

CHEMISTRY

SECTION-A

1. Given below are two statement : one is labelled as Assertion A and the other is labelled as Reason R :

Assertion A : Size of Bk^{3+} ion is less than Np^{3+} ion.

Reason R : The above is a consequence of the lanthanoid contraction.

In the light of the above statements, choose the correct answer from the options given below :

- (1) A is false but R is true
- (2) Both A and R are true but R is not the correct explanation of A
- (3) Both A and R are true and R is the correct explanation of A
- (4) A is true but R is false

Official Ans. by NTA (3)

Official Ans. by ALLEN (4)

- Sol.** Size of ${}_{97}Bk^{3+}$ ion is less than that of ${}_{93}Np^{3+}$ due to actinoid contraction.

As we know that in a period from left to right ionic radius decreases and in actinide series it is due to actinoid contraction.

2. Which among the following pairs of Vitamins is stored in our body relatively for longer duration ?

- (1) Thiamine and Vitamin A
- (2) Vitamin A and Vitamin D
- (3) Thiamine and Ascorbic acid
- (4) Ascorbic acid and Vitamin D

Official Ans. by NTA (2)

- Sol.** Vitamin-A & Vitamin-D

3. Given below are two statements :

Statement I : Both $CaCl_2 \cdot 6H_2O$ and $MgCl_2 \cdot 8H_2O$ undergo dehydration on heating.

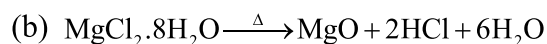
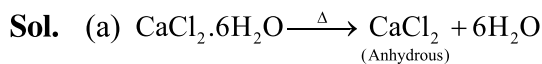
Statement II : BeO is amphoteric whereas the oxides of other elements in the same group are acidic.

In the light of the above statements, choose the correct answer from the options given below :

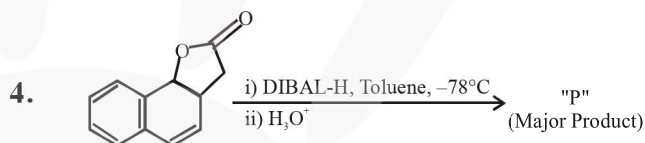
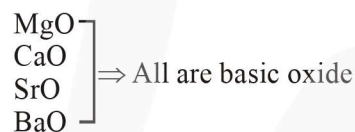
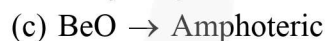
- (1) Statement I is false but statement II is true
- (2) Both statement I and statement II are false
- (3) Both statement I and statement II are true
- (4) Statement I is true but statement II is false

TEST PAPER WITH ANSWER & SOLUTION

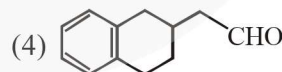
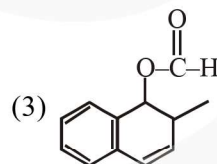
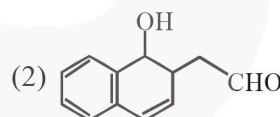
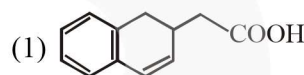
Official Ans. by NTA (2)



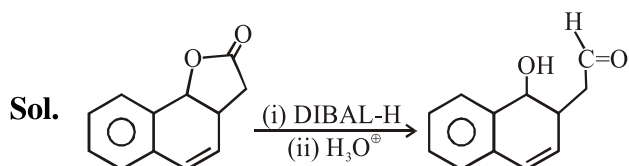
The dehydration of hydrated chloride of calcium can be achieved. The corresponding hydrated chloride of magnesium on heating suffer hydrolysis.



The product "P" in the above reaction is :



Official Ans. by NTA (2)



DIBAL can not reduce double bond
It can reduce cyclic ester.

