} = x_{solute}$

$$\left(\frac{\Delta P}{P^0}\right)_A = \frac{\frac{10}{100}}{\frac{10}{100} + \frac{180}{18}} : \left(\frac{\Delta P}{P^0}\right)_B = \frac{\frac{10}{200}}{\frac{10}{200} + \frac{180}{18}}$$

$$\left(\frac{\Delta P}{P^0}\right)_C = \frac{\frac{10}{10,000}}{\frac{10}{10,000} + \frac{180}{18}} : \left(\frac{\Delta P}{P^0}\right)_A > \left(\frac{\Delta P}{P^0}\right)_B > \left(\frac{\Delta P}{P^0}\right)_C$$

18. For a reaction,

$4M(s) + nO_2(g) \rightarrow 2M_2O_n(s)$,

the free energy change is plotted as a function of temperature. The temperature below which the oxide is stable could be inferred from the plot as the point at which :

(1) the slope changes from positive to zero

(2) the free energy change shows a change from negative to positive value

(3) the slope changes from negative to positive

(4) the slope changes from positive to negative

19. Match the following compounds (Column-I) with their uses (Column-II) :

S.No.	Column – I	S.No.	Column – II
(I)	$Ca(OH)_2$	(A)	casts of statues
(II)	NaCl	(B)	white wash
(III)	$CaSO_4.\frac{1}{2}H_2O$	(C)	antacid
(IV)	$CaCO_3$	(D)	washing soda preparation

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

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

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

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

Official Ans. by NTA (4)

Sol. (I) $Ca(OH)_2$ is used in white wash

(II) NaCl is used in preparation of washing soda

$$2NH_3 + H_2O + CO_2 \longrightarrow (NH_4)_2CO_3$$

$$(NH_4)_2CO_3 + H_2O + CO_2 \longrightarrow 2NH_4HCO_3$$

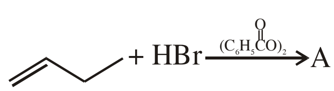
$$NH_4HCO_3 + NaCl \longrightarrow NH_4Cl + NaHCO_3(s)$$

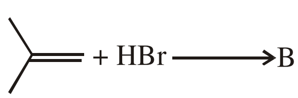
$$2NaHCO_3 \xrightarrow{\Delta} Na_2CO_3 + CO_2 + H_2O$$

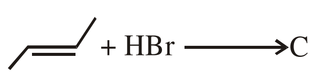
(III) $CaSO_4.\frac{1}{2}H_2O$ (Plaster of Paris) is used for making casts of statues

(IV) $CaCO_3$ is used as an antacid

20. The increasing order of the boiling points of the major products A, B and C of the following reactions will be :

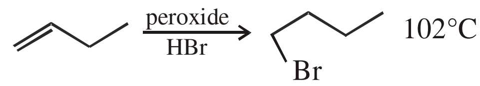
(a) 

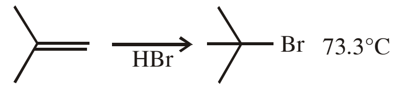
(b) 

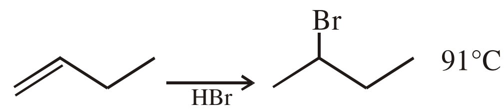
(c) 

(1) C < A < B (2) B < C < A

(3) A < B < C (4) A < C < B

Sol. (a) 

(b) 

(c) 

B.P. $\propto \frac{1}{\text{Branching}}$ $\therefore$ a > c > b (order of B.P.)

21. For Freundlich adsorption isotherm, a plot of log (x/m) (y-axis) and log p (x-axis) gives a straight line. The intercept and slope for the line is 0.4771 and 2, respectively. The mass of gas, adsorbed per gram of adsorbent if the initial pressure is 0.04 atm, is_ _ _ _ _ _ × 10^{-4}g.

(log 3 = 0.4771)

Official Ans. by NTA (48.00)

Sol. $\frac{x}{m} = KP^{1/n}$

$$\log\left(\frac{x}{m}\right) = \frac{1}{n}\log P + \log K$$

$$\text{slope} = \frac{1}{n} = 2$$

intercept = log K = 0.4771

K = 3

mass of gas adsorbed per gm of adsorbent = $\frac{x}{m}$

$$\frac{x}{m} = 3 \times (0.04)^2 = 48 \times 10^{-4}$$

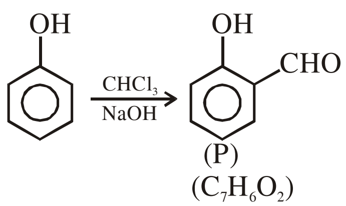
22. A solution of phenol in chloroform when treated with aqueous NaOH gives compound P as a major product. The mass percentage of carbon in P is________. (to the nearest integer)

(Atomic mass : C = 12; H = 1; O = 16)

Official Ans. by NTA (69.00)

Official Ans. by (68.85)

Sol.



(Reimer Tiemann reaction)

Molecular weight of $C_7H_6O_2$ = 122

$$\%C = \frac{12 \times 7 \times 100}{122} = 68.85 \approx 69$$

23. If the solubility product of AB_2 is 3.20×10^{-11} M^3, then the solubility of AB_2 in pure water is_ _ _ _ _ $\times 10^{-4}$ mol L^{-1}. [Assuming that neither kind of ion reacts with water]

Official Ans. by NTA (2.00)

Sol. $$AB_2(s) \rightleftharpoons \underset{S}{A^{+2}_{(aq.)}} + \underset{2S}{2B^{-}_{(aq.)}} : K_{sp}$$

$K_{SP} = S^1 \times (2s)^2 = 4s^3$

$3.2 \times 10^{-11} = 4 \times S^3$

$S = 2 \times 10^{-4}$ M/L

24. The rate of a reaction decreased by 3.555 times when the temperature was changed from 40°C to 30°C. The activation energy (in kJ mol^{-1}) of the reaction is_ _ _ _ _ _.

Take; R=8.314 J mol^{-1} K^{-1} In 3.555 = 1.268

Official Ans. by NTA (100.00)

Official Ans. by (99.98)

Sol. $$\ell n\left(\frac{K_{T_2}}{K_{T_1}}\right) = \frac{E_a}{R}\left[\frac{1}{T_1} - \frac{1}{T_2}\right]$$

$T_1 = 303$ K ; $T_2 = 313$ K

$$\frac{K_{T_2}}{K_{T_1}} = 3.555$$

$$\ell n(3.555) = \frac{E_a}{8.314}\left[\frac{1}{303} - \frac{1}{313}\right]$$

$E_a = 99980.715$

$$E_a = 99.98 \ \frac{kJ}{mole}$$

25. The atomic number of Unnilunium is _____.

Official Ans. by NTA (101.00)

Sol. Unnilunium $\Rightarrow$ 101