FINAL JEE–MAIN EXAMINATION – AUGUST, 2021

(Held On Friday 27th August, 2021) **TIME : 3 : 00 PM to 6 : 00 PM**

CHEMISTRY — TEST PAPER WITH SOLUTION

SECTION-A

1. Choose the **correct** statement from the following :

(1) The standard enthalpy of formation for alkali metal bromides becomes less negative on descending the group.

(2) The low solubility of CsI in water is due to its high lattice enthalpy.

(3) Among the alkali metal halides, LiF is least soluble in water.

(4) LiF has least negative standard enthalpy of formation among alkali metal fluorides.

Official Ans. by NTA (3)

Sol. 1. Standard enthalpy of formation for alkali metal bromides becomes more negative on desending down the group.

2. In case of CsI, lattice energy is less, but Cs^+ is having less hydration enthalpy due to which it is less soluble in water.

3. For alkali metal fluorides, the solubility in water increases from lithium to caesium. LiF is least soluble in water.

4. Standard enthalpy of formation for LiF is most negative among alkali metal fluorides.

2. The addition of dilute NaOH to Cr^{3+} salt solution will give :

(1) a solution of $[Cr(OH)_4]^-$

(2) precipitate of $Cr_2O_3(H_2O)_n$

(3) precipitate of $[Cr(OH)_6]^{3-}$

(4) precipitate of $Cr(OH)_3$

Official Ans. by NTA (2)

Sol. $Cr^{3+} + \underset{\text{dil.}}{NaOH} \longrightarrow \underset{\text{precipitate}}{Cr_2O_3.(H_2O)_n}$

3. Given below are two statements :

Statement I : Ethyl pent–4–yn–oate on reaction with CH_3MgBr gives a 3°–alcohol.

Statement II : In this reaction one mole of ethyl pent–4–yn–oate utilizes two moles of CH_3MgBr.

In the light of the above statements, choose the **most appropriate** answer from the options given below :

(1) Both **Statement I** and **Statement II** are false.

(2) **Statement I** is false but **Statement II** is true.

(3) **Statement I** is true but **Statement II** is false.

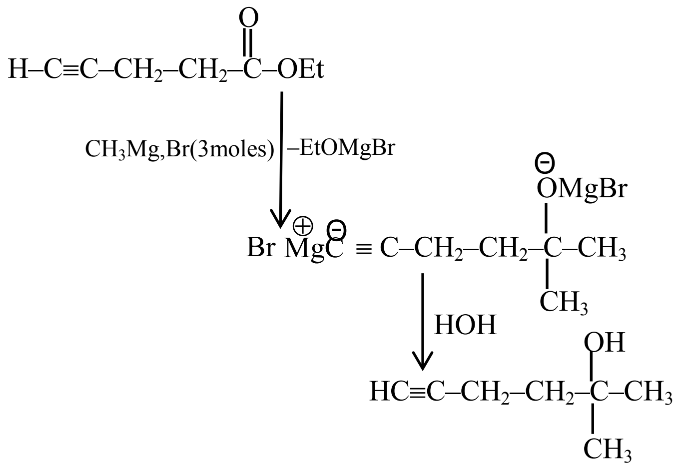
(4) Both **Statement I** and **Statement II** are true.

Official Ans. by NTA (3)

Sol. Statement 1 is true

But it consume 3 moles of G R

So statement 2 is false.



4. In stratosphere most of the ozone formation is assisted by :

(1) cosmic rays. (2) γ–rays.

(3) ultraviolet radiation. (4) visible radiations.

