JEE MAIN July 2021

CHEMISTRY

27th July 2021 [SHIFT – 2]

QUESTION WITH SOLUTION

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Section-A

1. To an aqueous solution containing ions such as Al^{3+}, Zn^{2+}, Ca^{2+}, Fe^{3+}, Ni^{2+}, Ba^{2+} and $Cu^{2+}$was added conc. HCl, followed by H_2S.
The total number of cations precipitated during this reaction is/are:
(1)4 (2)1 (3) 3 (4)2

Sol. **(2)**

Al^{3+} and Fe^{3+}sulphideshydrolyse inwater.

Ni^{2+} and Zn^{2+} require basic medium with H_2S to form ppt
Ca^{2+} and Ba^{2+} sulphides are soluble hence we will receive only CuS ppt.

2. Which one of the following set of elements can be detected using sodium fusion extract?
(1) Halogens, Nitrogen, Oxygen,Sulfur
(2) Sulfur, Nitrogen, Phosphorous,Halogens
(3) Nitrogen, Phosphorous, Carbon,Sulfur
(4) Phosphorous, Oxygen, Nitrogen,Halogens

Sol. **(2)**

By sodium fusion extract we can detect sulphur, nitrogen,
Phosphorous and halogens, because they are converted in to their ionic form with sodium metal.

3. The CORRECT order of first ionisation enthalpy is:
(1) Mg < Al < S <P (2) Al < Mg < S<P
(3) Mg < Al < P <S (4) Mg < S < Al <P

Sol. **(2)**

MgAlPS $\rightarrow$ I.E. order $\rightarrow$ Al< Mg < S <P

	Mg	Al	P	S
Valence $[N_e]$:	$3s^2$	$3s^23p^1$	$3s^23p^3$	$3s^23p^4$
		↑	↑	
		Full	Half	
		Filled	Filled	
		Stable	Stable	

4. $R-CN \xrightarrow[(ii)\ H_2O]{(i)\ DIBAL-H} R-Y$

Consider the above reaction and identify "Y"
(1) –CHO (2) $-CONH_2$
(3) $-CH_2NH_2$ (4) –COOH

Sol. **(1)**

$$R-C\equiv N \xrightarrow[(ii)\ H_2O]{(i)\ DIBAL-H} R-\underset{\underset{O}{\|}}{C}-H$$

Here Y is $-\underset{\underset{O}{\|}}{C}-H$ Aldehyde.

5. Given below are two statements:
Statement I: $[Mn(CN)_6]^{3-}$, $[Fe(CN)_6]^{3-}$ and $[Co(C_2O_4)_3]^{3-}$ are d^2sp^3hybridised.
Statement II: $[MnCl_6]^{3-}$ and $[FeF_6]^{3-}$ are paramagnetic and have 4 and 5 unpaired electrons, respectively.
In the light of the above statements, choose the c0orrect answer from the options given below :
(1) Both statement I and statement II are false
(2) Statement I is incorrect but statement II is true
(3) Statement I is correct but statement II is false
(4) Both statement I and statement II are true

Sol. **(4)**

$[Mn(CN)_6]^{3-}$ $[Fe(CN)_6]^{3-}$ $[Co(C_2O_4)_3]^{3-}$

$\Downarrow$

$Mn^{3+}CN^-$ Fe^{3+},CN^- $Co^{3+},C_2O_4^{2-}$

d^4configuration,SFLd^5 configuration, SFL d^6configuration, Chelatingligand
$\Rightarrow$ All will have larger splitting hence d^2sp^3hybridisation.

$[MnCl_6]^{3-}$ and $[FeF_6]^{3-}$

d^4 configuration, Cl^- d^5 configuration, F^-

WFL WFL

$\underline{1}$ $\underline{\quad}$ $\underline{1}$ $\underline{1}$
$\underline{1}$ $\underline{1}$ $\underline{1}$ $\underline{1}$ $\underline{1}$ $\underline{1}$

$\Downarrow$ $\Downarrow$

4 unpaired electrons 5 unpaired electrons

6. Given below are two statements:
Statement I: Hyperconjugation is a permanent effect.
Statement II: Hyper conjugation in ethyl cation $\left(CH_3-\overset{+}{C}H_2\right)$ involves the over lapping of $C_{sp^2}-H_{1s}$ bond with empty 2p orbital of other carbon.
Choose the correct option:
(1) Both statement I and statement II are true
(2) Statement I is incorrect but statement II is true
(3) Statement I is correct but statement II is false
(4) Both Statement I and statement II are false.

