Solid Lead nitrate is dissolved in 1 litre of water. The solution was found to boil at 100.15°C. When 0.2 mol of NaCl is added to the resulting solution, it was observed that the solution froze at −0.8°C. The solubility product of $PbCl_2$ formed is _____ $\times 10^{-6}$ at 298K. (Nearest integer) Given : $K_b = 0.5K$ $kgmol^{-1}$ and $K_f = 1.8$ kg mol^{-1}. Assume molality to be equal to molarity in all cases. [29-Jan-2023 Shift 1]

$$Pb(NO_3)_2 \longrightarrow Pb^{2+} + 2NO_3^{-}$$

$$\Delta T_b = 0.15$$

$$\boxed{13}$$

$$\Delta T_b = i K_b m$$

$$m \Rightarrow 0.1$$
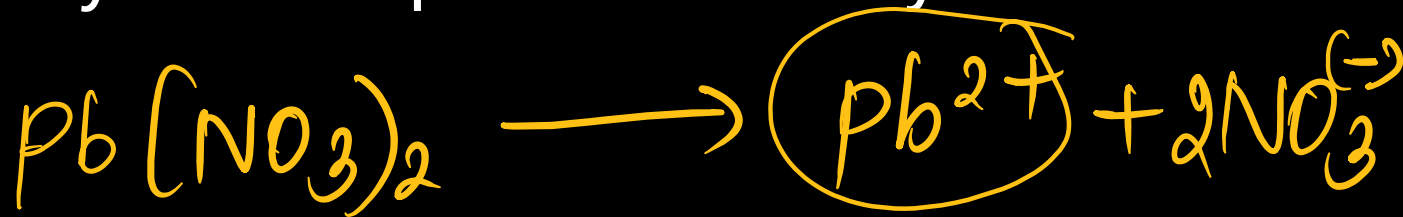
$$0.15 = 3 \times 0.5$$

$$0.2 \text{ mol of } NaCl \qquad Pb^{2+} + 2Cl^- \rightleftharpoons PbCl_2$$

$$[Pb^{2+}] = 0.1 - x$$

$$[Cl^-] = 0.2 - 2x$$

$$[Na^+] = 0.2$$

$$[Cl^-] = 0.2$$

$$\Delta T_f = 0.8 \, K$$

$$\Delta T_f = k_f \times m$$

$$0.8 = 1.8 \times m$$

$$m = \frac{0.8}{1.8} = 0.44$$

$$\text{Total Particles} = (0.1 - x) + (0.2 - 2x)$$
$$+ 0.2 + 0.2 = 0.7 - 3x$$

$$0.7 - 3x = 0.44$$
$$x = 0.085$$

$$K_{sp} = [Pb^{2+}][Cl^-]^2$$
$$= (0.0147)(0.029)^2$$
$$= 1.27 \times 10^{-5}$$

We have three aqueous solutions of NaCl labelled as ' A ', ' B ' and ' C ' with concentration 0.1M, 0.01M & 0.001M, respectively. The value of van t' Hoff factor (i) for these solutions will be in the order.
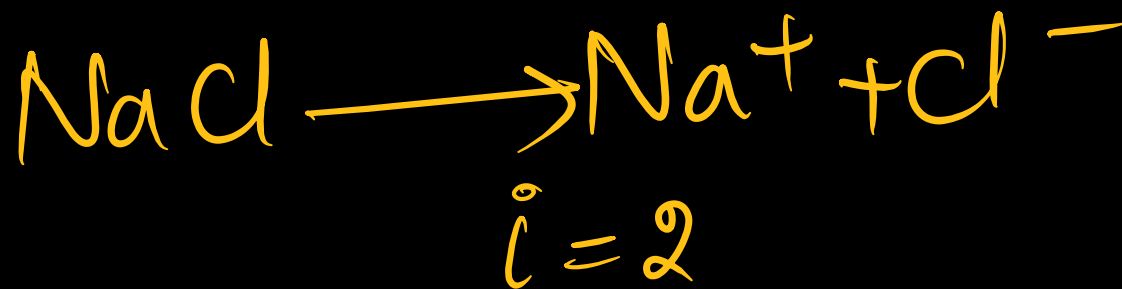[1-Feb-2024 Shift 1]
Options:
A. iA < iB < iC
B. iA < iC < iB
C. iA = iB = iC
D. iA > iB > iC

$$NaCl \longrightarrow Na^+ + Cl^-$$

$$\overset{\circ}{i} = 2$$

$$\overset{\circ}{i}_C > \overset{\circ}{i}_B > \overset{\circ}{i}_A$$

Two liquids X and Y form an ideal solution. At 300K , vapour pressure of the solution containing 1mol of X and 3mol of Y is 550mmHg. At the same temperature, if 1 mol of Y is further added to this solution, vapour pressure of the solution increases by 10mmHg. Vapour pressure (in mmH g) of X and Y in their pure states will be, respectively:
A. 300 and 400
B. 400 and 600
C. 500 and 600
D. 200 and 300

$$P_T = P_x^o X_x + P_y^o X_y$$

$$550 = P_x \times \frac{1}{4} + P_y^o \frac{3}{4}$$

$$P_x^0 + 3P_y^0 = 550 \times 4 \quad \textcircled{1}$$

Case: II
$$P_T = P_x^0 \times \frac{1}{5} + P_y^0 \times \frac{4}{5}$$

$$P_x^0 + 4P_y^0 = 560 \times 5 \quad \textcircled{2}$$

$$P_y^0 = 600 \qquad P_x^0 = 400$$

A 5.25% solution of a substance is isotonic with a 1.5% solution of urea (molar mass = 60gmol−1) in the same solvent. If the densities of both the solutions are assumed to be equal to 1.0gcm−3, molar mass of the substance will be

$$C_1 = \frac{5.25/MM}{V}$$

$$C_2 = \frac{1.5/60}{V}$$

$$\pi = CRT$$

$$\pi_1 = \pi_2$$

$$C_1 = C_2 \Rightarrow \frac{5.25}{MM} = \frac{1.5}{60}$$

$$\Rightarrow 210 g/mol$$

80 mole percent of $MgCl_2$ is dissociated in aqueous solution. The vapour pressure of 1.0 molal aqueous solution of $MgCl_2$ at 38∘C is _____ mmHg. (Nearest integer)

Given : Vapour pressure of water at 38∘C is 50 mm Hg.

[12-Apr-2023 shift 1]

$$MgCl_2 \longrightarrow Mg^{2+} + 2Cl^-$$

$$i = 1 + \alpha(n-1) = 1 + 0.8(3-1)$$
$$= 2.6$$

$1 \, m \quad MgCl_2 \Rightarrow$ Moles of $MgCl_2 = 1$

Moles of water $= \dfrac{1000}{18} = 55.5$

$(Solute) = i \times 1 = 2.6 \, mol$

$X_{water} = \dfrac{55.5}{55.5 + 2.6} = 0.9$

$$P = X_{water} \times P^{o}$$

$$P = 0.955 \times 50$$

$$= 48 \, mmHg$$

If the boiling points of two solvents X and Y (having same molecular weights) are in the ratio 2 : 1 and their enthalpy of vaporizations are in the ratio 1 : 2, then the boiling point elevation constant of X is m times the boiling point elevation constant of Y . The value of m is _____ (nearest integer) [8-Apr-2023 shift 2]

$$K_b = \dfrac{RT_b^2 M}{1000 \, \Delta H_{vap}}$$

$$\dfrac{(K_b)_x}{(K_b)_y} = \dfrac{(T_b^2 M)_x}{(T_b^2 M)_y} \times \dfrac{(\Delta H)_y}{(\Delta H)_x} =$$

