# JEE Main January 2026

## Question Paper With Text Solution

## 28 January | Shift-2

# CHEMISTRY

MATRIX

JEE Main & Advanced | XI-XII Foundation| VI-X Pre-Foundation

Office : Piprali Road, Sikar (Raj.) | Ph. 01572-241911

Website : www.matrixedu.in ; Email : smd@matrixacademy.co.in

# JEE MAIN JANUARY 2026 | 28 JANUARY SHIFT-2

## SECTION – A

Question ID : 8606541713

51. Identify the correct statements :

The presence of $-NO_2$ group in benzene ring

A. activates the ring towards electrophilic substitutions.

B. deactivates the ring towards electrophilic substitutions.

C. activates the ring towards nucleophilic substitutions.

D. deactivates the ring towards nucleophilic substitutions.

Choose the correct answer from the options given below :

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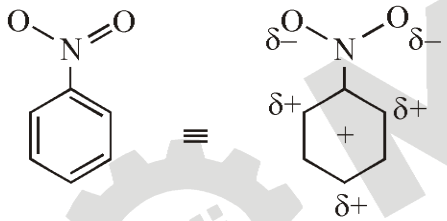
(1) A and D Only (2) C and A Only (3) B and D Only (4) B and C Only

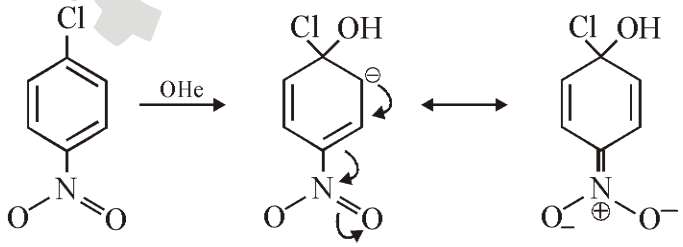
**Ans.** Official answer NTA (4 )

**Sol.**



due to – M effect of $-NO_2$ group

$-NO_2$ group deactiveate benzene rign toward ESR reaction.




– M effect of $-NO_2$ ↑ stability of intermediate, that's why $-NO_2$ activate benzene ring toward NSR.

Question ID : 8606541720

52. A student has been given 0.314 g of an organic compound and asked to estimate Sulphur. During the experiment, the student has obtained 0.4813 g of barium sulphate. The percentage of sulphur present in the compound is _____ (Given Molar mass in $gmol^{-1}$ $S:32, BaSO_4:233$)

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(1) 65.15% (2) 21.05% (3) 48.24% (4) 42.10%

**Ans.** Official answer NTA (2)

**Sol.** Mass of S $= \frac{32}{233} \times .4813$

$\%$ of S $= \frac{32 \times .4813}{233 \times .314} \times 100$

$= 21.05\ \%$

Question ID : 8606541717

53. A student performed analysis of aliphatic organic compound 'X' which on analysis gave $C = 61.01\%$, $H = 15.25\%, N = 23.74\%$.

This compound, on treatment with $HNO_2/H_2O$ produced another compound ' Y ' which did not contain any nitrogen atom. However, the compound 'Y ' upon controlled oxidation produced another compound ' Z ' that responded to iodoform test.

The structure of 'X ' is :

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(1) $CH_3-\underset{\underset{NH_2}{|}}{CH_2CH}-CH_3$ (2) $Ph-\underset{\underset{CH_3}{|}}{CH}-NH_2$

(3) $CH_3CH_2CH_2NH_2$ (4) $\begin{matrix} CH_3 \\ CH_3 \end{matrix}\!\!\diagdown\!\!\diagup CH-NH_2$

**Ans.** Official answer NTA (4)

**Sol.** (i) % of C in first compound $= \frac{48}{73} \times 100$

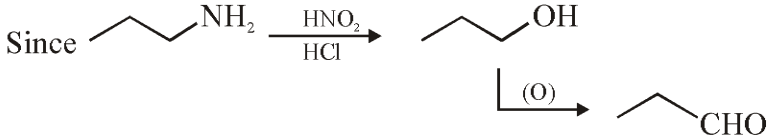
$= 65.75\%$

Compound 1 is not possible

(ii) % of C in second $= \frac{96 \times 100}{116}$

$= 82.75\%$

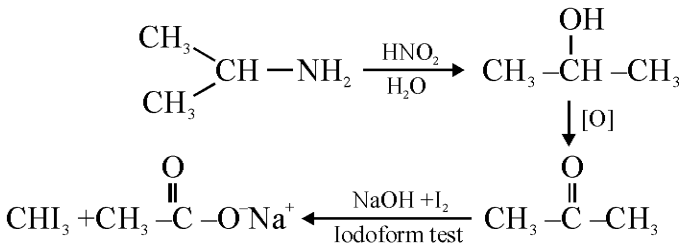
Compound 2 is not possible

(iii) Since 


Will not give iodoform test

(iv) % C in 4th compound $= \frac{36}{59} \times 100$

$= 67\%$




Question ID : 8606541708

54. Given below are two statements :

Statement I : The increasing order of boiling point of hydrogen halides is HCl < HBr < HI < HF.