Sol. **(3)**

Statement I: It is correct statement

Statement II: $CH_3-\overset{\oplus}{C}H_2$ involve $C_{sp^3}-H_{1s}$ bond with empty 2p orbital hence given statement is false.

7. The addition of silica during the extraction of copper from its sulphide ore:
(1) converts iron oxide into iron silicate
(2) converts copper sulphide into copper silicate
(3) reduces copper sulphide into metallic copper
(4) reduces the melting point of the reaction mixture

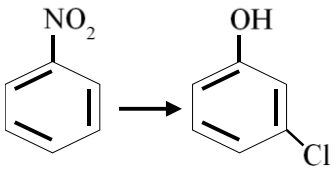
Sol. **(1)**

Silica is used to remove FeO impurity from the ore of copper

$FeO + SiO_2 \rightarrow FeSiO_3$

iron silicate
(Slag)

8. The correct sequence of correct reagents for the following transformation is



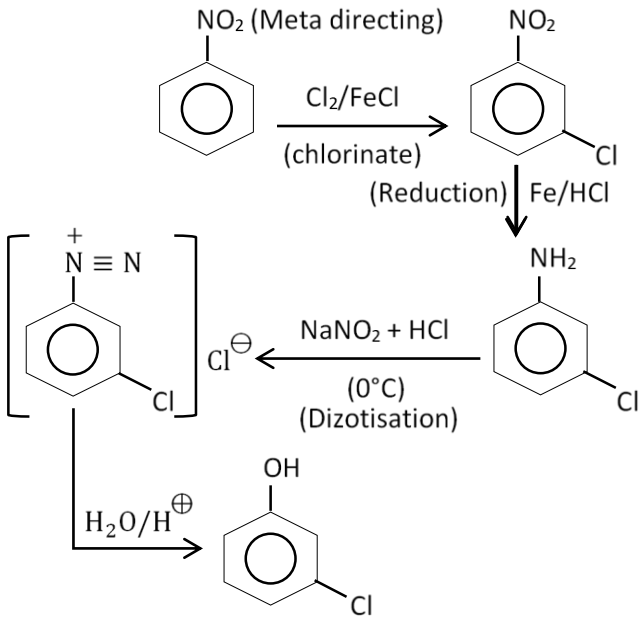
(1) (i) Fe, HCl(ii) $NaNO_2$, HCl, 0°C(iii) H_2O/H^+(iv) Cl_2, $FeCl_3$

(2) (i) Cl_2, $FeCl_3$(ii) $NaNO_2$, HCl, 0°C(iii) Fe, HCl(iv) H_2O/H^+

(3) (i) Fe, HCl(ii) Cl_2, HCl(iii) $NaNO_2$, HCl, 0°C(iv) H_2O/H^+

(4) (i) Cl_2, $FeCl_3$(ii) Fe, HCl(iii) $NaNO_2$, HCl, 0°C(iv) H_2O/H^+

Sol. (4)



9. The number of neutrons and electrons, respectively, present in the radioactive isotope of hydrogen is:

(1) 1 and 1 (2) 2 and 1 (3) 2 and 2 (D) 3 and 1

Sol. (2)

Radioactiveisotope ofhydrogenis Tritium $\left({}_1^3\mathrm{T}\right)$

No. of neutrons (A–Z) = 3 – 1 = 2

No. of electrons = 1

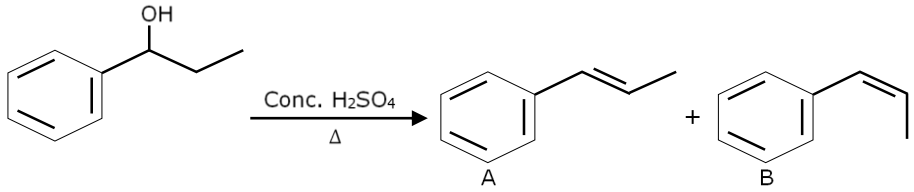
10. Compound A gives D-Galactose and D-Glucose on hydrolysis. The compound A is:
(1) Lactose (2) Amylose (3) Sucrose (4) Maltose

Sol. **(1)**

Lactose : It is a disaccharide of β–D–Galactose and β–D–Glucose with C_1 of galactose and $C_4$of glucoselink.