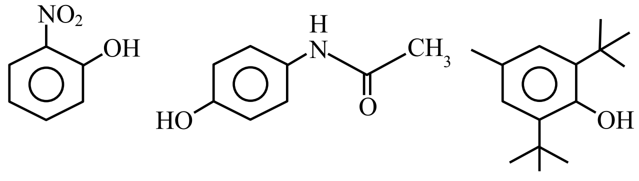
Official Ans. by NTA (3)

Sol. Ozone in the stratosphere is a product of UV radiations acting on dioxygen (O_2) molecules.

$$O_2(g) \xrightarrow{UV} O(g) + O(g)$$

$$O(g) + O_2(g) \underset{}{\overset{UV}{\rightleftharpoons}} O_3(g)$$

5. The compound/s which will show significant intermolecular H–bonding is/are :



(a) (b) (c)

(1) (b) only (2) (c) only
(3) (a) and (b) only (4) (a), (b) and (c)

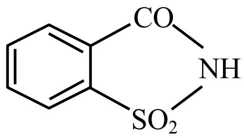
Official Ans. by NTA (1)

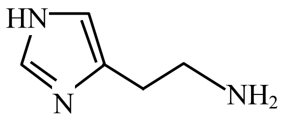
Sol. (a) Shows intra molecular H-bonding

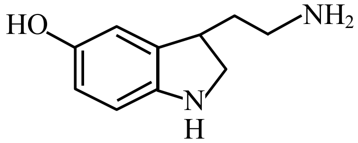
(b) Shows significant intermolecular H-bonding

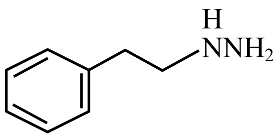
(c) It do not show intermolecular H-bonding due to steric hindrance.

6. Which one of the following chemicals is responsible for the production of HCl in the stomach leading to irritation and pain?

(1) 

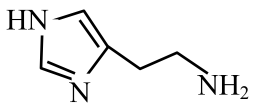
(2) 

(3) 

(4) 

Official Ans. by NTA (2)

Sol. Histamine stimulate the secretion of HCl



Histamine structure

7. The oxide that gives H_2O_2 most readily on treatment with H_2O is :

(1) PbO_2 (2) Na_2O_2
(3) SnO_2 (4) $BaO_2\cdot 8H_2O$

Official Ans. by NTA (2)

Sol. 1. $PbO_2 + 2H_2O \rightarrow Pb(OH)_4$

2. $Na_2O_2 + 2H_2O \rightarrow 2NaOH + H_2O_2$

this reaction is possible at room temperature

3. $SnO_2 + 2H_2O \rightarrow Sn(OH)_4$

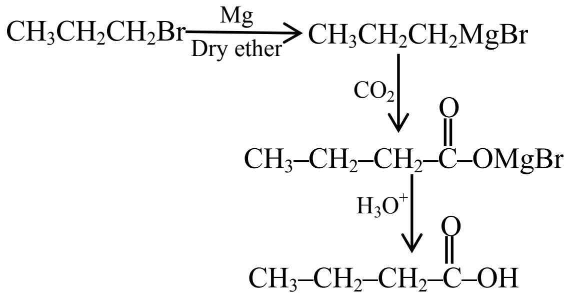
4. Acidified $BaO_2.8H_2O$ gives H_2O_2 after evaporation.

8. Which one of the following reactions will **not** yield propionic acid?

(1) $CH_3CH_2COCH_3 + OI^-/H_3O^+$
(2) $CH_3CH_2CH_3 + KMnO_4(Heat), OH^-/H_3O^+$
(3) $CH_3CH_2CCl_3 + OH^-/H_3O^+$
(4) $CH_3CH_2CH_2Br + Mg, CO_2$ dry ether/H_3O^+

Official Ans. by NTA (4)

Sol. All gives propanoic acid as product but option 4 gives butanoic as product



Butanoic acid

9. The correct order of ionic radii for the ions, P^{3-}, S^{2-}, Ca^{2+}, K^+, Cl^- is :

(1) $P^{3-} > S^{2-} > Cl^- > K^+ > Ca^{2+}$
(2) $Cl^- > S^{2-} > P^{3-} > Ca^{2+} > K^+$
(3) $P^{3-} > S^{2-} > Cl^- > Ca^{2+} > K^+$
(4) $K^+ > Ca^{2+} > P^{3-} > S^{2-} > Cl^-$

Official Ans. by NTA (1)

