The Solid State + Solutions + Surface Chemistry

1. In a binary compound, atoms of element A form a hcp structure and those of elements M occupy $2/3$ of the tetrahedral voids of the hcp structure. The formula of the binary compound is:

   A. M_2A_3

   B. M_4A_3

   C. M_4A

   D. MA_3

   Number of atom in hcp unit cell = 6
   So, $A = 6$
   Total number of tetrahedral void in hcp unit cell = 12
   $\therefore M = \frac{2}{3} \times 12 = 8$

   Thus, the formula of the binary compound would be A_6M_8
   A_3M_4
   or M_4A_3
   Hence, option (b) is correct answer.

2. A hard substance melts at high temperature and is an insulator in both solid and in molten state. This solid is most likely to be a/an:

   A. Metallic solid

   B. Ionic solid

   C. Molecular solid

   D. Covalent solid

   Covalent solid have high melting point due to network like structure and they are insulator e.g. diamond, SiO_2.

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3. Given below are two statements:
Statement I: Frenkel defects are vacancy as well as interstitial defects.
Statement II: Frenkel defect leads to colour in ionic solids due to presence of F-centres.
Choose the most appropriate answer for the statements from the options given below:

- ✔ **A.** Statement I is true but Statement II is false
- ✘ **B.** Both Statement I and Statement II are true
- ✘ **C.** Statement I is false but Statement II is true
- ✘ **D.** Both Statement I and Statement II are false

Frenkel defect: This defect is shown by ionic solids. The smaller ion (usually cation) is dislocated from its normal site to an interstitial site.

It creates a vacancy defect at its original site and an interstitial defect at its new location.

F-centre is formed in metal excess defect which is a non-stoichiometric defect.

4. Which of the following compounds is likely to show both Frenkel and Schottky defects in its crystalline form ?

- ✘ **A.** ZnS
- ✘ **B.** $CsCl$
- ✔ **C.** $AgBr$
- ✘ **D.** KBr

Solids like $ZnS,\ AgCl,\ AgBr\ \&\ AgI$ shows Frenkel defects.
Solids like $NaCl,\ KCl,\ KBr,\ AgBr$ and $CsCl$ shows Schottky defect.
Hence, $AgBr$ shows both, Frenkel as well as Schottky defects.

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5. An element crystallises in a face-centred cubic (fcc) unit cell with edge length a. The distance between the centres of two nearest octahedral voids in the crystal lattice is:

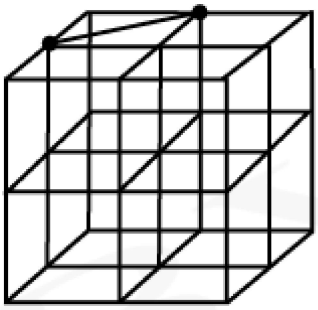
A. a

B. $\sqrt{2}a$

C. $\frac{a}{\sqrt{2}}$

D. $\frac{a}{2}$

Octahedral void in fcc is present at edge centre and body centre.



● = Octahedral void

Minimum distance between two nearest octahedral void is:

$$= \sqrt{\left(\frac{a}{2}\right)^2 + \left(\frac{a}{2}\right)^2} = \frac{a}{\sqrt{2}}$$

6. A diatomic molecule X_2 has a body-centred cubic (bcc) structure with a cell edge of $300\ pm$. The density of the molecule is $6.17\ g/cm^3$. The number of molecules present in $200\ g$ of X_2 is:
$\text{Avogadro constant } (N_A) = 6 \times 10^{23}\ mol^{-1})$

A. $40\ N_A$

B. $4\ N_A$

C. $2\ N_A$

D. $8\ N_A$

A diatomic molecule X_2 has bcc structure.

$a = 300\ pm$

$$d = 6.17\ g/cm^3 = \frac{2 \times MM}{6 \times 10^{23} \times (300 \times 10^{-10})^3}$$

$$\text{MM} = \frac{6.17 \times 6 \times 9 \times 3 \times 10^{-1}}{2}$$

$$\text{MM} = 81 \times 6.17 \times 10^{-1} = 49.97\ g/mol$$

$$\text{Number of moles} = \frac{200\ g}{49.97\ g/mol} = 4\ mol$$

$$\text{Number of molecules} = 4N_A$$

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7. Which one of the following 0.06 M aqueous solution has lowest freezing point?

A. KI

B. $Al_2(SO_4)_3$

C. $C_6H_{12}O_6$

D. K_2SO_4

$\Delta T_f = iK_f m$
m is molality
$\Delta T_f = T_f^0 - T_f$
i is van't Hoff factor
T_f^0 is the freezing point of pure solvent
T_f is the freezing point of solution
Here
$\Delta T_f \propto i$ (for equimolar solutions)
For minimum T_f, the value of i should be the highest

$$KI \xrightarrow{H_2O} K^+(aq) + I^-(aq)$$

$$Al_2(SO_4)_3 \xrightarrow{H_2O} 2Al^{3+}(aq) + 3SO_4^{2-}(aq)$$

For organic solvents like $C_6H12O_6; i = 1$

$$K_2(SO_4) \xrightarrow{H_2O} 2K^+(aq) + SO_4^{2-}(aq)$$

Summarising:

Solute	i
KI	2
$Al_2(SO_4)_3$	5
$C_6H_{12}O_6$	1
K_2SO_4	3

$Al_2(SO_4)_3$ has the highest value of i and hence has lowest freezing point

8. Which one of the following $0.10\ M$ aqueous solutions will exhibit the largest freezing point depression ?

A. glycine

B. $KHSO_4$

C. hydrazine

D. glucose

Freezing point depression of a solution is given by,
$\triangle T_f = K_f \times m$
where,
$\triangle T_f$ is the depression in freezing point.
K_f is molal depression constant.
m is molality of solution.
i is Van't hoff factor
Since, all are of $0.1\ M$ aqueous solution,
$\Delta T_f \propto i$

Greater the value of i, greater will be the ΔT_f value.
Compound which does not show any dissociation with water will have van't hoff factor value of 1.