Statement II : The increasing order of melting point of hydrogen halides is HCl < HBr < HF <HI.

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

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(1) Statement I is false but Statement II is true

(2) Both Statement I and Statement II are false

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

(4) Both Statement I and Statement II are true

**Ans.** Official answer NTA (4)

**Sol.** Order of B.P. → HF > HI > HBr > HCl

Order of M.P. → HI > HF > HBr > HCl

Generally M.P. & B.P. increases with increases molecular mass due to increase in Van der Waals forces. However, HF shows exceptional behaviour due to Hydrogen bonding.

Question ID : 8606541716

55. The correct order of acidic strength of the major products formed in the given reactions, is :

A. $PhNH_2 \xrightarrow[(2)\ CuCN \\ (3)\ H_3O^+/\Delta]{(1)\ NaNO_2 + HCl\ (<5^\circ C)} [A]$

B. $CH_3CH_2CHO \xrightarrow[\Delta]{[Ag(NH_3)_2]^+, OH^-} [B]$

C. $CH_4 + O_2 \xrightarrow[(ii)\ Na_2Cr_2O_7/H^+]{(i)\ Mo_2O_3} [C]$

D. $PhCH_2MgBr + CO_2 \xrightarrow[H_3O^+]{Dry\ ether} [D]$

Choose the correct answer from the options given below :

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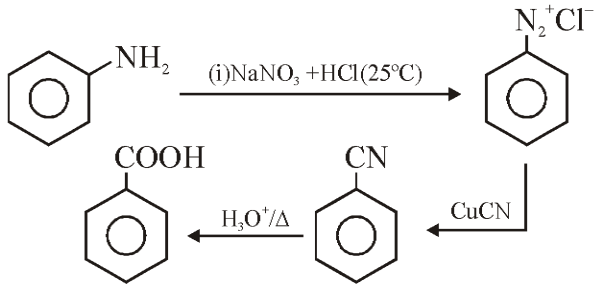
(1) $A > D > C > B$ (2) $C > A > D > B$ (3) $C > B > A > D$ (4) $A > D > B > C$

**Ans.** Official answer NTA (2)

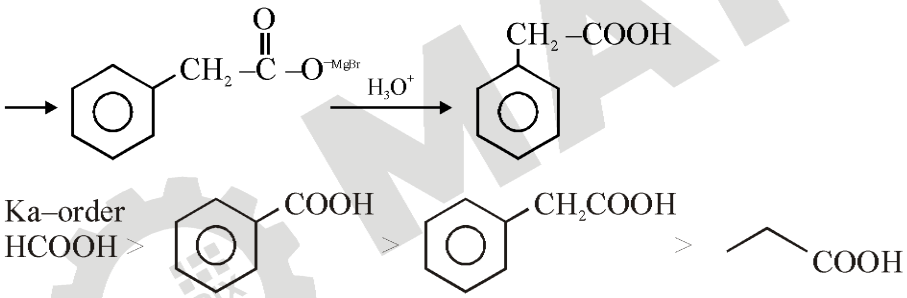
**Sol.** (A)




(B) $CH_3 - CH_2 - CHO \xrightarrow[\Delta]{[Ag(NH_3)_2]OH^-} CH_3 - CH_2 - COOH$

(C) $CH_4 + O_2 \xrightarrow[(ii)Na_2Cr_2O_7/H^+]{(i)MO_2O_3} HCOOH$

(D) $Ph - CH_2 - Mg - Br + O = C = O$




Ka–order




Question ID : 8606541704

56. Consider the following aqueous solutions.

I. 2.2 g Glucose in 125 mL of solution.

II. 1.9 g Calcium chloride in 250 mL of solution.

III. 9.0 g Urea in 500 mL of solution.

IV. 20.5 g Aluminium sulphate in 750 mL of solution.

The correct increasing order of boiling point of these solutions will be :

[Given : Molar mass in g $mol^{-1}$ : $H = 1, C = 12, N = 14, O = 16, Cl = 35.5, Ca = 40, Al = 27$ and S = 32

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(1) II < III < IV < I (2) I < II < III < IV (3) III < I < II < IV (4) II < III < I < IV

**Ans.** Official answer NTA (2)

**Sol.** We know that $\rightarrow \Delta T_b = ik_b \cdot m$

for dilute solutions molarity approximately equal to molality.