$$\left(\frac{2}{1}\right)^2 \times \left(\frac{2}{1}\right) = \frac{8}{1}$$

$$\boxed{8}$$

The vapour pressure vs. temperature curve for a solution solvent system is shown below: The boiling point of the solvent is _____ °C
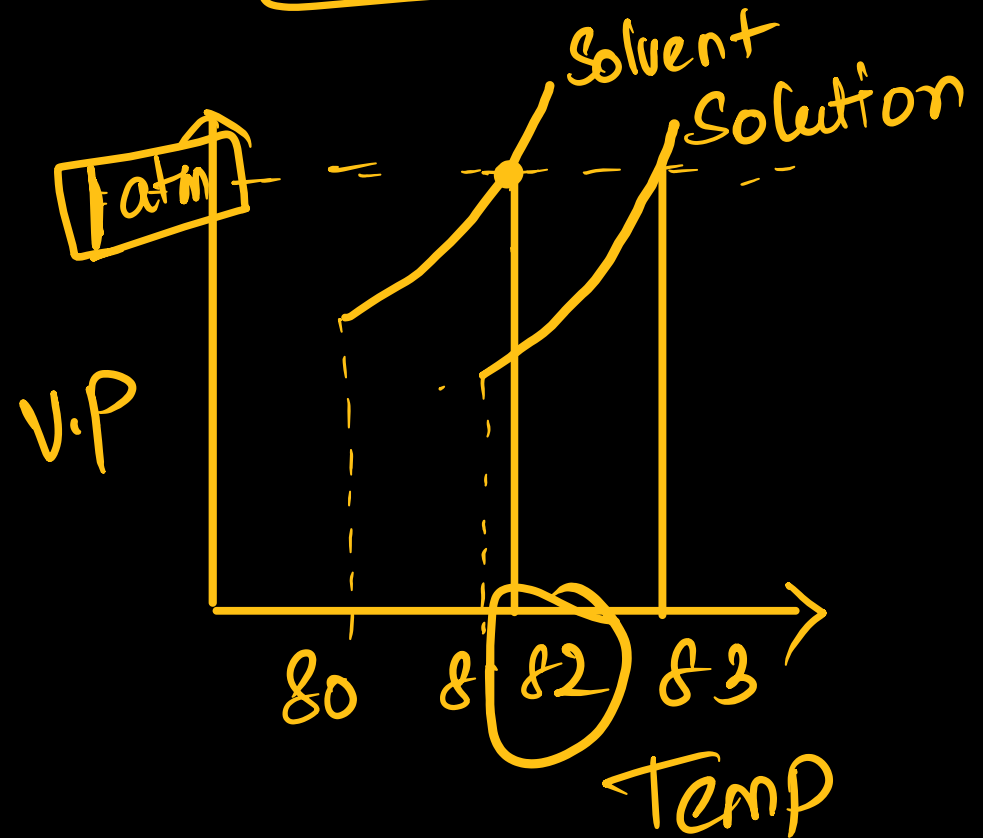
Physical Chemistry Questions

The number of pairs of the solution having the same value of the osmotic pressure from the following is _____.

(Assume 100\% ionization)

A. $0.500M \, C_2H_5OH$(aq) and $0.25M$ KBr(aq)

B. $0.100M \, K_4[Fe(CN)_6]$ (aq) and $0.100M \, FeSO_4(NH_4)_2SO_4$(aq)

C. $0.05M \, K_4[Fe(CN)_6]$(aq) and $0.25M$ NaCl (aq)

D. $0.15M$ NaCl(aq) and $0.1M \, BaCl_2$(aq)

E. $0.02M$ KCl . $MgCl_2.6H2O$(aq) and $0.05M$ KCl(aq)

[25-Jan-2023 Shift 2]

$\pi = iCRT$

$\pi \propto iC$

A, B, D, E

The freezing point depression of a 0.1 m aqueous solution of a monobasic weak acid HA is 0.20 °C. The dissociation constant for the acid is

Given: (H$_2$O) = 1.8 K kg mol^{-1}, molality ≡ molarity

$$\Delta T_f = i \, K_f \, m$$

$$0.2 = i \times 1.8 \times 0.1 \Rightarrow i = \frac{10}{9}$$

$$HA \rightleftharpoons H^+ + A^-$$

$$K_{eq} = \frac{[H^+][A^-]}{[HA]}$$
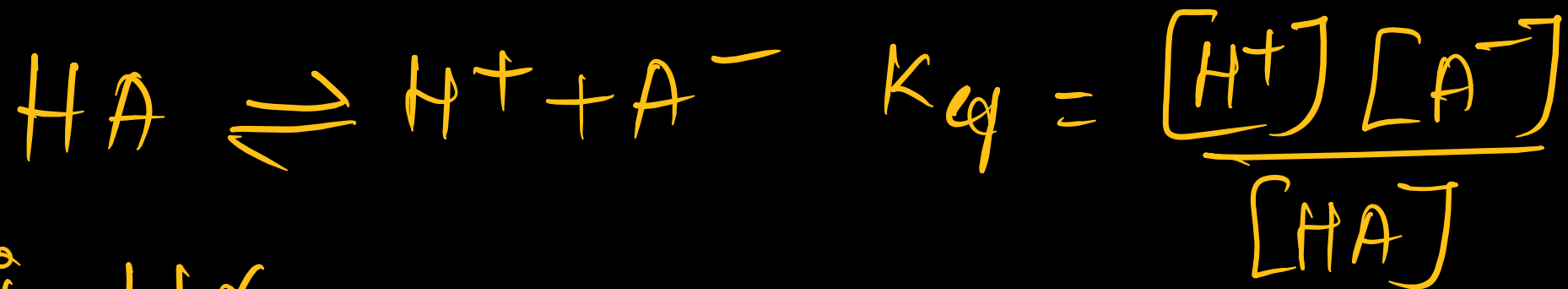
$$i = 1 + \alpha$$

$$\frac{10}{9} = 1 + \alpha \Rightarrow \alpha = 1/9$$

$$[H^+] = [A^-] = C\alpha = 0.1/9$$

$$[HA] = 0.1 \times (1-\alpha) = 0.1 \times \left(1 - \frac{1}{9}\right)$$

$$k_{eq} = \frac{(0.1 \times \frac{1}{9})^2}{0.1 \times (1 - \frac{1}{9})}$$

$$k_{eq} = 1.38 \times 10^{-3}$$

If a_0 is denoted as the Bohr radius of hydrogen atom, then what is the de-Broglie wavelength (λ) of the electron present in the second orbit of hydrogen atom? [n : any integer]

$\rightarrow n = 2$

$$r_n = a_0 \times n^2 \ -$$

$$r_2 = a_0 \times 2^2 = \underline{4a_0}$$

$$2\pi r = n\lambda \qquad \Rightarrow \quad 2\pi r_2 = n\lambda$$

$$2\pi \times 4a_0 = n\lambda$$

$$8\pi a_0 = n\lambda$$

$$\lambda = \frac{8\pi a_0}{n}$$

For electrons in ' 2 s ' and ' 2 p ' orbitals, the orbital angular momentum values, respectively are

$$\text{Orbital ang. momentum} = \sqrt{l(l+1)}\,\frac{h}{2\pi}$$

$$2s \Rightarrow \sqrt{0(0+1)}\,\frac{h}{2\pi} = 0 \quad \checkmark$$

$$2p \Rightarrow \sqrt{1(1+1)}\,\frac{h}{2\pi} = \frac{\sqrt{2}\,h}{2\pi} \quad \checkmark$$
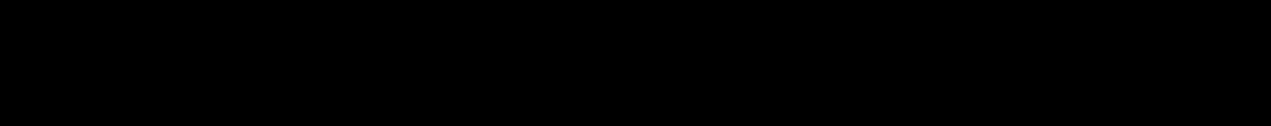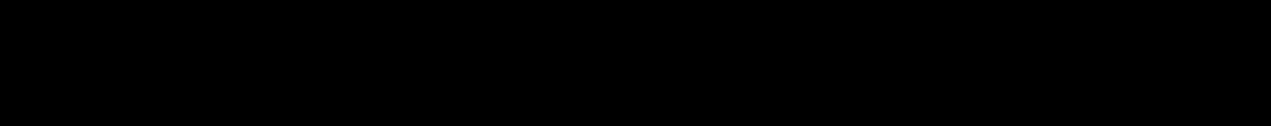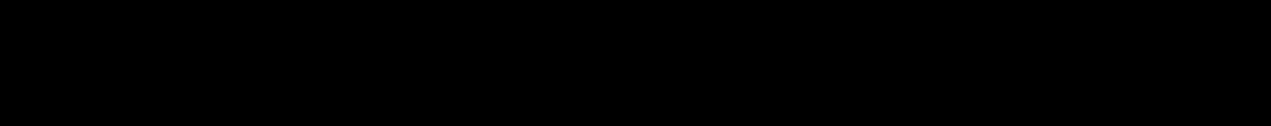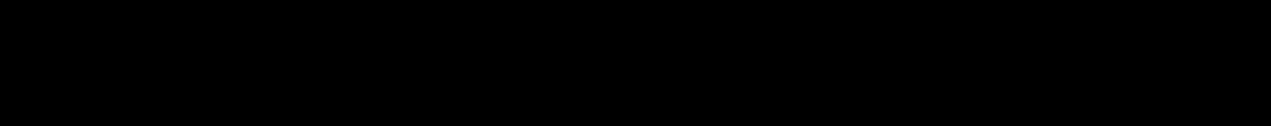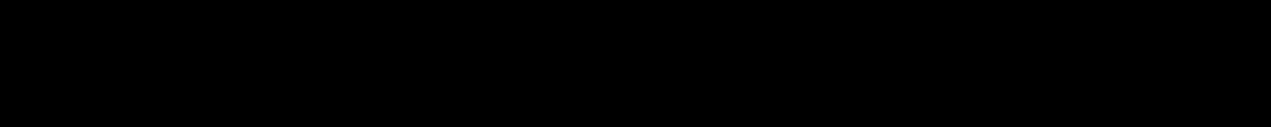
Physical Chemistry Questions