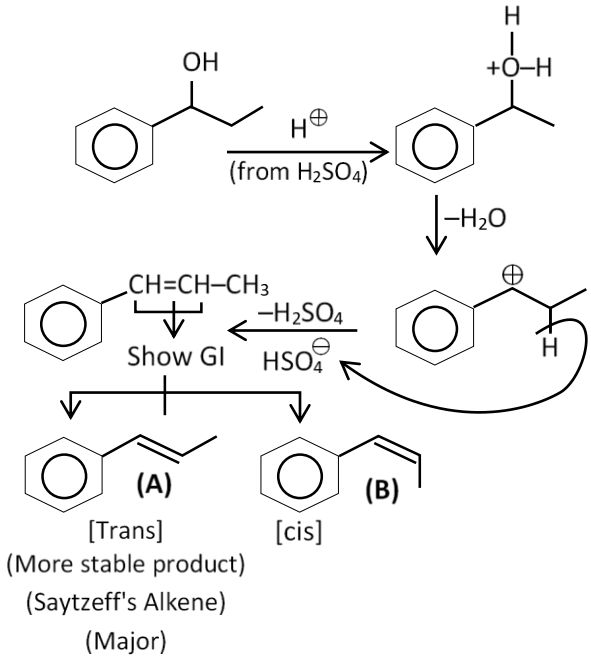
Lactose : β–D–Galactose + β–D–Glucose.

11. Consider the below reaction, and choose the correct statement:

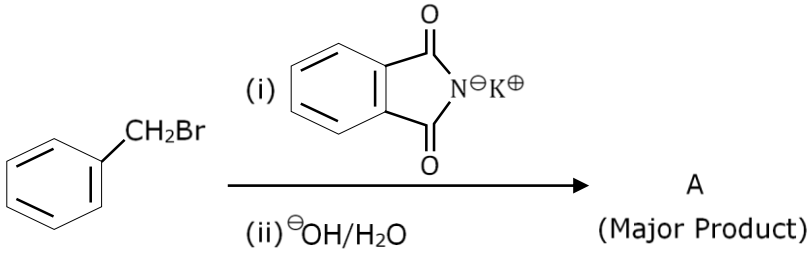


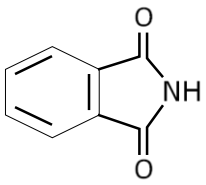
(1) The reaction is not possible in acidic medium
(2) Both compounds A and B are formed equally
(3) Compound B will be the major product
(4) Compound A will be the major product

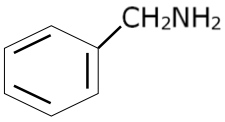
Sol. **(4)**

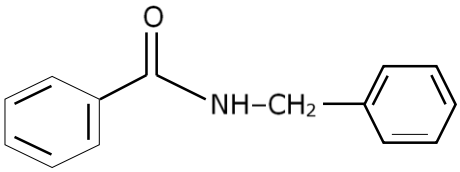


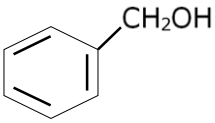
12. What is A in the following reaction?