(i) $M_{glucose} = \frac{2.2}{180} \times \frac{1000}{125} = 0.098$

$\Delta T_b = 1 \times k_b \times 0.098 = 0.098\ k_b$

(ii) $M_{CaCl_2} = \frac{1.9}{111} \times \frac{1000}{250} = 0.068$

$\Delta T_b = 3 \times k_b \times 0.068 = 0.204\ k_b$

(iii) $M_{urea} = \frac{9}{60} \times \frac{1000}{500} = 0.3$

$\Delta T_b = 1 \times k_b \times 0.3 = 0.3\ k_b$

(iv) $M_{Al_2(SO_4)_2} = \frac{20.5}{342} \times \frac{1000}{750} = 0.08$

$\Delta T_b = 5 \times k_b \times 0.08 = 0.4\ k_b$

Order of $\Delta T_b = Al_2(SO_4)_3 > Urea > CaCl_2 > Glucose$

Hence, order of B.P. = $Al_2(SO_4)_3 > Urea > CaCl_2 > Glucose$

Question ID : 8606541709

57. Consider the following statements about manganate and permanganate ions. Identify the correct statements.

A. The geometry of both manganate and permanganate ions is tetrahedral.

B. The oxidation states of Mn in manganate and permanganate are +7 and +6 , respectively.

C. Oxidation of Mn (II) salt by peroxodisulphate gives manganate ion as the final product.

D. Manganate ion is paramagnetic and permanganate ions is diamagnetic.

E. Acidified permanganate ion reduces oxalate, nitrite and iodide ions.

Choose the correct answer from the options given below :

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(1) A, B and C Only (2) A, C and D Only (3) A, D and E Only (4) A and D Only

**Ans.** Official answer NTA (4)

**Sol.** Permanganate ion $\rightarrow MnO_4^- \rightarrow Mn^{+7}$

Manganate ion $\rightarrow MnO_4^{2-} \rightarrow Mn^{+6}$

$\rightarrow$ Both ions have tetrahedral geometry.

$\rightarrow Mn^{2+} + S_2O_8^{2-} \rightarrow MnO_4^-$

$\rightarrow MnO_4^- \rightarrow d^0 \rightarrow$ diamagnetic

$MnO_4^{2-} \rightarrow d^1 \rightarrow$ Paramagnetic

$\rightarrow MnO_4^-$ is a strong oxidising agent.

Question ID : 8606541718

58. Total number of alkali insoluble solid sulphonamides obtained by reaction of given amines with Hinsberg's reagent is _____ .

Aniline, N-Methylaniline, Methanamine, N, N-Dimethylmethanamine, N-Methyl methanamine, Phenylmethanamine, N-propylaniline, N-phenylaniline, N, N-Dimethylaniline, Allyl amine, Isopropyl amine

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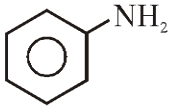
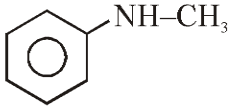
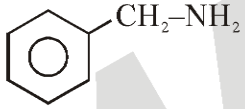
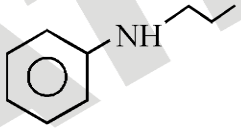
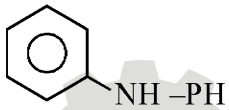
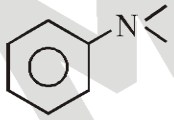
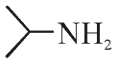
(1) 2 (2) 4 (3) 8 (4) 5

**Ans.** Official answer NTA (4)

**Sol.** (1)  (2)  (3) $CH_3-NH_2$ (4) 

(5) $CH_3-NH-CH_3$ (6)  (7) 

(8)  (9)  (10)  (11) 

Only 2° amine give alkali insoluble sulphonamide on reaction with hinsberg reagent

[Compound 2, 5, 7, 8 ar 2° amine]

Question ID : 8606541711

59. Consider the following reactions

$$Na_2B_4O_7 \xrightarrow{\Delta} 2X + Y$$

$$CuSO_4 + Y \xrightarrow{\text{Non-Luminous flame}} Z + SO_3$$

$$2Z + 2X + \text{Carbon}$$

$$\xrightarrow{\text{Luminous flame}} 2Q + Na_2B_4O_7 + CO$$

The oxidation states of Cu in Z and Q, respectively are:

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(1) +2 and +1 (2) +1 and +2 (3) +1 and +1 (4) +2 and +2

**Ans.** Official answer NTA (1)

**Sol.** $Na_2B_4O_7 \xrightarrow{\Delta} \underset{X}{2NaBO_2} + \underset{Y}{B_2O_3}$

$CuSO_4 + B_2O_3 \xrightarrow{\text{Non-Luminous flame}} \underset{Z}{\overset{+2}{Cu}(BO_2)_2} + SO_3$

$2Cu(BO_2)_2 + 2NaBO_2 + C \xrightarrow{\text{Luminous flame}} 2\overset{+1}{Cu}BO_2(Q) + Na_2B_4O_7 + CO$

Question ID : 8606541715

60. Which of the following reaction is NOT correctly represented?

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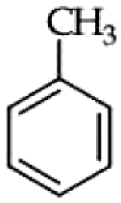
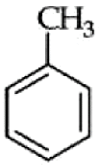
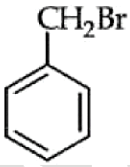
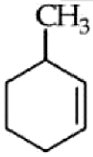
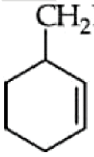
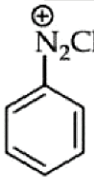
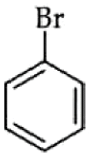
(1)  $\xrightarrow[\text{dark}]{Br_2, Fe}$ *ortho* and *para* Bromotoluenes