Number of spectral lines obtained in He^+ spectra, when an electron makes transition from fifth excited state to first excited state will be
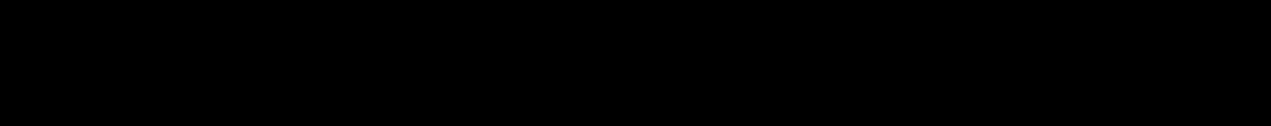
$$n_1 = 6 , \qquad n_2 = 2$$
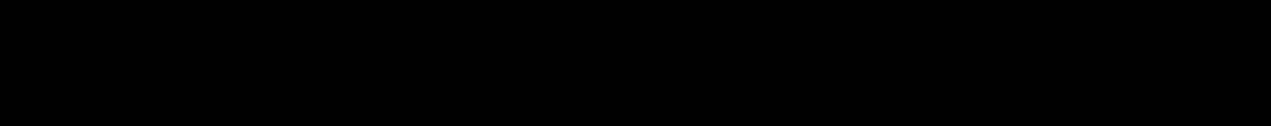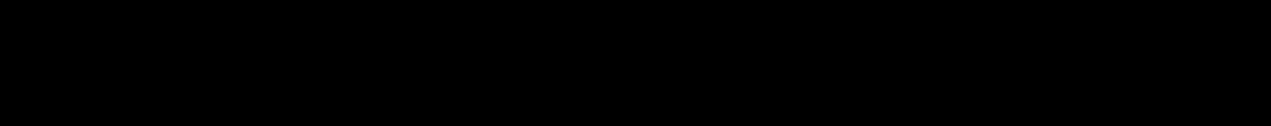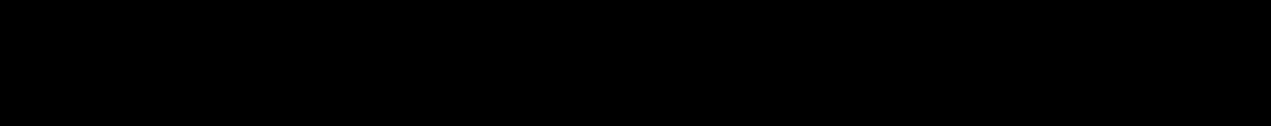
$$\Delta n = n_1 - n_2 = 6 - 2 = 4$$

$$= \frac{\Delta n (\Delta n + 1)}{2} = \frac{4(4+1)}{2} = 10$$
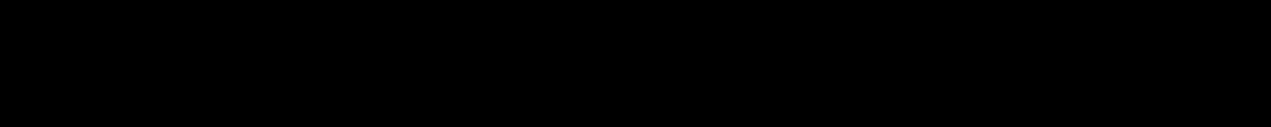
Physical Chemistry Questions

If wavelength of the first line of the Paschen series of hydrogen atom is 720 nm, then the wavelength of the second line of this series is _____ nm

$$\left(\frac{1}{\lambda}\right)_{1st} = R_H Z^2 \left(\frac{1}{9} - \frac{1}{16}\right)$$

$$\left(\frac{1}{\lambda}\right)_{2nd} = R_H Z^2 \left(\frac{1}{9} - \frac{1}{25}\right)$$

$4, 5, 6, 7, 8 \cdots$

3rd

$$720 \leftarrow \frac{\lambda_2}{\lambda_1} = \frac{25 \times 7}{16 \times 16}$$

$$\lambda_2 = 492$$

The number of s-electrons present in an ion with 55 protons in its unipositive state is

$$[Cs^+]$$

$$[Xe]6s^1$$

$$5s \longrightarrow 5 \times 2$$

$$= \boxed{10}$$

The wave function (Ψ) of $2s$ is given by

$$\Psi_{2s} = \frac{1}{2\sqrt{2\pi}} \left(\frac{1}{a_0}\right)^{1/2} \left(2 - \frac{r}{a_0}\right) e^{-r/2a_0}$$

At $r = r_0$, radial node is formed. Thus, r_0 in terms of a_0

[30-Jan-2023 Shift 2]

The number of electrons in the orbitals of sub-shell of $n = 4$ are
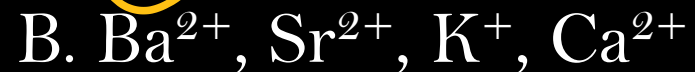
A. r0 = a0

B. r0 = 4a0

C. r0 = a02

D. r0 = 2a

$$r_0 = 2a_0$$

At node $= \Psi_{2s} = 0$

$$\therefore \left(2 - \frac{r_0}{a_0}\right) = 0$$

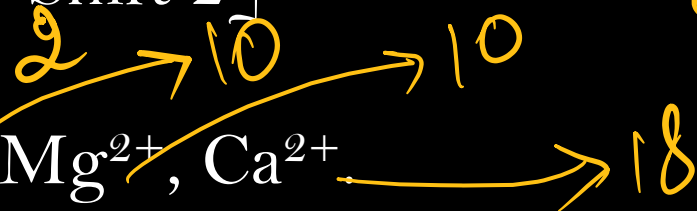Which one of the following sets of ions represents a collection of isoelectronic species?

[1-Feb-2023 Shift 2]

Options:

A. Li^+, Na^+, Mg^{2+}, Ca^{2+}

B. Ba^{2+}, Sr^{2+}, K^+, Ca^{2+}

C. CN^{3-}, O^{2-}, F^-, S^{2-}

D. K^+, Cl^-, Ca^{2+}, Sc^{3+}

$\rightarrow 2 \rightarrow 10 \rightarrow 10$

$\rightarrow 18$

no. of e^- are Same.

If the radius of the 3rd Bohr's orbit of hydrogen atom is r3 and the radius of 4th Bohr's orbit is r4. Then :

[26-Jun-2022-Shift-1]

a) $r_4 = \dfrac{9}{16} r_3$

b) $r_4 = \dfrac{16}{9} r_3$

c) $r_4 = \dfrac{3}{4} r_3$

d) $r_4 = \dfrac{4}{3} r_3$

$r_4 = \dfrac{16}{9} r_3$

$r = r_0 \times \dfrac{n^2}{z}$

$r_3 = r_0 \times \dfrac{3^2}{1}$

$r_3 = 9$

$r_4 = r_0 \times \dfrac{4^2}{1}$

$r_4 = 16$

The number of radial and angular nodes in 4d orbital are, respectively

$n-l-1$

$4-2-1$

$=1$

$l=2$

$S=0$

$P=1$

$d=2$

$f=3$

If the uncertainty in velocity and position of a minute particle in space are, $2.4 \times 10^{-26} (ms^{-1})$ and $10^{-7} (m)$ respectively. The mass of the particle in g is _____ (Nearest integer)

(Given : h = 6.626×10^{-34} Js)

$$m = 22$$

$$\Delta x \cdot \Delta p = \frac{h}{4\pi}$$

$$\Delta x \cdot m\Delta v = \frac{h}{4\pi}$$

$$10^{-7} \times m \times 2.4 \times 10^{-26} = \frac{6.6 \times 10^{-34}}{4 \times \pi}$$

If the work function of a metal is 6.63×10^{-19} J, the maximum wavelength of the photon required to remove a photoelectron from the metal is ___ nm. (Nearest integer)

[Given : h = 6.63×10^{-34} Js, and c = $3 \times 108 \text{ms}^{-1}$]

[28-Jun-2022-Shift-1]

$$\frac{6.63 \times 10^{-19}}{1.6 \times 10^{-19}} = 4.14 \, eV$$

$$E = \frac{1240}{\lambda} = 4.14 \Rightarrow \lambda = 300$$

For a reaction, $N_2O_5 \longrightarrow 2NO_2 + \frac{1}{2}O_2$

in a constant volume container, no products were present initially. The final pressure of the system when 50% of reaction gets completed is