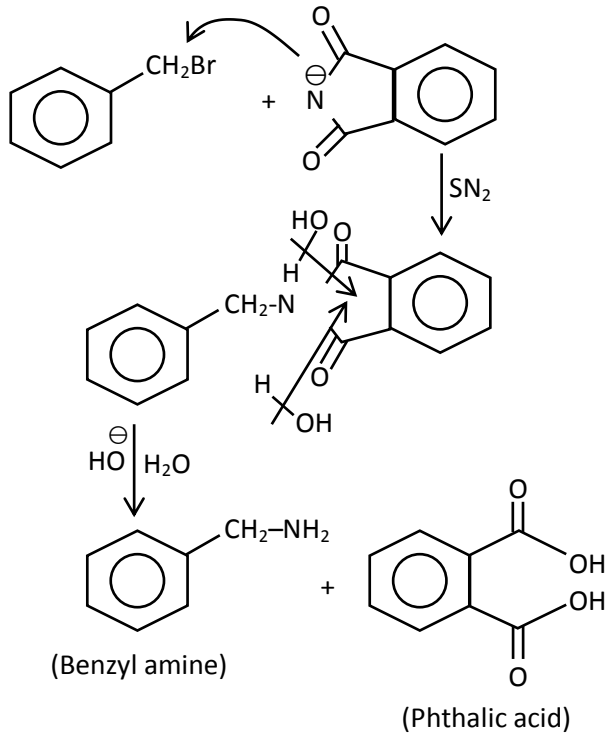
(1) 

(2) 

(3) 

(4) 

Sol. **(2)**



13. Select the correct statements.

(A) Crystalline solids have long range order.

(B) Crystalline solid are isotropic.

(C) Amorphous solids are sometimes called pseudo solids.

(D) Amorphous solid soften over a range of temperature.

(E) Amorphous solids have a definite heat of fusion.

Choose the most appropriate answer form the options given below:

(1) (C), (D) only

(2) (A), (C), (D) only

(3) (B), (D) only

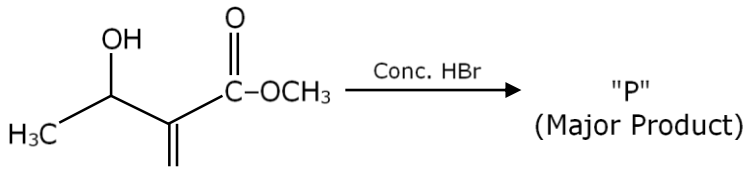
(4) (A), (B), (E) only

Sol. **(2)**

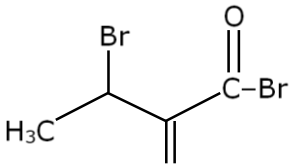
(A) Crystalline solids have definite arrangement of constituent particles and have long range order.

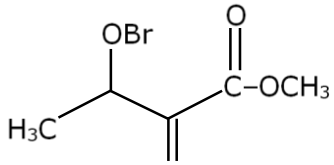
(C), (D) Different constituent particles ofan amorphous solid have different bond strengths and soften over a range of temperatures.

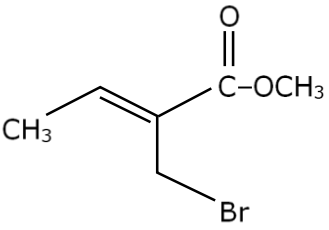
14.

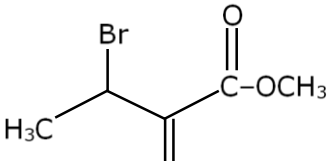


Consider the above reaction, the major product "P" formed is:

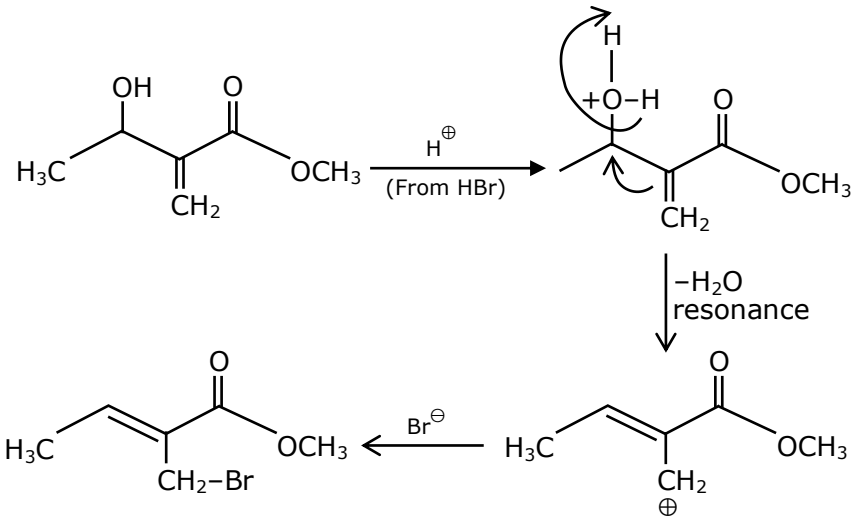
(1) 

(2) 

(3) 

(4) 

Sol. **(3)**



15. Given below are two statements: one is labelled as **Assertion A** and the other is labelled as **Reason R.**

Assertion A: $SO_2(g)$ is adsorbed to a larger extent than $H_2(g)$ on activated charcoal.