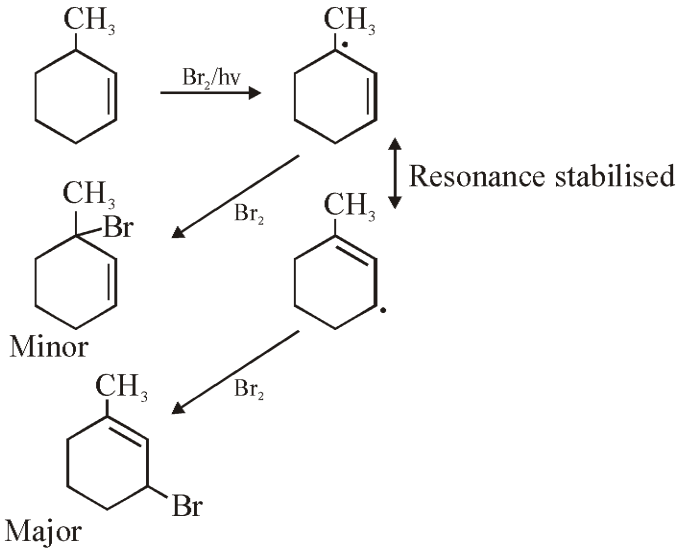
(2)  $\xrightarrow{Br_2, h\nu}$ 

(3)  $\xrightarrow{Br_2, h\nu}$ 

(4)  $\xrightarrow{Cu_2Br_2/HBr}$ 

**Ans.** Official answer NTA (3)

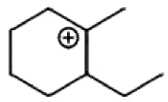
**Sol.**

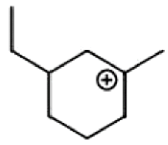


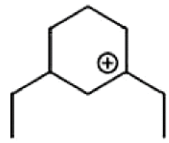

1, 2 & 4 are correct

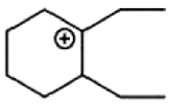
Question ID : 8606541712

61. The cyclic cations having the same number of hyperconjugation are :

A. 

B. 

C. 

D. 

Choose the correct answer from the options given below :

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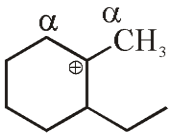
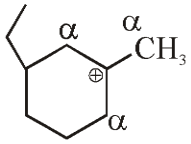
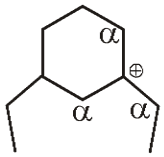
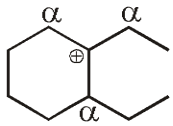
(1) B and C Only (2) A, C and D only (3) A and C Only (4) A and B Only

**Ans.** Official answer NTA (3)

**Sol.** (A)  $\Rightarrow 6\alpha - H$

(B)  $\Rightarrow 7\alpha - H$

(C)  $\Rightarrow 6\alpha - H$

(D)  $\Rightarrow 5\alpha - H$

Question ID : 8606541719

62. Structures of four disaccharides are given below. Among the given disaccharides, the non-reducing sugar is :

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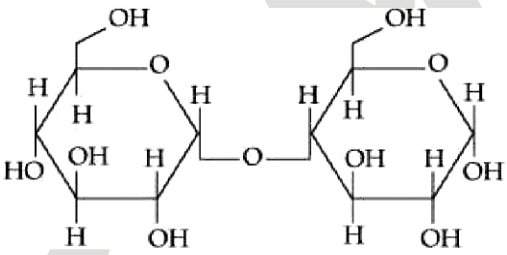
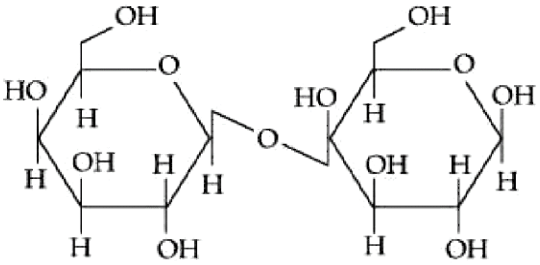
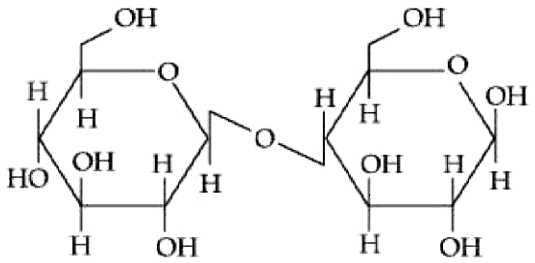
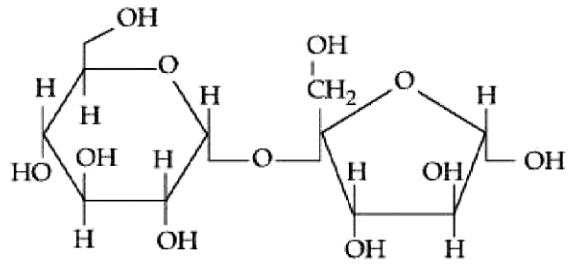
(1) 

(2) 

(3) 

(4) 

**Ans.** Official answer NTA (4)

**Sol.** 1, 2, structure has hemiacetel structure in basic medium. These compound will give tollen's & fehling test in compound 4

Acetal & ketal structure is present in 4th compound which is stable in basic medium, that why compound 4 will not give tollen's & fehling test.