5. Match List-I with List-II :

List-I	List-II
Industrial process	Application
(a) Haber's process	(i) HNO ₃ synthesis
(b) Ostwald's process	(ii) Aluminium extraction
(c) Contact process	(iii) NH ₃ synthesis
(d) Hall-Heroult process	(iv) H ₂ SO ₄ synthesis

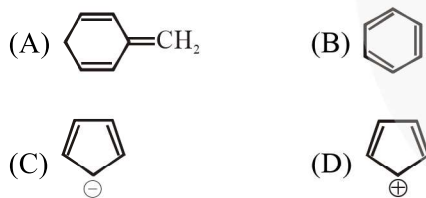
Choose the correct answer from the options given below :

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

Official Ans. by NTA (3)

- Sol.** (a) Haber's process is used for NH₃ synthesis.
 (b) Ostwald's process is used for HNO₃ synthesis.
 (c) Contact process is used for H₂SO₄ synthesis.
 (d) In Hall-Heroult process, electrolytic reduction of impure alumina can be done. (Aluminium extraction)

6. Among the following, the aromatic compounds are :

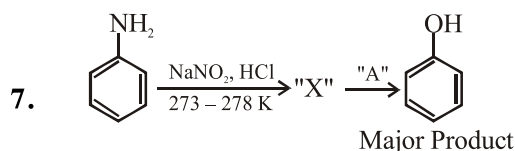


Choose the correct answer from the following options :

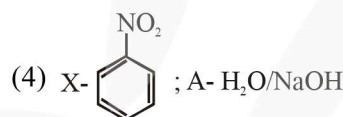
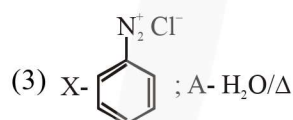
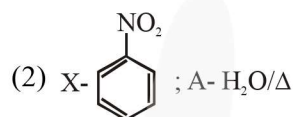
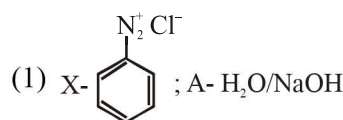
- (1) (A) and (B) only
 (2) (B) and (C) only
 (3) (B), (C) and (D) only
 (4) (A), (B) and (C) only

Official Ans. by NTA (2)

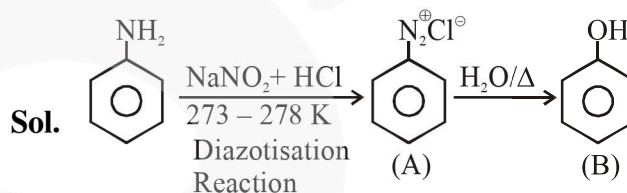
- Sol.** (A) Non-Aromatic (B) Aromatic
 (C) Aromatic (D) Anti-Aromatic



In the above chemical reaction, intermediate "X" and reagent/condition "A" are :



Official Ans. by NTA (3)



8. Given below are two statements :

Statement I : The E° value of Ce⁴⁺ / Ce³⁺ is + 1.74 V.

Statement II : Ce is more stable in Ce⁴⁺ state than Ce³⁺ state.

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 correct
 (2) Statement I is incorrect but statement II is correct
 (3) Both statement I and statement II are incorrect
 (4) Statement I is correct but statement II is incorrect

Official Ans. by NTA (4)

Sol. The E° value for Ce^{4+}/Ce^{3+} is +1.74 V because the most stable oxidation state of lanthanide series elements is +3. It means Ce^{3+} is more stable than Ce^{4+} .

9. The functions of antihistamine are :

- (1) Antiallergic and Analgesic
- (2) Antacid and antiallergic
- (3) Analgesic and antacid
- (4) Antiallergic and antidepressant

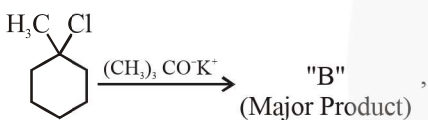
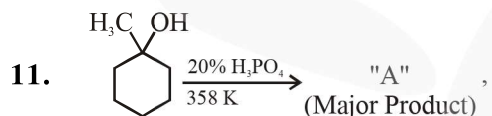
Official Ans. by NTA (2)

10. Which of the following is Lindlar catalyst ?

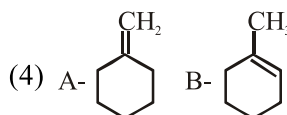
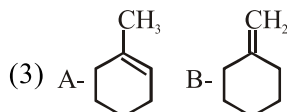
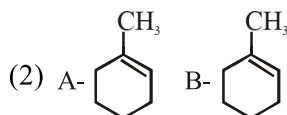
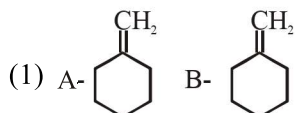
- (1) Zinc chloride and HCl
- (2) Cold dilute solution of $KMnO_4$
- (3) Sodium and Liquid NH_3
- (4) Partially deactivated palladised charcoal