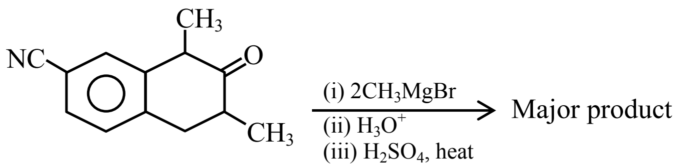
Sol. $P^{3-} > S^{2-} > Cl^- > K^+ > Ca^{2+}$

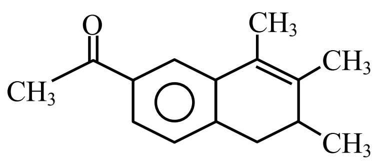
(Correct order of ionic radii)

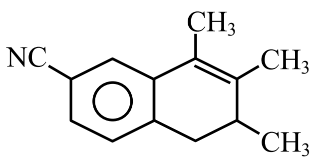
all the given species are isoelectronic species.

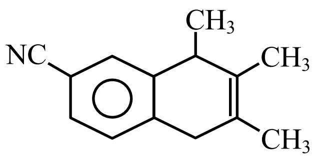
In isoelectronic species size increases with increase of negative charge and size decreases with increase in positive charge.

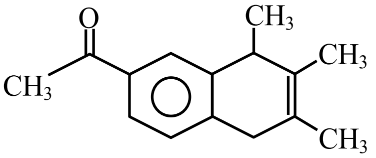
10. Which one of the following is the major product of the given reaction?



(1) 

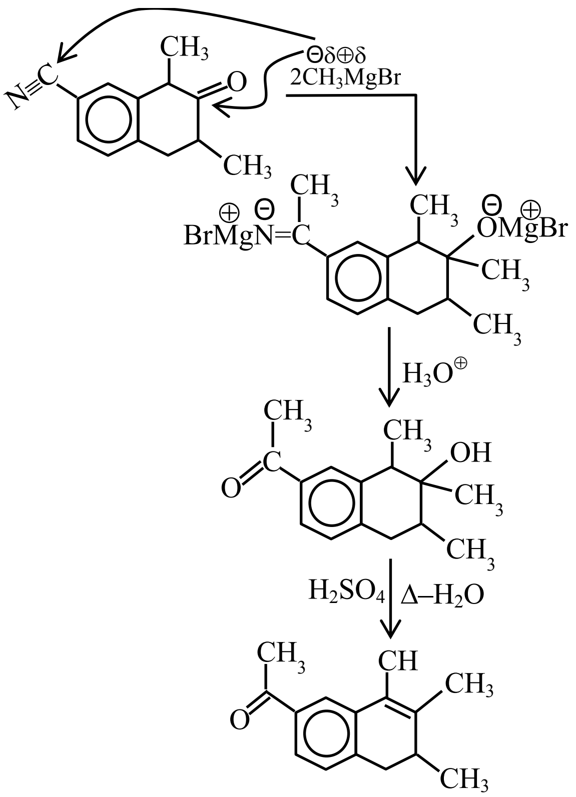
(2) 

(3) 

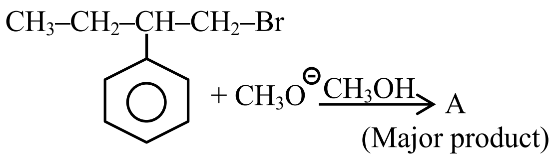
(4) 

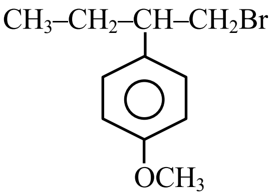
Official Ans. by NTA (1)

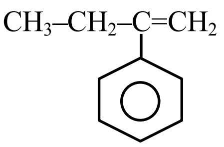
Sol.