Reason R: $SO_2(g)$ has a higher critical temperature than $H_2(g)$.

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

(1) Both A and R are correct and R is the correct explanation of A.

(2) A is not correct but R is correct.

(3) A is correct but R is not correct.

(4) Both A and R are correct but R is not the correct explanation of A.

Sol. **(1)**

Gases having higher critical temperature absorb to a greaterextent.

16. Match List-I and List-II:

	List – I (Compound)		List – II (effect/affected species)
(a)	Carbon monoxide	(i)	Carcinogenic
(b)	Sulphur dioxide	(ii)	Metabolized by pyrus plants
(c)	Polychlorinated biphenyls	(iii)	Haemoglobin
(d)	Oxides of nitrogen	(iv)	Stiffness of flower buds

Choose the correct answer from the options given below:

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

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

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

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

Sol. **(1)**

17. If the Thomson model of the atom was correct, then the result of Rutherford's gold foil experiment would have been:

(1)α-Particles pass through the gold foil deflected by small angles and with reduced speed.

(2)All α-particles get bounced back by 180°.

(3)α-Particles are deflected over a wide range of angles.

(4) All of the α-particles pass through the gold foil without decrease in speed

Sol. **(1)**

As in Thomson model, protons are diffused (charge is not centered) α-particles deviate by small angles and due to repulsion from protons, their speeddecreases.

18. Match List-I with List-II:

	List-I		List-II
(a)	Li	(i)	photoelectric cell
(b)	Na	(ii)	absorbent of CO_2
(c)	K	(iii)	coolant in fast breeder nuclear reactor
(d)	Cs	(iv)	treatment of cancer
		(v)	bearings for motor engines

Choose the correct answer from the options given below:

(1) (a) – (v), (b) – (ii) , (c) – (iv), (d) – (i)

(2) (a) – (v), (b) – (iii), (c) – (ii), (d) – (i)

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

(4) (a) – (v), (b) – (i), (c) – (ii), (d) – (iv)

Sol. **(2)**

Li makes alloy with Lead to make white metal bearings for motorengines.

Liquid Na metal is used as coolant in fast breeder nuclearreactor.

K is a very absorbent of CO_2.

Cs is used in making photoelectric cell.

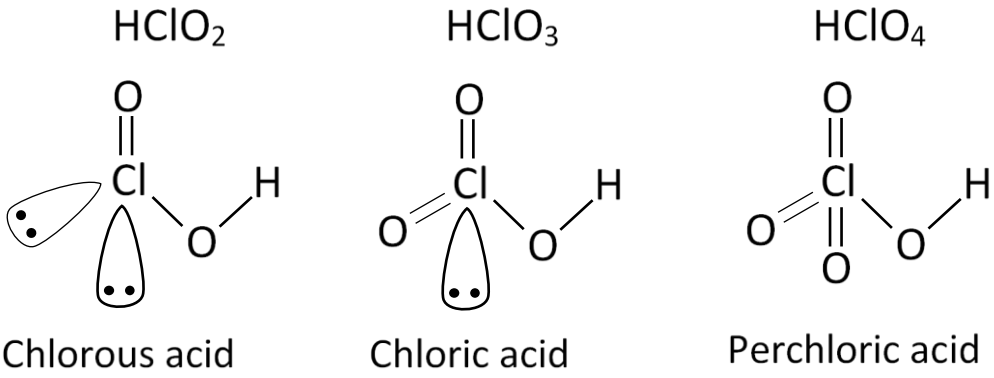
19. Number of Cl=O bonds in chlorous acid, chloric acid and perchloric acid respectively are :