Official Ans. by NTA (4)

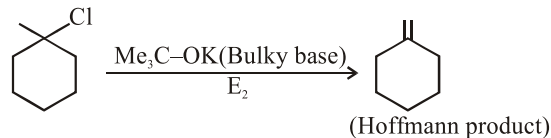
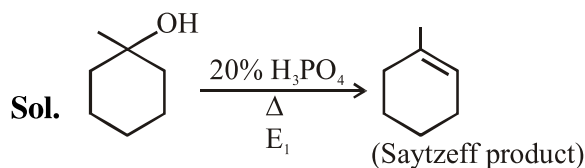
Sol. Partially deactivated palladised charcoal ($H_2/pd/CaCO_3$) is lindlar catalyst.



The product "A" and "B" formed in above reactions are :



Official Ans. by NTA (3)



12. Given below are two statements :

Statement I : H_2O_2 can act as both oxidising and reducing agent in basic medium.

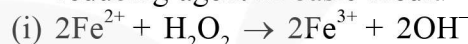
Statement II : In the hydrogen economy, the energy is transmitted in the form of dihydrogen.

In the light of the above statements, choose the correct answer from the options given below :

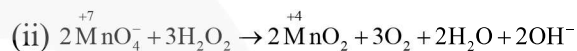
- (1) Both statement I and statement II are false
- (2) Both statement I and statement II are true
- (3) Statement I is true but statement II is false
- (4) Statement I is false but statement II is true

Official Ans. by NTA (2)

Sol. (a) H_2O_2 can acts as both oxidising and reducing agent in basic medium.



In this reaction, H_2O_2 acts as oxidising agent.



In this reaction, H_2O_2 acts as reducing agent.

(b) The basic principle of hydrogen economy is the transportation and storage of energy in the form of liquids or gaseous dihydrogen.

Advantage of hydrogen economy is that energy is transmitted in the form of dihydrogen and not as electric power

13. The type of pollution that gets increased during the day time and in the presence of O_3 is :

- (1) Reducing smog
- (2) Oxidising smog
- (3) Global warming
- (4) Acid rain

Official Ans. by NTA (2)

Sol. In presence of ozone(O_3), oxidising smog gets increased during the day time because automobiles and factories produce main components of the photochemical smog (oxidising smog) results from the action of sunlight on unsaturated hydrocarbon and nitrogen oxide.

Ozone is strong oxidising agent and can react with the unburnt hydrocarbons in the polluted air to produce chemicals.

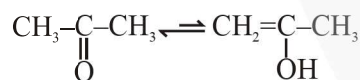
14. Assertion A : Enol form of acetone $[\text{CH}_3\text{COCH}_3]$ exists in $< 0.1\%$ quantity. However, the enol form of acetyl acetone $[\text{CH}_3\text{COCH}_2\text{OCCH}_3]$ exists in approximately 15% quantity.

Reason R : enol form of acetyl acetone is stabilized by intramolecular hydrogen bonding, which is not possible in enol form of acetone.

Choose the correct statement :

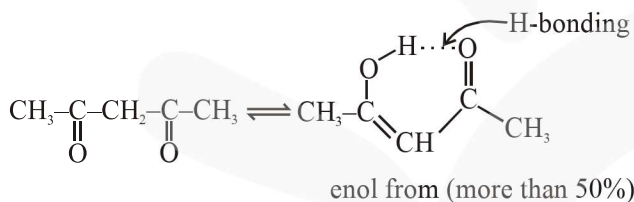
- (1) A is false but R is true
- (2) Both A and R are true and R is the correct explanation of A
- (3) Both A and R are true but R is not the correct explanation of A
- (4) A is true but R is false

Official Ans. by NTA (2)

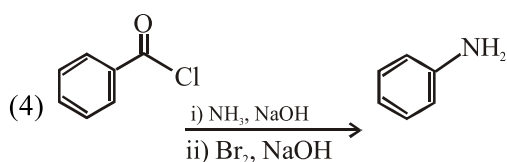
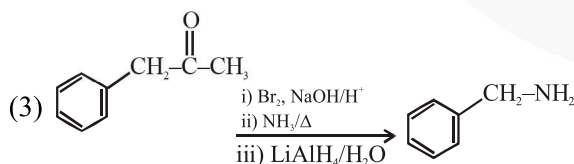
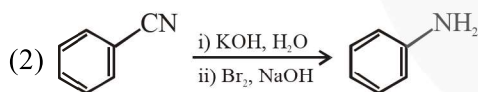
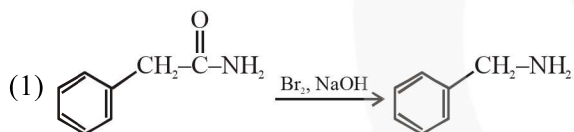