A. 5/2 times of initial pressure
B. 7/2 times of initial pressure
C. 7/4 times of initial pressure
D. 5 times of initial pressure

$$N_2O_5 \longrightarrow 2NO_2 + \frac{1}{2}O_2$$

$$t=0 \qquad P_0$$

$$t=t \qquad P_0 - x \qquad 2x \qquad x/2$$

$$x = \frac{P_0}{2}$$

$$P_T = P_0 - \frac{P_0}{2} + P_0 + \frac{P_0}{4} =$$
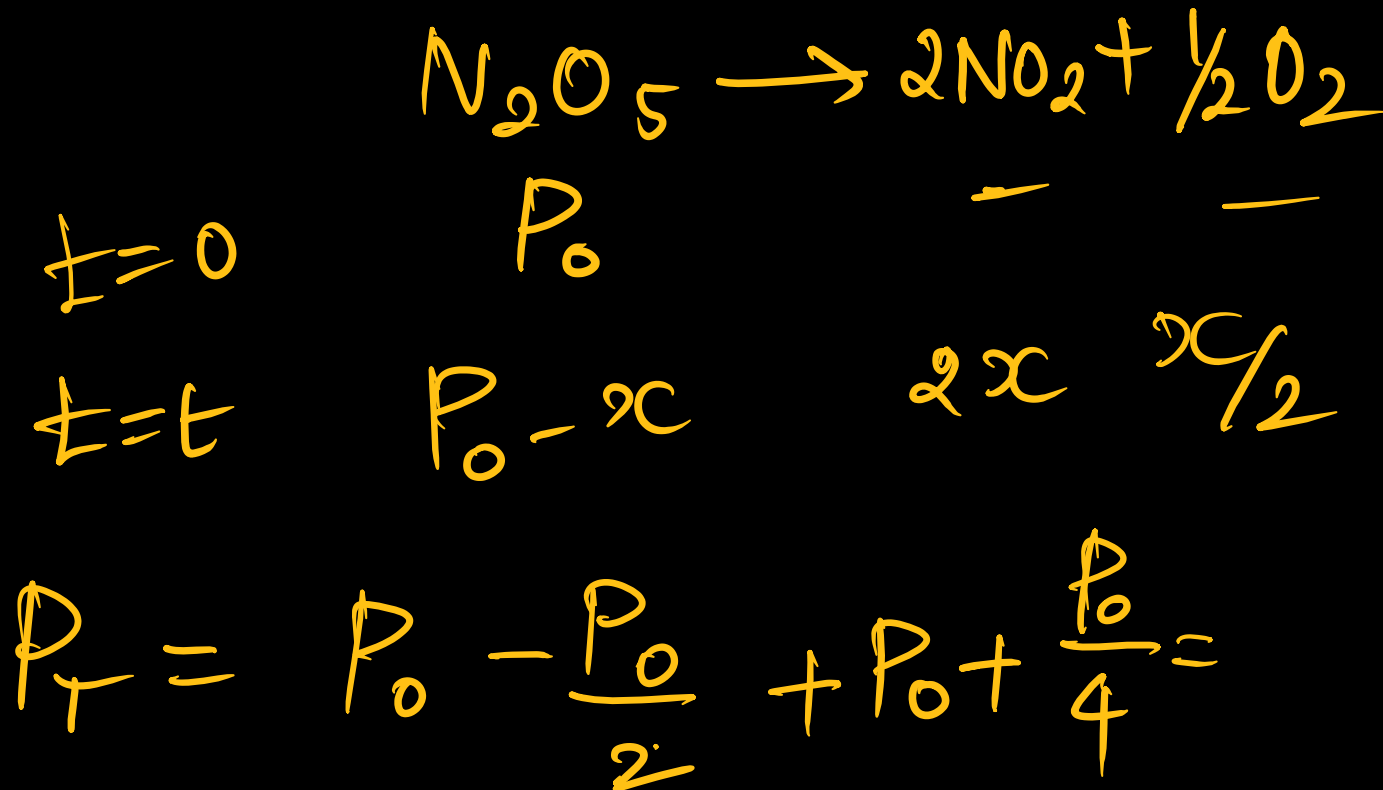
Rate law for a reaction between A and B is given $r = K[A]^n[B]^m$
If concentration of A is doubled and concentration of B is halved from their
initial value, the ratio of new rate of reaction to the initial rate of reaction
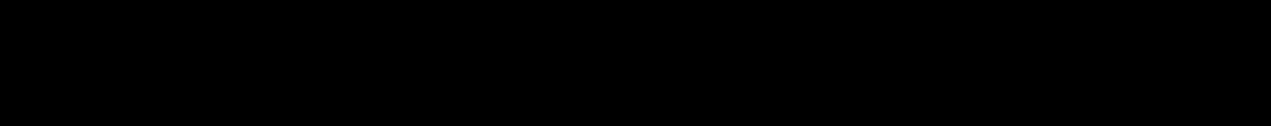
$$r_1 = K[A]^n[B]^m$$

$$r_2 = K[2A]^n\left[\frac{B}{2}\right]^m$$
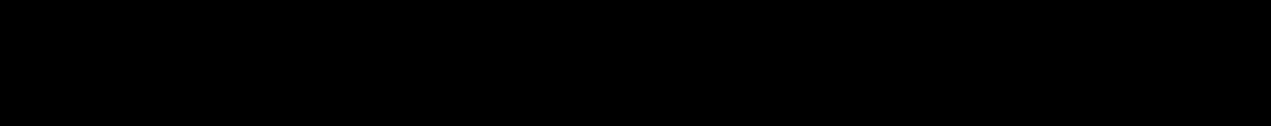
$$\frac{r_2}{r_1}$$

$$\frac{r_1}{r_2} = \frac{[A]^n[B]^m}{2^n[A]^n \times [B]^m} \times 2^m = 2^{m-n}$$
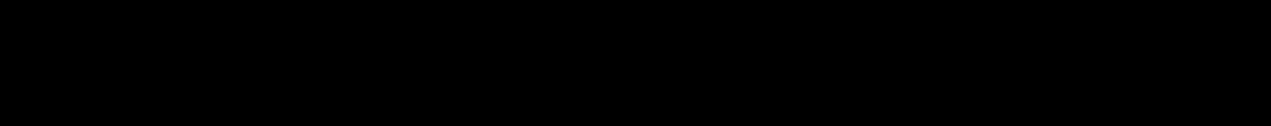
$$\boxed{2^{n-m}}$$
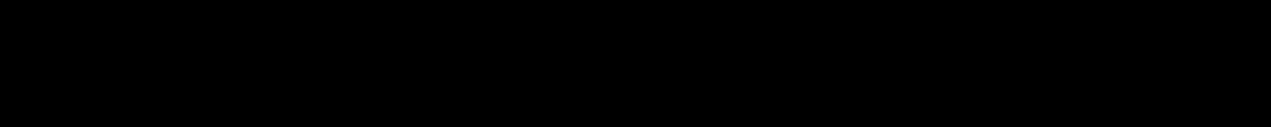
Physical Chemistry Questions

Half life of zero order reaction A gives Products is 1 hour, when initial concentration of reactant is 2 mol/L . The time required to decrease concentration of A from 0.50 to 0.25 mol/L is

$$t_{1/2} = \frac{A_0}{2k}$$

$$60 = \frac{2}{2k} \Rightarrow k = \frac{1}{60} \, M/min.$$

$$A_t = A_0 - kt$$

$$t = \frac{A_0 - A_t}{k} = \frac{0.5 - 0.25}{1/60}$$

$$t = 15 \text{ mins}$$

The rate of first order reaction is $0.04 \text{molL}^{-1}\text{s}^{-1}$ at 10 minutes and $0.03 \text{molL}^{-1}\text{s}^{-1}$ at 20 minutes after initiation. Half life of the reaction is_____ minutes. (Given log2 = 0.3010, log3 = 0.4771)