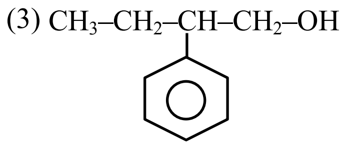


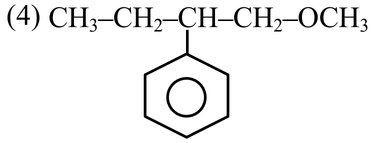
11. The major product (A) formed in the reaction given below is :



(1) 

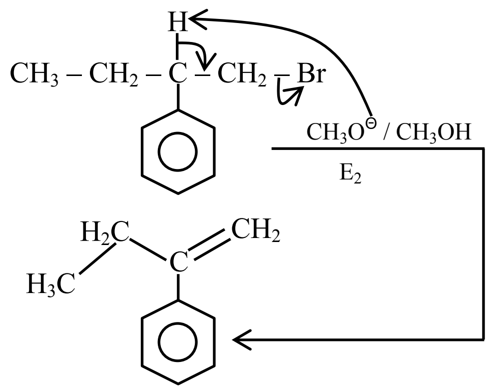
(2) 

(3) 

(4) 

Official Ans. by NTA (2)

Sol.



Major product (A)

12. Which one of the following is used to remove most of plutonium from spent nuclear fuel?

(1) ClF_3 (2) O_2F_2 (3) I_2O_5 (4) BrO_3

Official Ans. by NTA (2)

Sol. O_2F_2 oxidises plutonium to PuF_6 and the reaction is used in removing plutonium as PuF_6 from spent nuclear fuel.

13. Lyophilic sols are more stable than lyophobic sols because :

(1) there is a strong electrostatic repulsion between the negatively charged colloidal particles.

(2) the colloidal particles have positive charge.

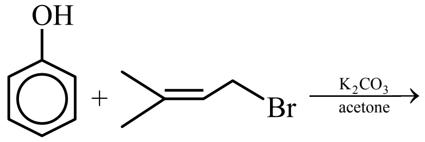
(3) the colloidal particles have no charge.

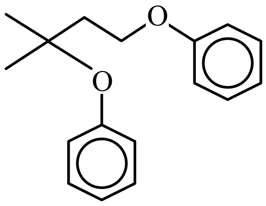
(4) the colloidal particles are solvated.

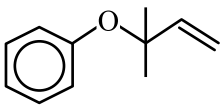
Official Ans. by NTA (4)

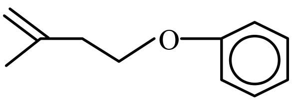
Sol. In the lyophilic colloids, the colloidal particles are extensively solvated.

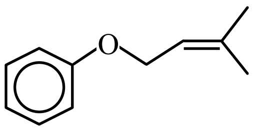
14. The major product of the following reaction, if it occurs by S_N2 mechanism is :



(1) 

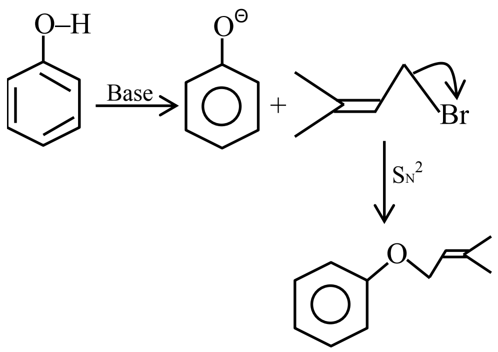
(2) 

(3) 

(4) 

Official Ans. by NTA (4)

Sol.



15. Potassium permanganate on heating at 513 K gives a product which is :

(1) paramagnetic and colourless

(2) diamagnetic and green

(3) diamagnetic and colourless

(4) paramagnetic and green

Official Ans. by NTA (4)

Sol. $2KMnO_4 \xrightarrow[200°C]{\Delta} \underset{\text{Green}}{K_2MnO_4} + \underset{\text{Black}}{MnO_2} + O_2$

In K_2MnO_4, manganese oxidation state is +6 and hence it has one unpaired e^-.

16. Which one of the following tests used for the identification of functional groups in organic compounds does not use copper reagent ?

(1) Barfoed's test

(2) Seliwanoff's test

(3) Benedict's test

(4) Biuret test for peptide bond

Official Ans. by NTA (2)

Sol. In Seliwanoff's reagent, Cu is not present.