(1) 3, 1 and 1 (2) 4, 1 and 0

(3) 1, 1 and 3 (4) 1, 2 and 3

Sol. **(4)**

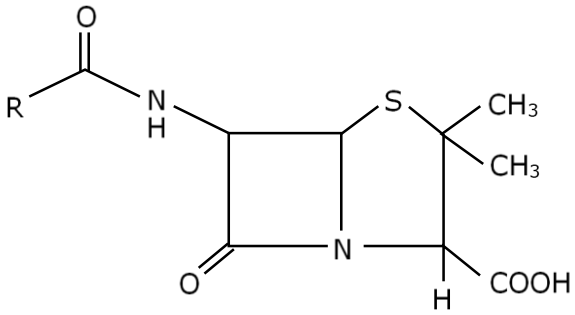
Number of Cl=O bonds



20. Given below are two statements:

Statement I: Penicillin is bacteriostatic type antibiotic.

Statement II: The general structure of Penicillin is:



Choose the correct option:

(1) Statement I is correct but statement II is false

(2)Statement I is incorrect but statement II is true

(3)Both statement I and statement II are false

(4)Both statement I and statement II are true

Sol. **(2)**

Section – (B)

1. The equilibrium constant for the reation

$A(s) \rightleftharpoons M(s) + \frac{1}{2}O_2(g)$

Is $K_p = 4$, At equilibrium, the partial pressure of O_2 is _____ atm. (Round off to the nearest integer).

Sol. **16**

$k_p = Po_2^{\frac{1}{2}} = 4$

$\therefore Po_2 = 16$ bar $= 16$ atm

2. The total number of electrons in all bonding molecular orbitals of O_2^{2-} is _____.
(Round off to the Nearest Integer).

Sol. **10**

$\sigma 1s^2 \overset{*}{\sigma} 1s^2 \sigma 2s^2 \overset{*}{\sigma} 2s^2 \sigma 2p_z^2 \pi 2p_x^2 = \pi 2p_y^2$

$\overset{*}{\pi} 2p_x^2 = \overset{*}{\pi} 2p_y^2$

3. For the cell $Cu(s)|Cu^{2+}(aq)(0.1M)||Ag^+(aq)(0.01\ M)|Ag(s)$ the cell potential $E_1 = 0.3095\ V$
For the cell $Cu(s)|Cu^{2+}(aq)(0.01\ M)||Ag^+(aq)(0.001\ M)|Ag(s)$ the cell potential = _____ $\times 10^{-2}V$.
(Round off to the Nearest Integer).
[Use: $\frac{2.303\ RT}{F} = 0.059$]

Sol. **28**

Cell reaction is:

$Cu(s) + 2Ag^+(aq) \rightarrow Cu^{2+} + 2Ag\ (s)$

Now, $E_{cell} - \frac{0.059}{2}\log\frac{[Cu^{2+}]}{[Ag^+]^2}$ ...(1)

$\therefore E_1 = 0.3095 = E^0_{cell} - \frac{0.059}{2}.\log\frac{0.01}{(0.001)^2}$ ...(2)

From (1) and (2), $E_2 = 0.28\ V = 28 \times 10^{-2}V$

4. For the first order reaction $A \rightarrow 2B$, 1 mole of reactant A gives 0.2 moles of B after 100 minutes. The half life of the reaction is _____ min. (Round off to the nearest integer).
[Use :$\ln 2 = 0.69$, $\ln 10 = 2.3$
Properties of logarithms :$\ln x^y = y \ln x$;
$\ln\left(\frac{x}{y}\right) = \ln x - \ln y$

Sol. **NTA-300, Motion-600 to 700**

	A	$\longrightarrow$	B
$t = 0$	1 mole		0
$t = 100$ min	$1 - x$		$2x$
	$= 0.9$ mol		$= 0.2$ mol

Now, $t = \frac{t_{1/2}}{\ln 2} \times \frac{[A_0]}{[A_t]}$

$100 = \frac{t_{1/2}}{\ln 2} \times \ln\frac{1}{0.9} \Rightarrow t_{1/2} = 690$ min. (Taking $\ln 3 = 1.11$)

Answer is 700. (Nearest integer).

5. $2SO_2(g) + O_2(g) \rightarrow 2SO_3(g)$

The above reaction is carried out in a vessel starting with partial pressure $P_{SO_2} = 250$ m bar, $P_{O_2} = 750$ m bar and $P_{SO_3} = 0$ bar. When the reaction is complete, the total pressure in the reaction vessel is _____ m bar. (Round off to the Nearest Integer).