Question ID : 8606541714

63. The reactions which produce alcohol as the product are :

A. $CH_4 + O_2 \xrightarrow[\Delta]{Mo_2O_3}$

B. $2CH_3CH_3 + 3O_2 \xrightarrow[\Delta]{(CH_3COO)_2Mn}$

C. $(CH_3)_3CH \xrightarrow{KMnO_4}$

D. $2CH_4 + O_2 \xrightarrow{Cu/523\ K/100\ atm.}$

E. $CH_3-CH=CH-CH_3 \xrightarrow{KMnO_4/H^+}$

Choose the correct answer from the options given below :

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(1) B, D and E Only (2) A and D Only (3) A, C and E Only (4) C and D Only

**Ans.** Official answer NTA (4)

**Sol.** (A) $CH_4 + O_2 \xrightarrow[\Delta]{MO_2O_3} HCHO$

(B) $CH_3CH_3 + 3O_2 \xrightarrow[\Delta]{(CH_3COO)_2Mn} CH_3COOH$

(C) $(CH_3)_3C-H \xrightarrow{KMnO_4} (CH_3)_3C-OH$

(D) $2CH_4 + O_2 \xrightarrow{Cu/523\,K/100\,atm} 2CH_3OH$

(E) $CH_3CH=CH-CH_3 \xrightarrow{KMnO_4/H^+} 2CH_3COOH$

Question ID : 8606541707

64. Consider the elements N, P, O, S, Cl and F. The number of valence electrons present in the elements with most and least metallic character from the above list is respectively.

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(1) 5 and 6 (2) 7 and 5 (3) 5 and 7 (4) 6 and 7

**Ans.** Official answer NTA (3)

**Sol.** Most metallic element = P

Valence electron in P = 5

Least Metallic element = F

Valence electron in F = 7

Metallic character increases down the group and decreases from left to right along the period.

Question ID : 8606541705

65. The correct increasing order of spin-only magnetic moment values of the complex ions

$[MnBr_4]^{2-}(A), [Cu(H_2O)_6]^{2+}(B), [Ni(CN)_4]^{2-}(C)$ and $[Ni(H_2O)_6]^{2+}(D)$ is :

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(1) $C=D<B<A$ (2) $A=B<D<C$ (3) $C<B<D<A$ (4) $A=B<C<D$

**Ans.** Official answer NTA (3)

**Sol.** $[MnBr_4]^{2-} \rightarrow$ Tetrahedral

$Mn^{2+} \rightarrow d^5 \rightarrow e^{1\cdot1}\ t_2^{1\cdot1\cdot1}$

$\Rightarrow$ Unpaired electron = 5

$[Cu(H_2O)_6]^{2+} \rightarrow$ Octahedral

$Cu^{2+} \rightarrow d^9 \rightarrow t_{2g}^{2\cdot2\cdot2}\ e_g^{1}$

$\Rightarrow$ unpaired electron = 1

$[Ni(CN)_4]^{2-} \rightarrow$ Square planar

$Ni^{2+} \rightarrow 3d^8 \Rightarrow$ Unpaired electron = 0

$[Ni(H_2O)_6]^{2+} \rightarrow$ Octahedral

$Ni^{2+} \rightarrow 3d^8 \rightarrow t_{2g}^{2\cdot2\cdot2}$ $\quad e.g.^{1\cdot1}$

$\Rightarrow$ Unpaired electron = 2

Spin only magnetic moment = $\sqrt{n(n+2)}$

where n = no. of unpaired electrons.

Higher the value of n, higher will be spin only magnetic moment.

Question ID : 8606541705

66. Observe the following equilibrium in a 1 L flask.

$A(g) \rightleftharpoons B(g)$

At T(K), the equilibrium concentrations of A and B are 0.5 M and 0.375 M respectively. 0.1 moles of A is added into the flask and heated to T(K) to establish the equilibrium again. The new equilibrium concentrations (in M ) of A and B are respectively

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(1) *0.367,0.275* (2) *0.742,0.557* (3) *0.53,0.4* (4) *0.557,0.418*

**Ans.** Official answer NTA (4)

**Sol.** $A \rightleftharpoons B$

Eq$^m$ concentration $\rightarrow$ 0.5 0.375

$$k_{eq.} = \frac{[B]}{[A]} = \frac{0.375}{0.5} = 0.75$$

when 0.1 mole of A is added. So reaction will move in forward direction.