(Keto form) (enol form)

enol form of acetone is very less ($< 0.1\%$)

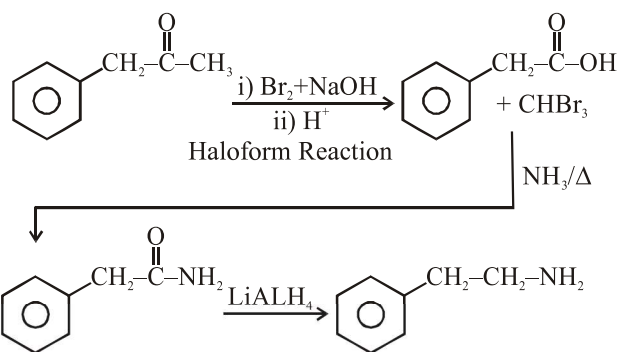


15. Which of the following reaction DOES NOT involve Hoffmann Bromamide degradation ?



Official Ans. by NTA (3)

Sol.



⇒ This reaction does not involve haffmann bromamide degradation.

⇒ Rest all options involve haffmann bromamide degradation during the reaction of Br_2+NaOH with amide.

16. The process that involves the removal of sulphur from the ores is :

- (1) Smelting
- (2) Roasting
- (3) Leaching
- (4) Refining

Official Ans. by NTA (2)

Sol. In roasting process, metal sulphide (MS) ore are converted into metal oxide and sulphur is remove in the form of SO_2 gas.



17. Match List-I with List-II :

List-I

List-II

Name of oxo acid

Oxidation state of 'P'

- | | |
|---------------------------|----------|
| (a) Hypophosphorous acid | (i) +5 |
| (b) Orthophosphoric acid | (ii) +4 |
| (c) Hypophosphoric acid | (iii) +3 |
| (d) Orthophosphorous acid | (iv) +2 |
| | (v) +1 |

Choose the correct answer from the options given below :

- (1) (a)-(v), (b)-(i), (c)-(ii), (d)-(iii)
- (2) (a)-(iv), (b)-(i), (c)-(ii), (d)-(iii)
- (3) (a)-(iv), (b)-(v), (c)-(ii), (d)-(iii)
- (4) (a)-(v), (b)-(iv), (c)-(ii), (d)-(iii)

Official Ans. by NTA (1)

Sol. (a) Hypophosphorus acid : H_3PO_2
 $(+1)3 + x + (-2)2 = 0$

$$x = +1$$

(b) Orthophosphoric acid : H_3PO_4

$$(+1) 3 + x + (-2) 4 = 0$$

$$x = +5$$

(c) Hypophosphoric acid : $\text{H}_4\text{P}_2\text{O}_6$

$$(+1) 4 + 2x + (-2) 6 = 0$$

$$x = +4$$

(d) Orthophosphorous acid : H_3PO_3

$$(+1) 3 + x + (-2) 3 = 0$$

$$x = +3$$

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

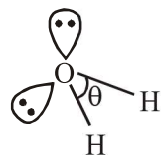
Assertion A : The H–O–H bond angle in water molecule is 104.5° .

Reason R : The lone pair – lone pair repulsion of electrons is higher than the bond pair - bond pair repulsion.

- (1) A is false but R is true
- (2) Both A and R are true, but R is not the correct correct explanation of A
- (3) A is true but R is false
- (4) Both A and R are true, and R is the correct explanation of A

Official Ans. by NTA (4)

Sol. H_2O



$$\theta = 104.5^\circ$$

the hybridisation of oxygen in water molecule is sp^3 .

So electron geometry of water molecule is tetrahedral and the bond angle should be $109^\circ 28''$ but as we know that lone pair-lone pair repulsion of electrons is higher than the bond pair-bond pair repulsion because lone pair is occupied more space around central atom than that of bond pair.