$$0.04 = K[A]_0 \, e^{-K \times 10 \times 60} \quad\text{—①}$$

$$0.03 = K[A]_0 \, e^{-k \times 20 \times 60} . \quad\text{—②}$$

$$\frac{①}{②} \Rightarrow \frac{4}{3} = e^{600k} \qquad \ln\frac{4}{3} = 600k$$

$$\ln \frac{4}{3} = 600 \times \frac{\ln 2}{t_{1/2}}$$

$$t_{1/2} = 600 \times \frac{\ln 2}{\ln \frac{4}{3}}$$

$$t_{1/2} = 600 \times \frac{\log 2}{\log 4 - \log 3} =$$
$$\times 2.303$$

NO_2 required for a reaction is produced by decomposition of N_2O_5 in CCl_4 as by equation $2N_2O_5(g) \rightarrow 4NO_2(g) + O_2(g)$
The initial concentration of N_2O_5 is 3molL^{-1} and it is 2.75molL^{-1} after 30 minutes. The rate of formation of NO_2 is $x \times 10^{-3} \text{molL}^{-1} \text{min}^{-1}$, value of x is_____
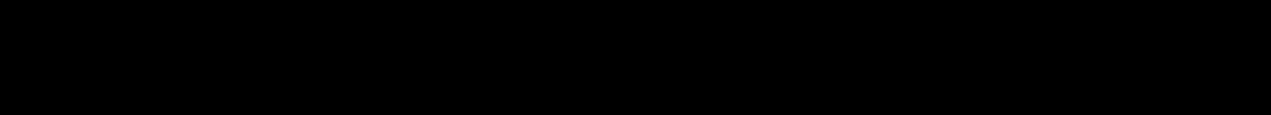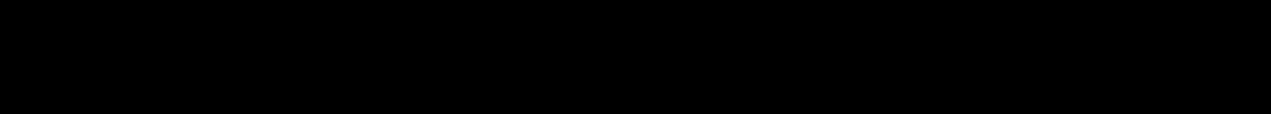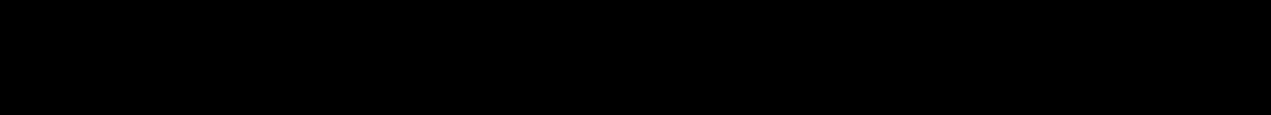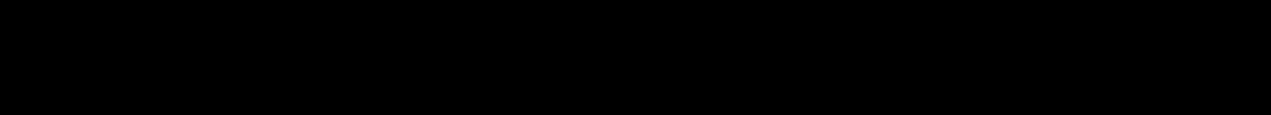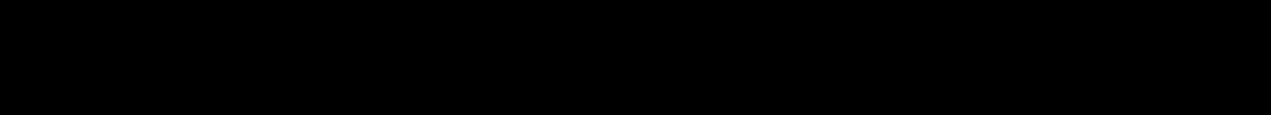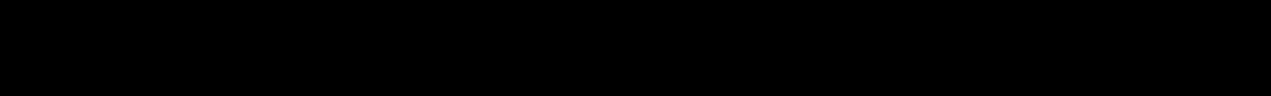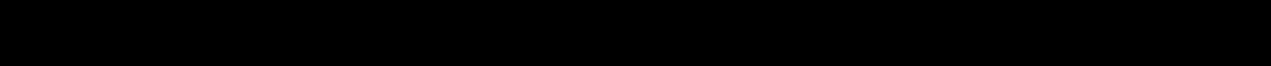
Integrated rate law equation for a first order gas phase reaction is given by (where P_i is initial pressure and P_t is total pressure at time t)
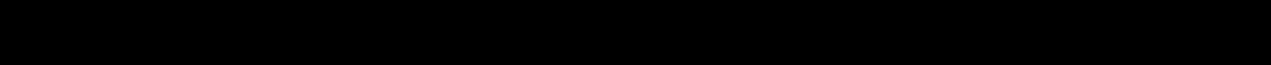
r = k[A] for a reaction, 50% of A is decomposed in 120 minutes. The time taken for 90% decomposition of A is _____ minutes
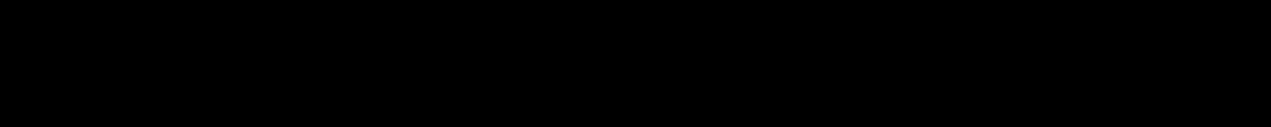
The ratio of 14C/12C in a piece of wood is 1/8 part that of atmosphere. If half life of 14C is 5730 years, the age of wood sample is ..... years.

Physical Chemistry Questions

The number of correct statement/s from the following is____

A. Larger the activation energy, smaller is the value of the rate constant.

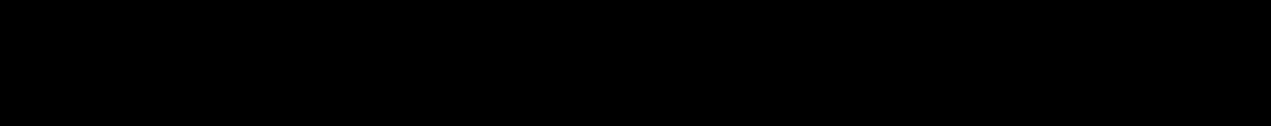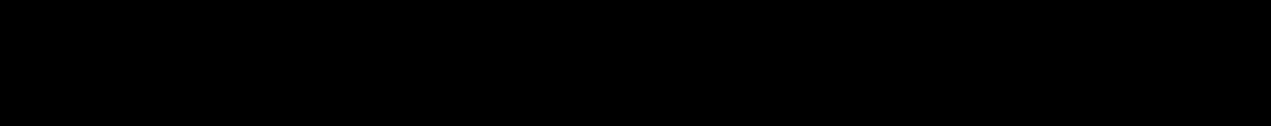B. The higher is the activation energy, higher is the value of the temperature coefficient.

C. At lower temperatures, increase in temperature causes more change in the value of k than at higher temperature.

D. A plot of ln k vs 1/T is a straight line with slope equal to $-E_a/R$

[24-Jan-2023 Shift 1]

Physical Chemistry Questions

The specific conductance of $0.0025M$ acetic acid is $5 \times 10^{-5} Scm^{-1}$ at a certain temperature. The dissociation constant of acetic acid is _____ $\times 10^{-7}$. Consider limiting molar conductivity of $CH_3 COOH$ as $400\ Scm^2 mol^{-1}$

Physical Chemistry Questions

For lead storage battery pick the correct statements
A. During charging of battery, $PbSO_4$
 on anode is converted into PbO_2
B. During charging of battery, $PbSO_4$
 on cathode is converted into PbO_2
C. Lead storage battery consists of grid of lead packed with PbO_2
 as anode
D. Lead storage battery has ~38% solution of sulphuric acid as an electrolyte Choose the correct answer from the options given below:
[12-Apr-2023 shift 1]

Physical Chemistry Questions

The resistance of a conductivity cell containing 0.01M KCl solution at 298K is 1750Ω. If the conductivity of 0.01M KCl solution at 298K is $0.152 \times 10^{-3} \text{Scm}^{-1}$, then the cell constant of the conductivity cell is _____$\times 10^{-3} \text{cm}^{-1}$

Physical Chemistry Questions

A solution of $Fe_2(SO_4)_3$ is electrolyzed for ' x ' min with a current of 1.5A to deposit 0.3482g of Fe. The value of x is [nearest integer]
Given : 1F = 96500C mol^{-1} Atomic mass of Fe = 56gmol^{-1}

Physical Chemistry Questions

Cu(s) + Sn2+ (0.001M) → Cu2+(0.01M) + Sn(s)

The Gibbs free energy change for the above reaction at 298K is x × 10−1 kJ mol−1. The value of x is _____ [nearest integer]

[Given : E

Cu

2+

/Cu

Θ = 0.34V ; E

Sn

2+

/Sn

Θ = −0.14V ; F = 96500Cmol−1

]

The solubility product of a sparingly soluble salt A_2X_3 is 1.1×10^{-23}. If specific conductance of the solution is $3 \times 10^{-5} Sm^{-1}$, the limiting molar conductivity of the solution is $x \times 10^{-3} Sm^2 mol^{-1}$. The value of x is____

[28-Jun-2022-Shift-1]

The amount of charge in F (Faraday) required to obtain one mole of iron from Fe_3O_4
is _____. (Nearest Integer)

The molar conductivities at infinite dilution of barium chloride, sulphuric acid and hydrochloric acid are 280, 860 and 426 Scm^2 mol^{-1} respectively.

The molar conductivity at infinite dilution of barium sulphate is .... Scm^2 mol^{-1} (Round off to the nearest Integer).

[18 Mar 2021 Shift 2]

Potassium chlorate is prepared by electrolysis of KCl in basic solution as shown by following equation.

$$6OH^- + Cl^- \rightarrow ClO_3^- + 3H_2O + 6e^-$$

A current of x A has to be passed for 10h to produce 10.0g of potassium chlorate. the value of x is _____.

(Nearest integer)

(Molar mass of K Cl O3 = 122.6g mol^{-1},

F = 96500C)

[20 Jul 2021 Shift 2]

Consider the following cell reaction,

$Cd(s) + Hg_2SO_4(s) + 95H_2O(l) \rightleftharpoons$

$CdSO_4 \cdot 95H_2O(s) + 2\ Hg(l)$
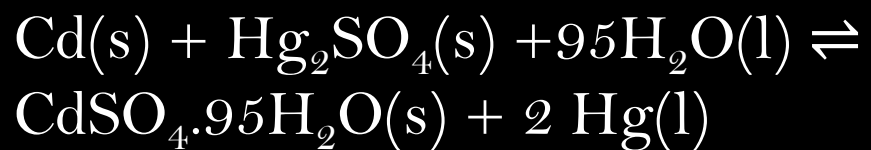
The value of $E_{cell}°$ is $4.315V$ at $25°C$.