In Barfoed, Biuret and in Benediet reagent Cu is present.

17. Hydrolysis of sucrose gives :

(1) α-D-(–)-Glucose and β-D-(–)-Fructose

(2) α-D-(+)-Glucose and α-D-(–)-Fructose

(3) α-D-(–)-Glucose and α-D-(+)-Fructose

(4) α-D-(+)-Glucose and β-D-(–)-Fructose

Official Ans. by NTA (4)

Sol. Sucrose is formed by α–D(+) . Glucose + β–D (–) Fructose.

we obtain these monomers on hydrolysis.

18. Match **List-I** with **List – II** :

List-I	**List-II**
(Name of ore/mineral)	**(Chemical formula)**
(a) Calamine	(i) Zns
(b) Malachite	(ii) $FeCO_3$
(c) Siderite	(iii) $ZnCO_3$
(d) Sphalerite	(iv) $CuCO_3 \cdot Cu(OH)_2$

Choose the **most appropriate** answer from the options given below :

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

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

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

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

Official Ans. by NTA (1)

Sol. (Name of ore/mineral)

(a) Calamine	$ZnCO_3$
(b) Malachite	$CuCO_3.Cu(OH)_2$
(c) Siderite	$FeCO_3$
(d) Sphalerite	ZnS

19. Which one of the following is formed (mainly) when red phosphorus is heated in a sealed tube at 803 K ?

(1) White phosphorus

(2) Yellow phosphorus

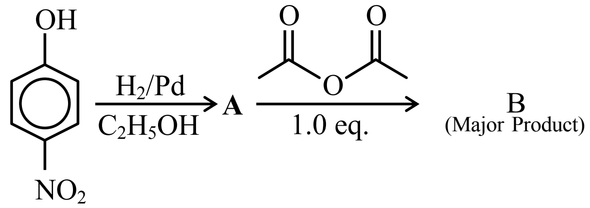
(3) β-Black phosphorus

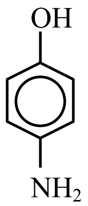
(4) α-Black phosphorus

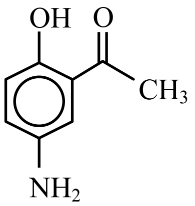
Official Ans. by NTA (4)

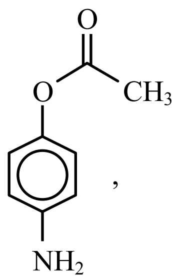
Sol. When red phosphorus is heated in a sealed tube at 803 K, α-black phosphorus is formed.

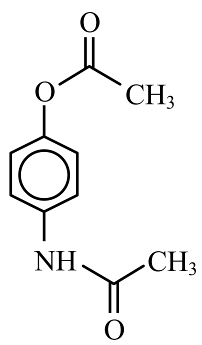
20. The correct structures of **A** and **B** formed in the following reactions are :

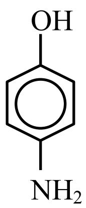


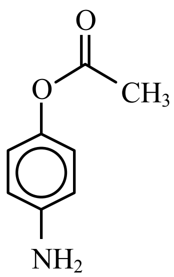
(1) **A** : 

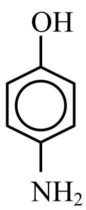
, **B** : 

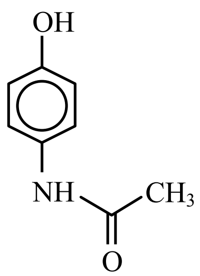
(2) **A** : 

, **B** : 

(3) **A** : 