Sol. **875**

	$2SO_2(g)$	+	$O_2(g)$	$\longrightarrow$	$2SO_3(g)$
Initial	250 m bar (L.R.)		750 m bar		0
Final	−250 m bar		−125 m bar		250 m bar
	0		625 m bar		250 m bar

$\therefore$ Final total pressure $= 625 + 250 = 875$ m bar

6. When 400 mL of 0.2 M H_2SO_4 solution is mixed with 600 mL of 0.1 M NaOH solution, the increase in temperature of the final solution is _____ $\times 10^{-2}$ K. (Round off to the Nearest Integer).

[Use : $H^+(aq) + OH^-(aq) \rightarrow H_2O : \Delta_r H = -57.1$ kJ mol^{-1}

Specific heat of H_2O = 4.18 Jk$^-$g$^-$

density of H_2O = 1.0 g cm^{-3}

Assume no change in volume of solution on mixing.]

Sol. **NTA-2, Motion-82**

$$n_{H^+} = \frac{400 \times 0.2}{1000} \times 2 = 0.16$$

$$n_{OH^-} = \frac{600 \times 0.1}{1000} = 0.06 \text{ (L.R.)}$$

Now, heat liberated from reaction

= heat gained by solutions

or, $0.06 \times 57.1 \times 10^3$

$= (1000 \times 1.0) \times 4.18 \times \Delta T$

$\therefore \Delta T = 0.8196$ K

$= 81.96 \times 10^{-2}$ K $\approx 82 \times 10^{-2}$ K

7. In a solvent 50% of an acid HA dimerizes and the rest dissociates. The van't Hoff factor of the acid is _____ $\times 10^{-2}$. (Round off to the nearest integer)

Sol. **125**

	$2HA \rightleftharpoons H_2A_2$		$HA \rightleftharpoons H^+ + A$	
Initial moles	$a \times \frac{50}{100}$	0	$a \times \frac{50}{100}$	0	0
Final moles	0	0.25 a	0	0.5a	0.5a

Now, $i = \frac{\text{final moles}}{\text{initial moles}} = \frac{0.25a + 0.5a + 0.5a}{0.5a + 0.5a}$

$= 1.25 = 125 \times 10^{-2}$

8. 10.0 mL of 0.05 M $KMnO_4$ solution was consumed in a titration with 10.0 mL of given oxalic acid dihydrate solution. The strength of given oxalic acid solution is _____ × 10^{-2} g/L.
(Round off to the nearest integer)

Sol. **1575**

$n_{eq} KMnO_4 = n_{eq} = H_2C_2O_4.2H_2O$

or, $\frac{10\times0.05}{1000}\times5 = \frac{10\times M}{1000}\times2$

∴ Conc. of oxalic acid solution = 0.125 M
= 0.125 × 126 g/L = 15.75 g/L
= 1575 × 10^{-2} g/L

9. 3 moles of metal complex with formula $Co(en)_2Cl_3$ gives 3 moles of silver chloride on treatment with excess of silver nitrate. The secondary valency of Co in the complex is _____. (Round off to the nearest integer)

Sol. **6**

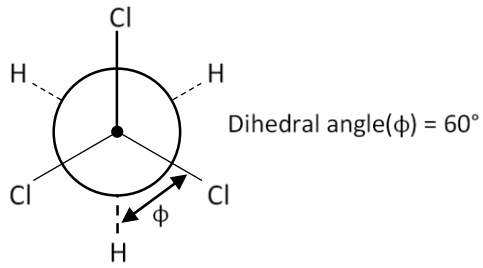
$$3[Co(en)_2Cl_2]Cl + \underset{(excess)}{AgNO_3} \rightarrow \underset{(white\ ppt.)}{3AgCl}$$

Secondary valency of Co = 6.
(C.N.)

10. The dihedral angle in staggered form of Newman projection of 1,1,1-Trichloro ethane is_____ degree. (Round off to the nearest integer)

Sol. **60**

1,1,1-Trichloro ethane [CCl_3–CH_3]



(Newman's staggered form)

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