If $\Delta H° = -825.2$ kJ mol^{-1}, the standard entropy change $\Delta S°$ in JK^{-1} is....

(Nearest integer)

[Given, Faraday constant = 96487 Cmol-1]

108g of silver (molar mass 108 $gmol^{-1}$) is deposited at cathode from $AgNO_3$ (aq) solution by a certain quantity of electricity. The volume (in L) of oxygen gas produced at 273K and 1 bar pressure from water by the same quantity of electricity is

For a certain reaction at 300K, K = 10, then ΔG° for the same reaction is_____ $\times 10^{-1}$ kJmol^{-1}. (Given R = $8.314 JK^{-1}mol^{-1}$)

An athlete is given 100g of glucose ($C_6H_{12}O_6$) for energy. This is equivalent to 1800 kJ of energy. The 50% of this energy gained is utilized by the athlete for sports activities at the event. In order to avoid storage of energy, the weight of extra water he would need to perspire is _____ g (Nearest integer)

Assume that there is no other way of consuming stored energy.

$1 \to 2 \Rightarrow$ Isobaric process

$2 \to 3 \Rightarrow$ Isochoric process

$3 \to 1 \Rightarrow$ Isothermal process

$W = W_1 \to 2 + W_2 \to 3 + W_3 \to 1$

$= -P(V_2 - V_1$

$) + 0 - P_1V_1$

$\ln V_2$

V_1

One mole of an ideal gas at 350K is in a 2.0L vessel of thermally conducting walls, which are in contact with the surroundings. It undergoes isothermal reversible expansion from 2.0L to 3.0L against a constant pressure of 4 atm. The change in entropy of the surroundings (ΔS) is_____ JK^{-1}

30.4 kJ of heat is required to melt one mole of sodium chloride and the entropy change at the melting point is _____ $28.4 JK^{-1}mol^{-1}$ at 1 atm. The melting point of sodium chloride is K. (Nearest Integer)

[15-Apr-2023 shift 1]

The pH of a 0.01 M weak acid is found to be 5 . Now the acid solution is diluted with excess of water so that the pH of the solution changes to 6 .
The new concentration of the diluted weak acid is given as . The value of
is _____ (nearest integer)

One litre buffer solution was
prepared by adding 0.10 mol each of
and in deionised water. The change
in pH on addition of 0.05 mol of
HCl to the above
solution is

Consider the reaction

The equation representing correct relationship between the degree of dissociation (x) of with its equilibrium constant Kp is _____. Assume to be very very small.

For the reaction $N_2O_4(g) \rightleftharpoons$ $2NO_2(g)$, $Kp = 0.492$atm at $300K$. Kc for the reaction at same temperature is $\times \ 10^{-2}$

Ksp for $Cr(OH)_3$ is 1.6×10^{-30}. What is the molar solubility of this salt in water?

Options:

A. $\sqrt{5} \times 1.8 \times 10^{-30}$

B. $(1.8 \times 10^{-30})/27$

C. $\sqrt[4]{(1.6 \times 10^{-30}/27)}$

D. $\sqrt{2} \times 1.6 \times 10^{-30}$

$$Cr(OH)_3 \rightleftharpoons Cr^{3+} + 3OH^-$$

$$K_{sp} = S \cdot (3S)^3$$

$$= 27S^4$$

$$27S^4 = 1.6 \times 10^{-30}$$

$$S = \sqrt[4]{\frac{1.6 \times 10^{-30}}{27}}$$

Consider the reaction, $N_2O_4(g) \rightleftharpoons 2NO_2(g)$. The temperature at which $K_c = 20.4$ and $K_p = 600.1$ is _____K.

[R = 0.0831L bar $K^{-1}mol^{-1}$]

$$\Delta ng = 2 - 1 = 1$$

$$K_p = K_c (RT)^{\Delta ng}$$

$$600.1 = 20.4 (RT)^1$$

$$T = 354 K$$

20 mL of 0.1M NaOH is added to 50 mL of 0.1M acetic acid solution. The pH of the resulting solution is _____ ×10⁻². 4.76

$$pH = pka + log \frac{[Salt]}{[acid]}$$

$$= 4.76 + log \frac{2}{3}$$

$$CH_3COOH + NaOH \longrightarrow CH_3COONa + H_2O \qquad pH = 4.58$$

5 mmol   2 mmol   0   0   = 458

3 mmol   0   2 mmol   2 mmol
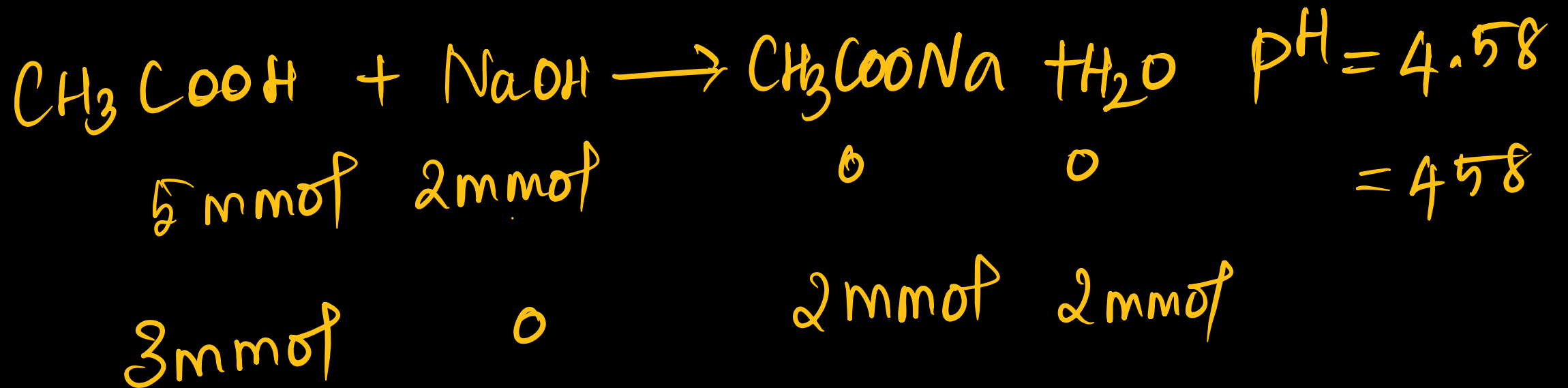
The solubility of $CdSO_4$ in water is 8.0×10^{-4} mol L^{-1}. Its solubility in 0.01M H_2SO_4 solution is .... $\times 10^{-6}$ mol L^{-1}.

$$k_{sp} = S^2 = (8.0 \times 10^{-4})^2 = 64 \times 10^{-8}$$

$$H_2SO_4 \longrightarrow 2H^+ + SO_4^{2-} \quad CdSO_4 \longrightarrow Cd^{2+} + SO_4^{2-}$$
$$\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad x \quad x+0.01$$
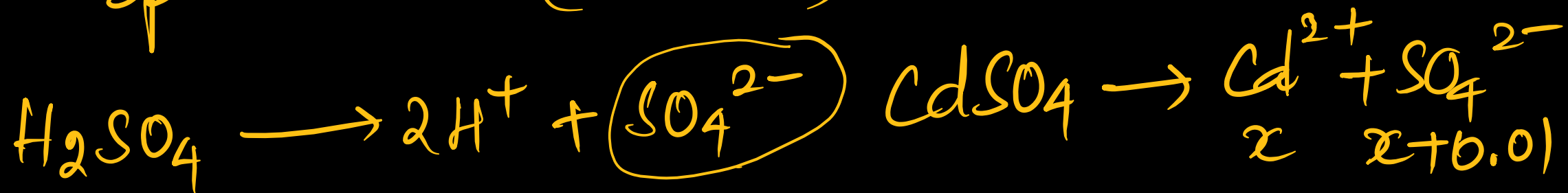
$$k_{sp} = x \cdot (x+0.01) = 64 \times 10^{-8}$$

$$x = 64 \times 10^{-6} M$$

For the reaction $X_2Y(g) \rightleftharpoons X_2(g) + \frac{1}{2}Y_2(g)$, the equation representing correct relationship between degree of dissociation (x) and Kp is _____.