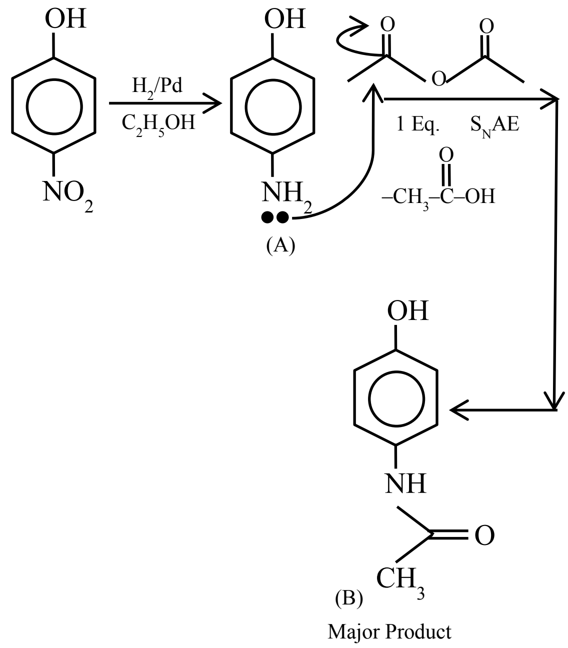
, **B** : 

(4) **A** : 

, **B** : 

Official Ans. by NTA (4)

Sol.



SECTION-B

1. The first order rate constant for the decomposition of $CaCO_3$ at 700 K is $6.36 \times 10^{-3} s^{-1}$ and activation energy is 209 kJ mol^{-1}. Its rate constant (in s^{-1}) at 600 K is $x \times 10^{-6}$. The value of x is ________. (Nearest integer)

[Given R = 8.31 J K^{-1} mol^{-1}; log $6.36 \times 10^{-3} = -2.19$, $10^{-4.79} = 1.62 \times 10^{-5}$]

Official Ans. by NTA (16)

Sol. $K_{700} = 6.36 \times 10^{-3} s^{-1}$;

$K_{600} = x \times 10^{-6} s^{-1}$

E_a = 209 kJ/mol

Applying ;

$$\log\left(\frac{K_{T_2}}{K_{T_1}}\right) = \frac{-E_a}{2.303R}\left(\frac{1}{T_2} - \frac{1}{T_1}\right)$$

$$\log\left(\frac{K_{700}}{K_{600}}\right) = \frac{-E_a}{2.303R}\left(\frac{1}{700} - \frac{1}{600}\right)$$

$$\log\left(\frac{6.36 \times 10^{-3}}{K_{600}}\right) = \frac{+209 \times 1000}{2.303 \times 8.31}\left(\frac{100}{700 \times 600}\right)$$

$\log(6.36 \times 10^{-3}) - \log K_{600} = 2.6$

$\Rightarrow \log K_{600} = -2.19 - 2.6 = -4.79$

$\Rightarrow K_{600} = 10^{-4.79} = 1.62 \times 10^{-5}$

$= 16.2 \times 10^{-6}$

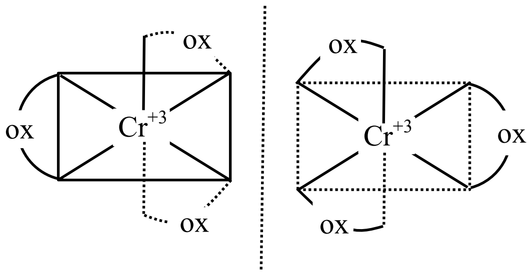
$= x \times 10^{-6}$

$\Rightarrow x = 16$

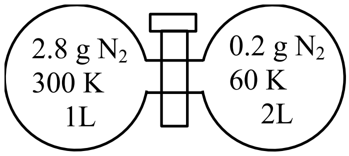
2. The number of optical isomers possible for $[Cr(C_2O_4)_3]^{3-}$ is ______.

Official Ans. by NTA (2)

Sol. The number of optical isomers for $[Cr(C_2O_4)_3]^{3-}$ is two.