$A \rightleftharpoons B$

0.6–x 0.375 + x

$$0.75 = \frac{0.375 + x}{0.6 - x}$$

x = 0.043

$\Rightarrow$ moles of A = 0.6 – 0.043 = 0.057

$\Rightarrow$ moles of B = 0.375 + 0.043 = 0.418

Question ID : 8606541702

67. The wavelength of photon 'A' is 400 nm. The frequency of photon 'B' is $10^{16} s^{-1}$. The wave number of photon 'C' is $10^4$ $cm^{-1}$. The correct order of energy of these photons is :

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(1) C > B > A (2) A > C > B (3) B > A > C (4) A > B > C

**Ans.** Official answer NTA (3)

**Sol.** $\lambda$ of A = 400 nm

$$\lambda \text{ of B} = \frac{c}{\nu} = \frac{3\times10^{8}}{10^{16}} = 3\times10^{-8}\text{m}$$

$= 30 \times 10^{-9}$ m

= 30 nm

$$\lambda \text{ of C} = \frac{1}{\bar{\nu}} = \frac{1}{10^{4}} = 10^{-4}\text{ cm} = 1000\text{ nm}$$

order of $\lambda$ = C > A > B

$$E = \frac{hc}{\lambda}$$

$$\Rightarrow E \propto \frac{1}{\lambda}$$

$\Rightarrow$ order of energy = B > A > C

Question ID : 8606541706

68. Match List - I with List - II according to shape.

| | **List - I** | | **List - II** |
|---|---|---|---|
| A. | $XeO_3$ | I. | $BrF_5$ |
| B. | $XeF_2$ | II. | $NH_3$ |
| C. | $XeO_2F_2$ | III. | $[I_3]^-$ |
| D. | $XeOF_4$ | IV. | $SF_4$ |

Choose the correct answer from the options given below :

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

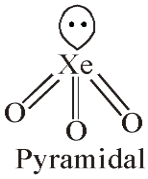
(2) A-II, B-I, C-III, D-IV

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

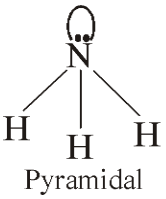
(4) A-III, B-II, C-IV, D-I

**Ans.** Official answer NTA (1)

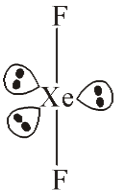
**Sol.**



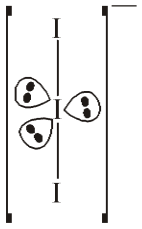
Pyramidal



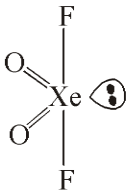
Pyramidal

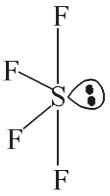


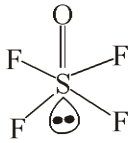
Linear

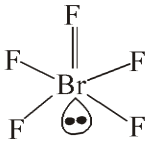


Linear


See-saw


See-saw


Square pyramidal


Square pyramidal

Question ID : 8606541703

69. The plot of $\log_{10} K$ vs $\frac{1}{T}$ gives a straight line. The intercept and slope respectively are (where K is equilibrium constant).

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(1) $-\frac{\Delta H^o}{2\cdot303R}, \frac{\Delta S^o}{2\cdot303R}$

(2) $\frac{\Delta S^o}{2\cdot303R}, -\frac{\Delta H^o}{2\cdot303R}$

(3) $-\frac{\Delta S^o R}{2\cdot303}, \frac{\Delta H^o R}{2\cdot303}$

(4) $\frac{2\cdot303R}{\Delta H^o}, \frac{2\cdot303R}{\Delta S^o}$

**Ans.** Official answer NTA (2)

**Sol.** $\log k = \frac{-\Delta H^o}{2.303R}\frac{1}{T} + \frac{\Delta S^o}{2.303R}$

$\downarrow \quad \downarrow \quad \downarrow \quad \downarrow$

y m x c

slope $\rightarrow \frac{-\Delta H^o}{2.303R}$

interpret $\rightarrow \frac{\Delta S^o}{2.303R}$

Question ID : 8606541701

70. For the given reaction;

$CaCO_3 + 2HCl \rightarrow CaCl_2 + H_2O + CO_2$

If 90 g $CaCO_3$ is added to 300 mL of HCl which contains 38.55% HCl by mass and has density 1.13 g $mL^{-1}$, then which of the following option is correct ?

Given molar mass of H, Cl Ca and O are 1, 35.5, 40 and 16 g $mol^{-1}$ respectively.