$$X_2Y \rightleftharpoons X_2 + \frac{1}{2}Y_2$$

$$t=0 \qquad 1 \qquad\qquad 0 \qquad 0$$

$$t=t_{eqm} \quad 1-x \qquad\quad x \qquad \frac{x}{2}$$
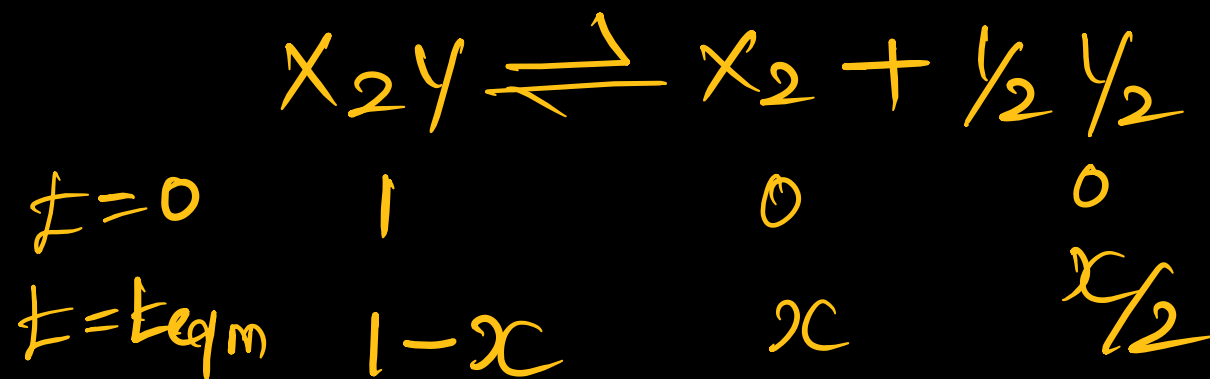
$$P_{X_2Y} = \frac{1-x}{1-x+x+\frac{x}{2}} \times P$$

$$P_X = \frac{x}{1+\frac{x}{2}} P$$

$$P_Y = \frac{x/2}{1+\frac{x}{2}} P$$

$$k_p = \frac{\left(\frac{x}{1+\frac{x}{2}} \cdot P\right)\left(\left(\frac{\frac{x}{2}}{1+\frac{x}{2}}\right) \cdot P\right)^{1/2}}{\frac{1-x}{1+\frac{x}{2}} \cdot P}$$

$$x = \left(\frac{2 \cdot K_p^2}{P}\right)^{1/3}$$

$$k_p = \frac{x^{3/2}}{1/3} \cdot P^{1/2}$$

$$x^{3/2} = \frac{K_p \cdot \sqrt{2}}{\sqrt{P}}$$

The pH of a 0.01 M weak acid is found to be 5. Now the acid solution is diluted with excess of water so that the pH changes to 6. The new concentration is x × 10^{-4}M. Find x.

$\boxed{2.5}$

$$pH = 6 \qquad [H^+] = 10^{-6}$$

$$\sqrt{K_a C} = [H^+] = 10^{-6}$$

$$\sqrt{4 \times 10^{-10} \times C} = 10^{-6}$$

$$C = \frac{10^{-12}}{4 \times 10^{-10}}$$

$$= 2.5 \times 10^{-3}$$

The pH of a 0.01 M weak acid is found to be 5. Now the acid solution is diluted with excess of water so that the pH changes to 6. The new concentration is x × 10^{-4}M. Find x.

$$HX \rightleftharpoons H^+ + x^-$$

$$C(1-\alpha) \quad C\alpha \quad C\alpha$$
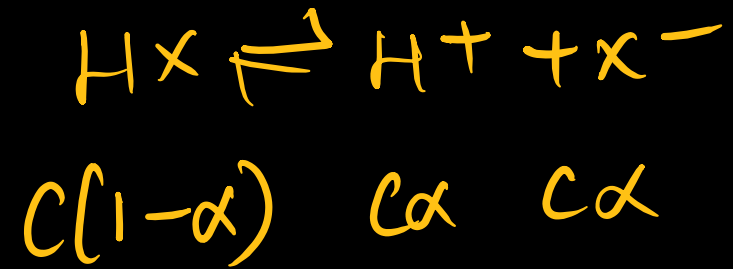
$$C\alpha = 10^{-6}$$

$$\frac{C\alpha^2}{1-\alpha} = Ka = 10^{-8}$$

$$\frac{(10^{-6})\alpha}{1-\alpha} = 10^{-8}$$

The pH of ammonium phosphate solution, if pKa of phosphoric acid and pKb of ammonium hydroxide are 5.23 and 4.75 respectively, is ....

$\rightarrow H_3PO_4$

$$pH = pKa + \frac{1}{2}[pK_w - pKa - pK_b]$$

$$= 5.23 + \frac{1}{2}[14 - 5.23 - 4.75]$$

$$pH = 7.24 \simeq 7$$

One litre buffer solution was prepared by adding 0.10 mol each of NH_3 and NH_4Cl in deionised water. The change in pH on addition of 0.05 mol of HCl is _____ $\times 10^{-2}$.

The number of moles of NH_3 that must be added to 2L of 0.80M AgNO₃ to reduce [Ag⁺] to $5.0\times10^{-8}M$ is_____.

[Kformation for $[Ag(NH_3)_2]^+$ = 1.0×10^8]

$1.6\ moles$

$$Ag^+ + 2NH_3 \rightleftharpoons Ag(NH_3)_2^+$$

$$[Ag^+] = 1.6 - \frac{A}{2}$$

$$k_f = \frac{[Ag(NH_3)_2]^+}{[Ag^+][NH_3]^2}$$

$$k_f = \frac{A/2}{(5.0\times10^{-8})(A/2)^2} = 1.0\times10^8$$

$$A = 0.4\ moles \cdot /0$$

Consider the equilibrium: $CO(g) + 3H_2(g) \rightleftharpoons CH_4(g) + H_2O(g)$

$n = 4 \longrightarrow n = 2$

If pressure increases by two fold at constant temperature:

(A) Concentration of reactants and products increases

(B) Equilibrium will shift in forward direction

(C) Equilibrium constant increases ✗

(D) Equilibrium constant remains unchanged as concentration of reactant and product remain same

An analyst wants to convert 1L HCl of pH = 1 to pH = 2. Volume of water needed is _____ mL.

$$0.1$$

$$0.01$$

$$M_1 V_1 = M_2 V_2$$

$$V_2 = \frac{M_1 V_1}{M_2} = \frac{0.1 \times 1}{0.01} = 10$$

$$900$$

If equal volumes of AB_2 and XY (both are salts) aqueous solutions are mixed, which of the following combination will give a precipitate of AY_2 at 300 K ?(Given at 300 K) for AY2 = 5.2×10^{-7}

In aqueous solution the ionization constants for carbonic acid are $K_1 = 4.2 \times 10^{-7}$ and $K_2 = 4.8 \times 10^{-11}$. For a saturated 0.034M solution, select correct statement:

A. $[CO_3^{2-}] = 0.034M$
B. $[CO_3^{2-}] > [HCO_3^-]$
C. $[H^+] \approx [HCO_3^-]$
D. $[H^+] = 2[CO_3^{2-}]$

The molar conductance of an infinitely dilute solution of ammonium chloride was found to be 185 Scm^2/mol and the ionic conductance of hydroxyl and chloride ions are 70 SCm^2/mol respectively. If molar conductance of 0.02 M solution of ammonium hydroxide is 85.5 S cm^2/mol , its degree of dissociation is given by X x 10^{-1}.The value of X is _____ . (Nearest integer)

$$\lambda^{o}_{m} \, NH_4Cl = 185$$

$$\left(\lambda^{o}_{m}\right)NH_4^{+} + \left(\lambda^{o}_{m}\right)Cl^{-} = 185$$

$$\lambda^{o}_{m} \, (NH_4OH) = 115 + 70$$

$$= 285$$

$$\alpha = \frac{(\lambda_m)NH_4OH}{(\lambda^{o}_{m}) \, NH_4OH}$$

$$\frac{85.5}{285} = 0.3$$

$$= 3 \times 10^{-1}$$

An aqueous solution of HCl with pH 1.0 is diluted by adding equal volume of water (ignoring dissociation of water). The pH of HCl solution would

Options:

A. increase to 1.3

B. reduce to 0.5

C. increase to 2

D. remain same

$$[H^+] = 0.1 M$$

$$[H^+]_{new} = 0.1/2 = 5 \times 10^{-2} M$$

$$pH = -\log(5 \times 10^{-2}) = -\log 5 + 2$$

$$pH = 1.3$$

500 J of energy is transferred as heat to 0.5 mol of Argon gas at 298 K and 1.00 atm. The final temperature and change in internal energy are:

Given: R = 8.3 J K⁻¹ mol⁻¹

Options:

A. 368 K and 500 J

B. 348 K and 300 J

C. 378 K and 300 J

D. 378 K and 500 J

$$C_p - C_v = R$$

$$C_p = \frac{5}{2}R$$

$$Q = nC_p \Delta T$$

$$500J = 0.5 \times \frac{5}{2} 8.3 \times (T_f - 298)$$

$$T_f = 348 \, k$$

$$\Delta U = nC_v \Delta T$$

$$= 0.5 \times \frac{3}{2} 8.3 \times (348 - 298)$$

One mole of ideal gas expands isothermally and reversibly from 10dm³ to 20dm³ at 300 K. Find ΔU, q and w.