3. Two flasks I and II shown below are connected by a valve of negligible volume.



I II

When the valve is opened, the final pressure of the system in bar is x × 10^{-2}. The value of x is ______. (Integer answer)

[Assume–Ideal gas; 1 bar = 10^5 Pa; Molar mass of N_2 = 28.0 g mol^{-1} ; R = 8.31 J $mol^{-1}K^{-1}$]

Official Ans. by NTA (84)

Sol. Applying ; $(n_I + n_{II})_{initial} = (n_I + n_{II})_{final}$

$\Rightarrow$ Assuming the system attains a final temperature of T (such that 300 < T < 60)

$$\Rightarrow \left(\begin{array}{c}\text{Heat lost by}\\ N_2 \text{ of container}\\ \text{I}\end{array}\right) = \left(\begin{array}{c}\text{Heat gained by}\\ N_2 \text{ of container}\\ \text{II}\end{array}\right)$$

$\Rightarrow n_I C_m(300–T) = n_{II} C_m (T–60)$

$$\Rightarrow \left(\frac{2.8}{28}\right)(300 - T) = \frac{0.2}{28}(T - 60)$$

$\Rightarrow 14(300–T) = T–60$

$$\Rightarrow \frac{(14 \times 300 + 60)}{15} = T$$

$\Rightarrow$ T = 284 K (final temperature)

$\Rightarrow$ If the final pressure = P

$$\Rightarrow (n_I + n_{II})_{final} = \left(\frac{3.0}{28}\right)$$

$$\Rightarrow \frac{P}{RT}(V_I + V_{II}) = \frac{3.0 gm}{28 gm / mol}$$

$$P = \left(\frac{3}{28} mol\right) \times 8.31 \frac{J}{mol - K} \times \frac{284K}{3 \times 10^{-3} m^3} \times 10^{-5} \frac{bar}{Pa}$$

$\Rightarrow$ 0.84287 bar

$\Rightarrow 84.28 \times 10^{-2}$ bar

$\Rightarrow$ 84

4. 100 g of propane is completely reacted with 1000 g of oxygen. The mole fraction of carbon dioxide in the resulting mixture is x × 10^{-2}. The value of x is ______. (Nearest integer)

[Atomic weight : H = 1.008; C = 12.00; O = 16.00]

Official Ans. by NTA (19)

Sol. $C_3H_{8(g)} + 5O_{2(g)} \longrightarrow 3CO_{2(g)} + 4H_2O_{(\ell)}$

t = 0 2.27 mole 31.25 mol

t = ∞ 0 19.9 mol 6.81 mol 9.08 mol

mole fraction of CO_2 in the final reaction mixture (heterogenous)

$$X_{CO_2} = \frac{6.81}{19.9 + 6.81 + 9.08}$$

$= 0.1902 = 19.02 \times 10^{-2}$

$\Rightarrow$ 19

5. 40 g of glucose (Molar mass = 180) is mixed with 200 mL of water. The freezing point of solution is _____ K. (Nearest integer)

[Given : K_f = 1.86 K kg mol^{-1} ; Density of water = 1.00 g cm^{-3}; Freezing point of water = 273.15 K]

Official Ans. by NTA (271)

Sol. $$\text{molality} = \frac{\left(\frac{40}{180}\right) mol}{0.2 Kg} = \left(\frac{10}{9}\right) molal$$

$$\Rightarrow \Delta T_f = T_f - T_f' = 1.86 \times \frac{10}{9}$$

$$\Rightarrow T_f' = 273.15 - 1.86 \times \frac{10}{9}$$

= 271.08 K

≃ 271 K (nearest-integer)

6. The resistance of a conductivity cell with cell constant 1.14 cm^{-1}, containing 0.001 M KCl at 298 K is 1500 Ω. The molar conductivity of 0.001 M KCl solution at 298 K in S cm^2 mol^{-1} is_______. (Integer answer)

Official Ans. by NTA (760)

Sol. $$K = \frac{1}{R} \times \ell/_A = \left(\left(\frac{1}{1500}\right) \times 1.14\right) S\ cm^{-1}$$

$$\Rightarrow \wedge_m = 1000 \times \frac{\left(\frac{1.14}{1500}\right)}{0.001}\ S\ cm^2 mol^{-1}$$

= 760 S cm^2 mol^{-1}

⇒ 760

7. The number of photons emitted by a monochromatic (single frequency) infrared range finder of power 1 mW and wavelength of 1000 nm, in 0.1 second is x × 10^{13}. The value of x is _____. (Nearest integer)