19. In chromatography technique, the purification of compound is independent of :

- (1) Mobility or flow of solvent system
- (2) Solubility of the compound
- (3) Length of the column or TLC Plate
- (4) Physical state of the pure compound

Official Ans. by NTA (4)

Sol. In chromatography technique, the purification of a compound is independent of the physical state of the pure compound.

20. A group 15 element, which is a metal and forms a hydride with strongest reducing power among group 15 hydrides. The element is :

- (1) Sb
- (2) P
- (3) As
- (4) Bi

Official Ans. by NTA (4)

Sol. In group 15

$\left[\begin{array}{c} \text{N} \\ \text{P} \end{array} \right] \rightarrow \text{Non metal}$

$\left[\begin{array}{c} \text{As} \\ \text{Sb} \end{array} \right] \rightarrow \text{Metalloid}$

$\left[\begin{array}{c} \text{Bi} \end{array} \right] \rightarrow \text{Metal}$

Hydrides of group 15 elements are

NH_3

PH_3

AsH_3

SbH_3

BiH_3

In NH_3 , hydrogen atom gets partial positive charge due to less electronegativity.

But in BiH_3 , hydrogen atom gets partial negative charge because hydrogen is more electronegative than bismuth.

i.e. BiH_3 is a strong reducing agent than others because we know that H^- is a strong reducing agent.

SECTION-B

1. For the reaction $\text{A}(\text{g}) \rightleftharpoons \text{B}(\text{g})$ at 495 K, $\Delta_r G^\circ = -9.478 \text{ kJ mol}^{-1}$.

If we start the reaction in a closed container at 495 K with 22 millimoles of A, the amount of B in the equilibrium mixture is _____ millimoles. (Round off to the Nearest Integer).

[$R = 8.314 \text{ J mol}^{-1} \text{ K}^{-1}$; $\ln 10 = 2.303$]

Official Ans. by NTA (20)

Sol. $\Delta G^\circ = -RT \ln K_{eq}$

Given $\Delta G^\circ = -9.478$ KJ/mole

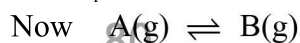
$$T = 495\text{K} \quad R = 8.314 \text{ J mol}^{-1}$$

$$\text{So } -9.478 \times 10^3 = -495 \times 8.314 \times \ln K_{eq}$$

$$\ln K_{eq} = 2.303$$

$$= \ln 10$$

$$\text{So } K_{eq} = 10$$



$$t = 0 \quad 22 \quad 0$$

$$t = t \quad 22-x \quad x$$

$$K_{eq} = \frac{[B]}{[C]} = \frac{x}{22-x} = 10$$

$$\text{or } x = 20$$

$$\text{So millmoles of B} = 20$$

2. Complete combustion of 750 g of an organic compound provides 420 g of CO_2 and 210 g of H_2O . The percentage composition of carbon and hydrogen in organic compound is 15.3 and _____ respectively. (Round off to the Nearest Integer)

Official Ans. by NTA (3)

Sol. 44 gm CO_2 have 12 gm carbon

$$\text{So, } 420 \text{ gm } \text{CO}_2 \Rightarrow \frac{12}{44} \times 420$$

$$\Rightarrow \frac{1260}{11} \text{ gm carbon}$$

$$\Rightarrow 114.545 \text{ gram carbon}$$

$$\text{So, \% of carbon} = \frac{114.545}{750} \times 100$$

$$\approx 15.3\%$$

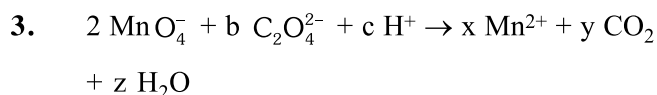
$$18 \text{ gm } \text{H}_2\text{O} \Rightarrow 2 \text{ gm } \text{H}_2$$

$$210 \text{ gm} \Rightarrow \frac{2}{18} \times 210$$

$$= 23.33 \text{ gm } \text{H}_2$$

$$\text{So, \% } \text{H}_2 \Rightarrow \frac{23.33}{750} \times 100 = 3.11\%$$

$$\approx 3\%$$

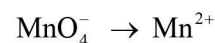


If the above equation is balanced with integer coefficients, the value of c is _____.

(Round off to the Nearest Integer).