Given: R = 8.3 J K⁻¹mol⁻¹, ln 2 = 0.693

$$\left(10L, 300k \longrightarrow 20L, 300k \right)$$

$$w = -q = -nRT \ln \frac{V_2}{V_1}$$

$$= -8.3 \times 300 \ln \left(\frac{20}{10} \right)$$

$$= -1.718 \, kJ$$

$$q = +1.1718$$

$$\Delta U = 0,$$

Consider the data:

Heat of formation of $CO_2(g)$ = −393.5 kJ mol⁻¹

Heat of formation of $H_2O(l)$ = −286.0 kJ mol⁻¹

Heat of combustion of benzene = −3267.0 kJ mol⁻¹

Heat of formation of benzene is _____ kJ mol⁻¹.

$$C_6H_6 + \frac{15}{2}O_2 \longrightarrow 6CO_2 + 3H_2O$$

$$\Delta H_R = \Delta H_C = \Sigma \Delta H_f(P) - \Sigma \Delta H_f(R)$$

$$-3267 = 6 \times (-393.5) + 3(-286) - \Delta H_f(C_6H_6)$$

$$\Delta H_f = 48\ kJ/mole\ .$$

For reaction A ⇌ B at 298K, find log K.
Given: $\Delta H^0 = -54.07$ kJ mol^{-1}, $\Delta S^0 = 10$ JK^{-1}mol^{-1} (2.303 × 8.314 × 298 = 5705)

$$\Delta G^0 = \Delta H^0 - T\Delta S$$

$$\Delta G^0 = -2.303\ RT \log k$$

$$\log k = \frac{\Delta H^0 - T\Delta S^0}{-2.303\ RT} = \frac{-54.07 - }{\frac{298 \times 10}{5705}}$$

$$= 10$$

An endothermic reaction is non-spontaneous at freezing point but spontaneous at boiling point. Choose correct option for ΔH and ΔS.

A. Both ΔH and ΔS are (−ve)

B. ΔH is (+ve) but ΔS is (−ve)

C. ΔH is (−ve) but ΔS is (+ve)

D. Both ΔH and ΔS are (+ve)

$$\Delta G = \Delta H - T\Delta S$$

Two vessels A and B connected via stopcock. Vessel A filled with gas. After opening stopcock, gas ~~expands~~ and no temperature change observed. Which statement is true?

Options:

A.   dq ≠ 0

B.   The pressure in vessel B before opening was zero

C.   dw ≠ 0

D.   dU ≠ 0

$$P_{ext} = 0$$

$$\Delta U = 0$$

$$w = 0 \qquad q = 0.$$

Resonance in X_2Y can be represented as $X\equiv X + \frac{1}{2}Y=Y \rightarrow X_2Y$
$\Delta Hf(X_2Y) = 80$ kJ mol^{-1}. Find magnitude of resonance energy.
Given: Bond energies $X\equiv X=940$, $X=X=410$, $Y=Y=500$, $X=Y=602$ kJ mol^{-1}

$$X \equiv X + \frac{1}{2}Y=Y \longrightarrow X=X=Y$$

$$80 - |178| = 98$$

$$\Delta H_f = 940 + \frac{1}{2}(500) - (410 + 602)$$

$$= 1190 - 1012 = 178$$

Given: *Correct*

$HCl(g) + 10H_2O(l) \rightarrow HCl \cdot 10H_2O$, $\Delta H = -69.01$ kJ mol^{-1}

$HCl(g) + \underline{40H_2O}(l) \rightarrow HCl \cdot 40H_2O$, $\Delta H = -72.79$ kJ mol^{-1}
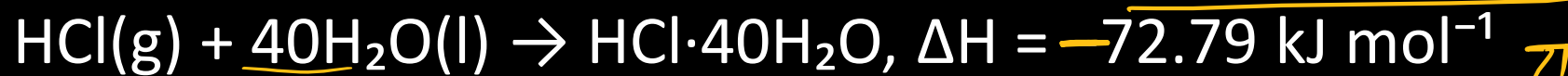
A. Heat of dilution = 3.78 kJ mol^{-1}

B. Dissolution is <u>endo</u>thermic   *exo*

C. Heat of solution depends on amount of solvent

D. Heat of formation represented by both

$-72.79 - (-69.01)$

$= -3.78$

Liquid in ~~thermally insulated~~ closed vessel at 25°C is mechanically stirred from outside. Correct option for thermodynamic parameters?

Options:
A. $\Delta U = 0$, $q < 0$, $w > 0$
B. $\Delta U > 0$, $q = 0$, $w > 0$
C. $\Delta U = 0$, $q = 0$, $w = 0$
D. $\Delta U < 0$, $q = 0$, $w > 0$

$$q = 0$$

$$\Delta U = q + w$$

$$\Delta U = w$$

$$\Delta U > 0 \qquad w > 0$$

Arrange work done in order of magnitude for processes at constant temperature using PV graphs.

(a) $\left| w_{\text{reversible}} \right|$ for expansion in infinite stages.

(b) $\left| w_{\text{irreversible}} \right|$ for expansion in single stage.

(c) $\left| \mathbf{w}_{\text{reversible}} \right|$ for compression in infinite stages.

(d) $\left| w_{\text{irreversible}} \right|$ for compression in single stage.

An ideal gas undergoes a cyclic transformation starting from the point A and coming back to the same point by tracing the path A→B→C→D→A as shown in the three cases above. Choose the correct option regarding ΔU :
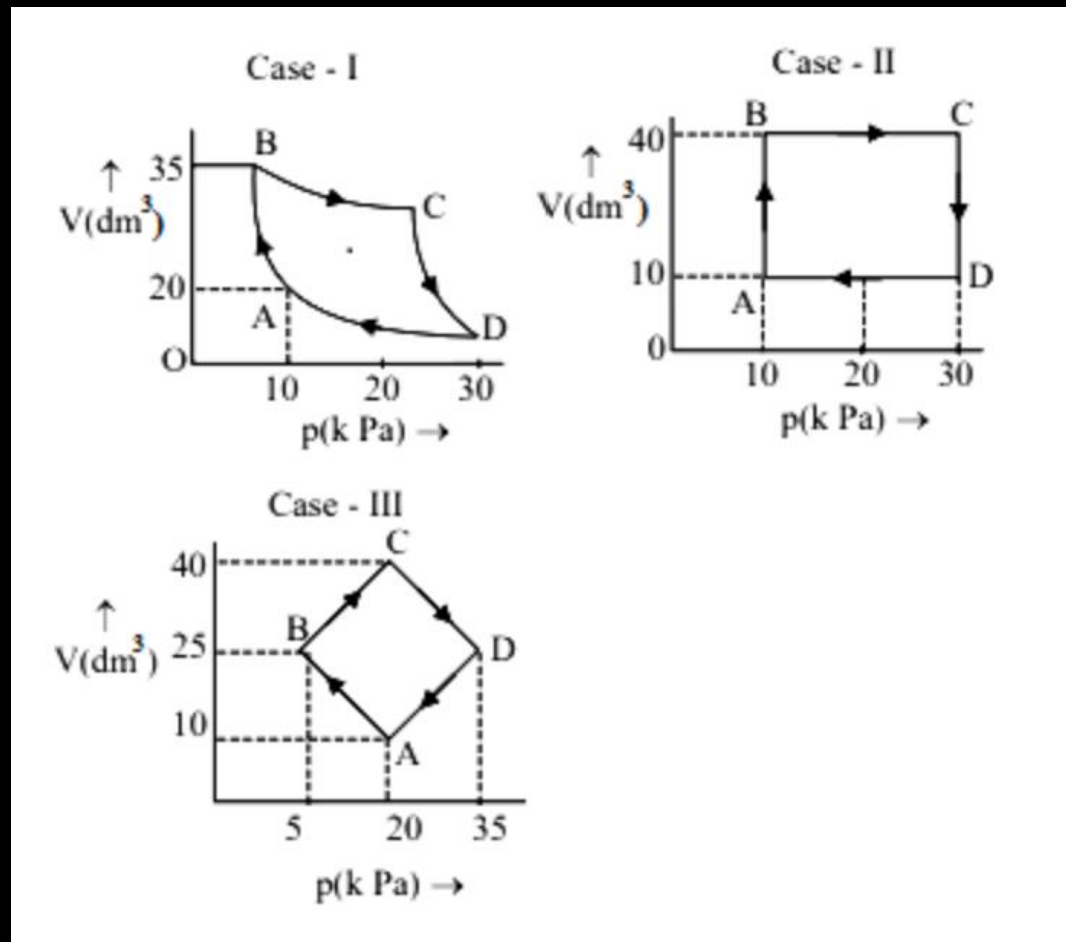
Hydration energies of K^+ and Cl^- are $-x$ and $-y$ kJ/mol. Lattice energy of KCl is $-z$ kJ/mol. Heat of solution of KCl is:

$$\Delta H_{Solution} = -\Delta H_{L.E} + \Delta H_{hydration}$$

$$= -(-z) + (-x-y)$$

$$= z - x + y$$

0.3g ethane combustion at 27°C in bomb calorimeter. Temperature rises by 0.5°C. Heat capacity = 20 kJ K⁻¹. Heat evolved at constant pressure is _____ kJ mol⁻¹.

$$C_2H_6 + \frac{7}{2}O_2 \longrightarrow 2CO_2 + 3H_2O$$

$$\Delta ng = -2.5$$

$$\Delta H = \Delta U + \Delta ng\, RT$$

$$= 1000 + (-2.5) \times 8.3 \times 300$$

$$= -1006\ kJ$$

$$\Delta U = \frac{20 \times 0.5}{0.3} \times 30$$

$$= 1000\ kJ$$