(h = 6.63 × 10^{-34} Js, c = 3.00 × 10^8 ms^{-1})

Official Ans. by NTA (50)

Sol. Energy emitted in 0.1 sec.

$$= 0.1\ sec. \times 10^{-3} \frac{J}{s}$$

= 10^{-4} J

If 'n' photons of λ = 1000 nm are emitted,

then ; $10^{-4} = n \times \frac{hc}{\lambda}$

$$\Rightarrow 10^{-4} = \frac{n \times 6.63 \times 10^{-34} \times 3 \times 10^8}{1000 \times 10^{-9}}$$

⇒ n = 5.02 × 10^{14} = 50.2 × 10^{13}

⇒ 50 (nearest integer)

8. When 5.1 g of solid NH_4HS is introduced into a two litre evacuated flask at 27°C, 20% of the solid decomposes into gaseous ammonia and hydrogen sulphide. The K_p for the reaction at 27°C is x × 10^{-2}. The value of x is _______. (Integer answer)

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

Official Ans. by NTA (6)

Sol. moles of NH_4HS initially taken = $\frac{5.1g}{51g/mol}$

= 0.1 mol

volume of vessel = 2ℓ

$$NH_4HS_{(s)} \rightleftharpoons NH_{3(g)} + H_2S_{(g)}$$

t = 0	0.1 mol		
t = ∞	0.1(1–0.2)	0.1×0.2	0.1×0.2

⇒ partial pressure of each component

$$P = \frac{nRT}{V} = \frac{0.1 \times 0.2 \times 0.082 \times 300}{2}$$

= 0.246 atm

$$\Rightarrow k_P = P_{NH_3} \times P_{H_2S} = (0.246)^2 = 0.060516$$

= 6.05 × 10^{-2}

⇒ 6

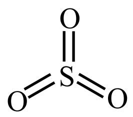
9. The number of species having non–pyramidal shape among the following is_______.

(A) SO_3 (B) NO_3^-

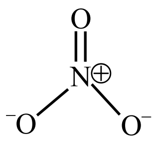
(C) PCl_3 (D) CO_3^{2-}

Official Ans. by NTA (3)

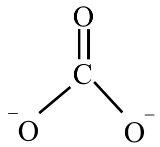
Sol.



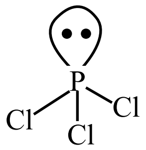
Trigonal planar



Trigonal planar



Trigonal planar



Pyramidal

Hence non-pyramidal species are SO_3, NO_3^- and CO_3^{2-}.

10. Data given for the following reaction is as follows:

$FeO_{(s)} + C_{(graphite)} \longrightarrow Fe_{(s)} + CO_{(g)}$

Substance	ΔH° (kJ mol^{-1})	ΔS° (J mol^{-1}K^{-1})
$FeO_{(s)}$	–266.3	57.49
$C_{(graphite)}$	0	5.74
$Fe_{(s)}$	0	27.28
$CO_{(g)}$	–110.5	197.6

The minimum temperature in K at which the reaction becomes spontaneous is _______.

(Integer answer)

Official Ans. by NTA (964)

Sol. $T_{min} = \left(\dfrac{\Delta^0 H}{\Delta^0 S}\right)$

$$\Delta^0 H_{rxn} = \left[\Delta_f^0 H(Fe) + \Delta_f^0 H(CO)\right] -$$

$$= \left[\Delta_f^0 H(FeO) + \Delta_f^0 H(C_{(graphite)})\right]$$

= [0 – 110.5] – [–266.3+0]

= 155.8 kJ/mol

$$\Delta^0 S_{rxn} = \left[\Delta^0 S(Fe) + \Delta^0 S(CO)\right] -$$

$$\left[\Delta^0 S(FeO) + \Delta^0 S(C_{(graphite)})\right]$$

= [27.28 + 197.6] – [57.49 + 5.74]

= 161.65 J/mol-K

$$T_{min} = \frac{155.8 \times 10^3 J/mol}{161.65 J/mol-K} = 963.8K$$

≃ 964 k (nearest integer)