Official Ans. by NTA (16)

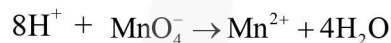
Sol. Writing the half reaction
oxidation half reaction



balancing oxygen



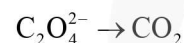
balancing Hydrogen



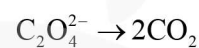
balancing charge



Reduction half



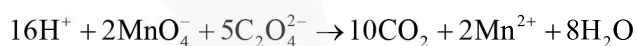
Balancing carbon



Balancing charge



Net equation



$$\text{So } c = 16$$

4. AB_2 is 10% dissociated in water to A^{2+} and B^- . The boiling point of a 10.0 molal aqueous solution of AB_2 is _____ $^\circ\text{C}$. (Round off to the Nearest Integer).

[Given : Molal elevation constant of water $K_b = 0.5 \text{ K kg mol}^{-1}$ boiling point of pure water = 100°C]

Official Ans. by NTA (106)



$$t = 0 \quad a \quad 0 \quad 0$$

$$t = t \quad a - a\alpha \quad a\alpha \quad 2a\alpha$$

$$n_T = a - a\alpha + a\alpha + 2a\alpha$$

$$= a(1 + 2\alpha)$$

$$\text{so } i = 1 + 2\alpha$$

$$\text{Now } \Delta T_b = i \times m \times K_b$$

$$\Delta T_b = (1 + 2\alpha) \times m \times K_b$$

$$\alpha = 0.1 \quad m = 10 \quad K_b = 0.5$$

$$\Delta T_b = 1.2 \times 10 \times 0.5$$

$$= 6$$

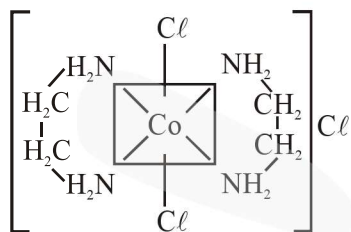
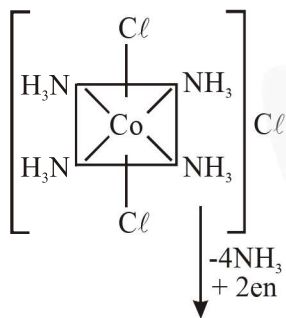
$$\text{So boiling point} = 106$$

5. The equivalents of ethylene diamine required to replace the neutral ligands from the coordination sphere of the trans-complex of $\text{CoCl}_3 \cdot 4\text{NH}_3$ is _____. (Round off to the Nearest Integer).

Official Ans. by NTA (2)

Sol. trans - $\text{CoCl}_3 \cdot 4\text{NH}_3$

or



As we know that ethylene diamine is a bidentate ligand and ammonia is a mono dentate ligand.

It means overall two ethylene diamine is required to replace the all neutral ligands (four ammonia) from the coordination sphere of this complex.

6. A 6.50 molal solution of KOH (aq.) has a density of 1.89 g cm^{-3} . The molarity of the solution is _____ mol dm^{-3} . (Round off to the Nearest Integer).

[Atomic masses: K :39.0 u; O :16.0 u; H :1.0 u]

Official Ans. by NTA (9)

Sol. 6.5 molal KOH = 1000gm solvent has 6.5 moles KOH
 so wt of solute = 6.5×56
 = 364 gm
 wt of solution = 1000 + 364 = 1364

$$\text{Volume of solution} = \frac{1364}{1.89} \text{ ml}$$

$$\begin{aligned} \text{Molarity} &= \frac{\text{mole of solute}}{V_{\text{solution in Litre}}} \\ &= \frac{6.5 \times 1.89 \times 1000}{1364} \\ &= 9.00 \end{aligned}$$

7. When light of wavelength 248 nm falls on a metal of threshold energy 3.0 eV, the de-Broglie wavelength of emitted electrons is _____ Å. (Round off to the Nearest Integer).

[Use : $\sqrt{3} = 1.73$, $h = 6.63 \times 10^{-34} \text{ Js}$

$m_e = 9.1 \times 10^{-31} \text{ kg}$; $c = 3.0 \times 10^8 \text{ ms}^{-1}$;
 $1\text{eV} = 1.6 \times 10^{-19}\text{J}$]

Official Ans. by NTA (9)

Sol. Energy incident = $\frac{hc}{\lambda}$

$$\begin{aligned} &= \frac{6.63 \times 10^{-34} \times 3.0 \times 10^8}{248 \times 10^{-9} \times 1.6 \times 10^{-19}} \text{ eV} \\ &= \frac{6.63 \times 3 \times 100}{248 \times 1.6} \\ &= 0.05 \text{ eV} \times 100 = 5 \text{ eV} \end{aligned}$$