क

(1) 64.97 g of HCl remains unreacted

(2) 97.30 g of HCl reacted

(3) 60.32 g of HCl remains unreacted

(4) 32.85 g of $CaCO_3$ remains unreacted

**Ans.** Official answer NTA (1)

**Sol.** Density of HCl solution = 1.13 g/ml

Volume = 300 ml

$$D = \frac{m}{v}$$

$$1.13 = \frac{m}{300}$$

m = 339 g

38.55% HCl by mass means 38.55 g HCl is present in 100 g of solution.

$$\Rightarrow \text{mass of HCl in 339 g of solution} = \frac{38.55}{100} \times 339 = 130.68 g$$

$$CaCO_3 + 2HCl \rightarrow CaCl_2 + H_2O + CO_2$$

| | $\frac{90}{100}$ | $\frac{130.68}{36.5}$ | | | |
|---|---|---|---|---|---|
| | 0.9 mole | 3.58 mole | | | |
| Reacted amount | 0.9 | 1.8 | 0.9 | 0.9 | 0.9 |
| Left amount | 0 | 1.78 | 0.9 | 0.9 | 0.9 |

So, 1.78 moles of HCl remains unreacted.

Mass = 1.78 × 36.5

= 64.97 g

## SECTION – B

Question ID : 8606541725

71. The number of isoelectronic species among $Sc^{3+}, Cr^{2+}, Mn^{3+}, Co^{3+}$ and $Fe^{3+}$ is 'n'. If 'n' moles of AgCl is formed during the reaction of complex with formula $CoCl_3(en)_2NH_3$ with excess of $AgNO_3$ solution, then the number of electrons present in the $t_{2g}$ orbital of the complex is _____.

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**Ans.** Official answer NTA (6)

**Sol.** $Sc^{3+} \rightarrow$ 18 electron

$Cr^{2+} \rightarrow$ 22 electron

$Mn^{+3} \rightarrow$ 22 electron

$Co^{+3} \rightarrow$ 24 electron

$Fe^{+3} \rightarrow 23$ electron

$Cr^{2+}$ & $Mn^{+3}$ are isoelectronic

$\Rightarrow n = 2$

Therefore, two moles of AgCl are formed.

So, complex is = $[Co(en)_2(NH_3)Cl]Cl_2$

$Co^{3+} \rightarrow 3d^6 \rightarrow t_{2g}^{2.2.2}\ e_g^{o}$

Question ID : 8606541722

72. For strong electrolyte $\Lambda_m$ increases slowly with dilution and can be represented by the equation

$\Lambda_m = \Lambda_m^{\circ} - Ac^{1/2}$

Molar conductivity values of the solutions of strong electrolyte AB at $18^{\circ}C$ are given below :

| c [mol $L^{-1}$] | 0.04 | 0.09 | 0.16 | 0.25 |
|---|---|---|---|---|
| $\Lambda_m$ [S $cm^2$ $mol^{-1}$] | 96.1 | 95.7 | 95.3 | 94.9 |

The value of constant A based on the above data [ in $Scm^2\ mol^{-1}\ /\ (mol\ /\ L)^{1/2}$ ] unit is ____ .

क

**Ans.** Official answer NTA (4)

**Sol.** $\Lambda_m = \Lambda_m^{o} - A\sqrt{C}$

$96.1 = \Lambda_m^{o} - A\sqrt{0.04}$

$96.1 = \Lambda_m^{o} - A(0.2)$ ...(1)

$95.7 = \Lambda_m^{o} - A\sqrt{0.09}$

$95.7 = \Lambda_m^{o} - A(0.3)$ ...(2)

By solving equation (1) & (2)
we get, A = 4

Question ID : 8606541723

73. A volume of x $mL$ of $5MNaHCO_3$ solution was mixed with 10 mL of $2MH_2CO_3$ solution to make an electrolytic buffer. If the same buffer was used in the following electrochemical cell to record a cell potential of 235.3 mV , then the value of x = _____mL (nearest integer).

$Sn(s)\left|Sn(OH)_6^{2-}(0.5M)\right|HSnO_2^{-}(0.05M)\left|OH^{-}\right|Bi_2O_3(s)\,|\,Bi(s)$

Consider upto one place of decimal for intermediate calculations

Given :

$E^{o}_{HSnO_2^-|Sn(OH)_6^{2-}} = -0.9\,V$

$E^{o}_{Bi_2O_3|Bi} = -0.44V$

$pKa_{(H_2CO_3)} = 6.11$

$\frac{2.303RT}{F} = 0.059V$

$Anti\log(1.29) = 19.5$

**Ans.** Official answer NTA (78)

Answer by MATRIX (Bonus)

**Sol.** Oxidation half reaction →

$HSnO_2^- + H_2O + 3OH^- \rightarrow [Sn(OH)_6]^2 + 2e^-$

0.05M 0.5 M

Reduction half reaction →

$Bi_2O_3 + 3H_2O + 6e^- \rightarrow 2Bi + 6OH^-$

---

$3HSnO_2^-(aq) + Bi_2O_3(s) + 6H_2O + 3OH^-(aq) \rightarrow 3[Sn(OH)_6]^{2-}(aq) + 2Bi(s)$