Now using

$$E = \phi + \text{K.E.}$$

$$5 = 3 + \text{K.E.}$$

$$\text{K.E.} = 2\text{eV} = 3.2 \times 10^{-19} \text{ J}$$

for debroglie wavelength $\lambda = \frac{h}{mv}$

$$\text{K.E} = \frac{1}{2}mv^2$$

$$\text{so } v = \sqrt{\frac{2\text{KE}}{m}}$$

$$\text{hence } \lambda = \frac{h}{\sqrt{2\text{KE} \times m}}$$

$$= \frac{6.63 \times 10^{-34}}{\sqrt{2 \times 3.2 \times 10^{-19} \times 9.1 \times 10^{-31}}}$$

$$= \frac{6.63}{7.6} \times \frac{10^{-34}}{10^{-25}} = \frac{66.3 \times 10^{-10} \text{ m}}{7.6}$$

$$= 8.72 \times 10^{-10} \text{ m}$$

$$\approx 9 \times 10^{-10} \text{ m}$$

$$= 9\text{\AA}$$

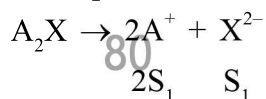
8. Two salts A_2X and MX have the same value of solubility product of 4.0×10^{-12} . The ratio of

their molar solubilities i.e. $\frac{S(A_2X)}{S(MX)} = \underline{\hspace{2cm}}$.

(Round off to the Nearest Integer).

Official Ans. by NTA (50)

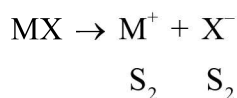
Sol. For A_2X



$$K_{sp} = 4S_1^3 = 4 \times 10^{-12}$$

$$S_1 = 10^{-4}$$

for MX



$$K_{sp} = S_2^2 = 4 \times 10^{-12}$$

$$S_2 = 2 \times 10^{-6}$$

$$\text{so } \frac{S_{A_2X}}{S_{MX}} = \frac{10^{-4}}{2 \times 10^{-6}} = 50$$

9. A certain element crystallises in a bcc lattice of unit cell edge length 27 \AA . If the same element under the same conditions crystallises in the fcc lattice, the edge length of the unit cell in Å will be $\underline{\hspace{2cm}}$. (Round off to the Nearest Integer).

[Assume each lattice point has a single atom]

[Assume $\sqrt{3} = 1.73$, $\sqrt{2} = 1.41$]

Official Ans. by NTA (33)

Sol. For BCC $\sqrt{3} a = 4r$

$$\text{so } r = \frac{\sqrt{3}}{4} \times 27$$

for FCC $a = 2\sqrt{2} r$

$$= 2 \times \sqrt{2} \times \frac{\sqrt{3}}{4} \times 27$$

$$= \frac{\sqrt{3}}{\sqrt{2}} \times 27$$

$$= 33$$

10. The decomposition of formic acid on gold surface follows first order kinetics. If the rate constant at 300 K is $1.0 \times 10^{-3} \text{ s}^{-1}$ and the activation energy $E_a = 11.488 \text{ kJ mol}^{-1}$, the rate constant at 200 K is $\underline{\hspace{2cm}} \times 10^{-5} \text{ s}^{-1}$. (Round off to the Nearest Integer).

(Given : $R = 8.314 \text{ J mol}^{-1} \text{ K}^{-1}$)

Official Ans. by NTA (10)

Sol. $K_{300} = 10^{-4}$ $K_{200} = ?$

$$E_a = 11.488 \text{ KJ/mole} \quad R = 8.314 \text{ J/mole-K}$$

$$\text{so } \ln\left(\frac{K_{300}}{K_{200}}\right) = \frac{E_a}{R} \left(\frac{1}{200} - \frac{1}{300}\right)$$

$$\ln\left(\frac{K_{300}}{K_{200}}\right) = \frac{11.488 \times 1000 \times 100}{8.314 \times 200 \times 300}$$

$$= 2.303$$

$$= \ln 10$$

$$\text{so } \frac{K_{300}}{K_{200}} = 10$$

$$K_{200} = \frac{1}{10} \times K_{300} = 10^{-4}$$

$$= 10 \times 10^{-5} \text{ sec}^{-1}$$