$E^{o}_{cell} = E^{o}_{anode} + E^{o}_{cathode}$

$= 0.9 + (-0.44)$

$= 0.46$

$$E_{cell} = E^{\circ}_{cell} - \frac{0.059}{6}\log\frac{\left[\left(sn(OH)_6\right)^{2-}\right]^3}{\left(OH^-\right)^3\left(HSnO_2^-\right)^3}$$

$$0.2353 = 0.46 - \frac{0.059}{6}\log\frac{(0.5)^3}{(0.05)^3 \times \left(OH^-\right)^3}$$

$$0.2353 = 0.46 - \frac{0.059}{6}\times 3\log\left[\frac{10}{\left(OH^-\right)}\right]$$

$$0.2353 = 0.46 - \frac{0.059}{2}\log\left[\frac{10}{\left(OH^-\right)}\right]$$

$$-0.2247 = -0.0295 \log\left[\frac{10}{(OH^-)}\right]$$

$$\frac{-0.2247}{-0.0295} = \log\left[\frac{10}{(OH^-)}\right]$$

$7.6 = \log 10 - \log(OH^-)$

$7.6 = 1 + p^{OH}$

$p^{OH} = 6.6$

$p^H = 14 - 6.6 = 7.4$

$$p^H = p^{k_a} + \log\frac{[HCO_3^-]}{[H_2CO_3]}$$

$$7.4 = 6.11 + \log\frac{5x}{20}$$

$$1.29 = \log\frac{x}{4}$$

$$\text{Anti}\log(1.29) = \frac{x}{4}$$

$$19.5 = \frac{x}{4}$$

$x = 78$

**Note :** This question is solved using $E^0_{HSnO_2^-}/Sn(OH)_6^{2-} = 0.9V$ if we use $E^0_{HSnO_2^-}/Sn(OH)_6^{2-} = -0.9V$ (given in question paper) then, the answer 78 (given by NTA ) does not match. So, this question should be bonus.

Question ID : 8606541724

74. $A \rightarrow B$ (First Reaction)

$C \rightarrow D$ (Second Reaction)

Consider the above two first-order reactions. The rate constant for first reaction at 500 K is double of the same at 300 K . At 500 K, 50% of the reaction becomes complete in 2 hour. The activation energy of the second reaction is half of that of first reaction. If the rate constant at 500 K of the second reaction becomes double of the rate constant of first reaction at the same temperature; then rate constant for the second reaction at 300 K is _____ $\times 10^{-1}$ hour $^{-1}$ (nearest integer).

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**Ans.** Official answer NTA (5)

**Sol.** $A \xrightarrow{k_1} B$

$$\frac{\ell n(k)_{500}}{\ell n(k)_{300}} = \frac{Ea_1}{R}\left(\frac{1}{300}-\frac{1}{500}\right)$$

$$\ell n2 = \frac{Ea_1}{R}\left(\frac{1}{300}-\frac{1}{500}\right)$$

$$Ea_1 = \frac{\ell n2 \times R \times 1500}{2}$$

$$Ea_2 = \frac{Ea_1}{2} = \frac{\ell n2 \times R \times 1500}{4}$$

$$(k_1)_{500k} = \frac{\ell n2}{2}$$

$$(k_2)_{500k} = \ell n2$$

$$C \xrightarrow{k_2} D$$

$$\ell n\left[\frac{(k_2)_{500k}}{(k_1)_{300k}}\right] = \frac{\ell n2 \times R \times 1500}{4} \times \frac{1}{R} \times \left(\frac{1}{300}-\frac{1}{500}\right)$$

$$(k_2)_{300k} = \frac{\ell n2}{\sqrt{2}}$$

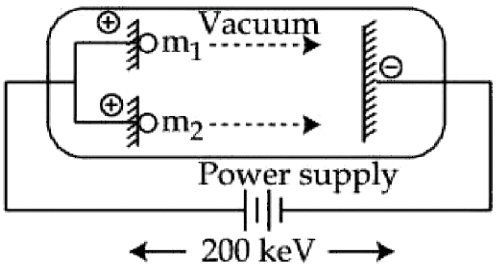
$= 0.49$

$= 4.9 \times 10^{-1}$

$= 5$

Question ID : 8606541721

75. Two positively charged particles $m_1$ and $m_2$ have been accelerated across the same potential difference of 200 keV as shown below.




[Given mass of $m_1$ = 1 amu and $m_2$ = 4 amu]

The deBroglie wavelength of $m_1$ will be x times of $m_2$. The value of x is _____ (nearest integer)

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**Ans.** Official answer NTA (2)

**Sol.** $\lambda_d = \frac{h}{\sqrt{2mkE}}$

K.E. is same for both $m_1$ & $m_2$.

h = Planck's constant

$\Rightarrow \lambda_d \propto \frac{1}{\sqrt{m}}$

$\frac{(\lambda_d)_{m_1}}{(\lambda_d)_{m_2}} = \sqrt{\frac{m_2}{m_1}}$

$= \sqrt{\frac{4}{1}} = 2$

$(\lambda_d)_{m_1} = 2(\lambda_d)_{m_2}$