$Solute$	i
Glycine	1
$KHSO_4$	2
Hydrazine	1
Glucose	1

Hence, freezing point depression will be highest for $KHSO_4$.

9. A set of solutions is prepared using $180\ g$ of water as a solvent and $10\ g$ of different non-volatile solutes $A,\ B\ and\ C$. The relative lowering of vapour pressure in the presence of these solutes are in the order [Given, molar mass of $A = 100\ g\ mo1^{-1}; B = 200\ g\ mol^{-1};\ C = 10,000\ g\ mol^{-1}$]

A. $A > C > B$

B. $C > B > A$

C. $A > B > C$

D. $B > C > A$

$$\text{Relative lowering in vapour pressure (RLVP)} = \frac{\Delta P}{P_o} = \frac{n}{n+N}$$

$n \rightarrow$ moles of solutes
$N \rightarrow$ moles of solvent

$$n_A = \frac{\frac{10}{100}}{\frac{10}{100} + \frac{180}{18}} = \frac{0.1}{10.1} = \frac{1}{101}$$

$$n_B = \frac{\frac{10}{200}}{\frac{10}{200} + \frac{180}{18}} = \frac{0.05}{10.05} = \frac{1}{201}$$

$$n_C = \frac{\frac{10}{10000}}{\frac{10}{10000} + \frac{180}{18}} = \frac{10^{-3}}{10}$$

From the above relation,

$RLVP\ (A) > RLVP\ (B) > RLVP\ (C)$

Hence, option (c) is correct.

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10. The size of a raw mango shrinks to a much smaller size when kept in a concentrated salt solution. Which one of the following processes can explain this?

- ✔ **A.** Osmosis
- ✘ **B.** Reverse osmosis
- ✘ **C.** Diffusion
- ✘ **D.** Dialysis

Raw mango shrink in salt solution due to net transfer of water molecules from mango to salt solution due to phenomenon of osmosis.
The solvent molecules will flow through the membrane from pure solvent to the solution. This process of flow of the solvent is called osmosis.

11. Two open beakers one containing a solvent and the other containing a mixture of that solvent with a non volatile solute are together sealed in a container. Over time:

- ✘ **A.** The volume of the solution and the solvent does not change
- ✔ **B.** The volume of the solution increases and the volume of the solvent decreases
- ✘ **C.** The volume of the solution does not change and the volume of the solvent decreases
- ✘ **D.** The volume of the solution decreases and the volume of the solvant increases.

There will be lowering in vapour pressure for solution containing non-volatile solute. So the pure solvent will vapourise and increase vapour pressure till that vapour pressure will come in equilibrium so volume decrease.

As in solution, there is non-volatile solute, so it will not vapourise for vapour pressure to be in equilibrium, solvent vapour will come towards the solution. So, the volume of solution increase.

Hence, volume of beaker containing solvent (pure) will decrease and volume of beaker containing solution will increase.

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12. At 35^oC, the vapour pressure of CS_2 is 512 mm Hg and that of acetone is 344 mm Hg. A solution of CS_2 in acetone has a total vapour pressure of 600 mm Hg. The false statement amongst the following is

- ✗ **A.** Raoult's law is not obeyed by this system
- ✓ **B.** A mixture of 100 mL CS_2 and 100 mL acetone has a volume < 200 mL
- ✗ **C.** Heat must be absorbed in order to produce the solution at $35^\circ C$
- ✗ **D.** CS_2 and acetone are less attracted to each other than to themselves

Since the vapour pressure of the solution is greater than individual vapour pressure of both pure components, the solution shows a positive deviation from Raoult's law.

Positive deviation:
Solvent-solute interaction is less than the solvent-solvent and the solute-solute interactions.

Hence, the mixture of 100 mL CS_2 and 100 mL acetone has a volume greater than 200 mL.

For positive deviation:
$\Delta H_{mix} > 0$, Hence heat is absorbed during the mixing of CS_2 and acetone.

Hence, option (b) is correct answer.

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13. Which one of the following statements is FALSE for hydrophilic sols ?

- ✔ **A.** Their viscosity is of the order of that of H_2O
- ✘ **B.** They do not require electrolytes for stability
- ✘ **C.** These sols are reversible in nature
- ✘ **D.** The sols cannot be easily coagulated

The colloidal sol in which the particles of the dispersed phase have a great affinity for water is called hydrophilic sol. The viscosity of the hydrophilic sols are much higher than that of the water due to the hydration.

An important characteristic of hydrophilic sols is that if the dispersion medium is separated from the dispersed phase (say by evaporation), the sol can be reconstituted by simply remixing with the dispersion medium. That is why these sols are also called reversible sols.

They are quite stable and are not easily coagulated because of considerable interaction between the dispersed phase and the dispersion medium.

Hence, option (a) is correct answer.

14. The nature of charge on resulting colloidal particles when $FeCl_3$ is added to excess of hot water is:

- ✘ **A.** Sometimes positive and sometimes negative
- ✘ **B.** Negative
- ✘ **C.** Neutral
- ✔ **D.** Positive

If $FeCl_3$ is added to excess hot water, a positively charged sol, hydrated ferric oxide is formed due to adsorption of Fe^{3+} ions. Hence, the resulting charge on colloidal particle is positive.

The Solid State + Solutions + Surface Chemistry

15. The INCORRECT statements below regarding colloidal solution is

A. The flocculating power of Al^{3+} is more than that of Na^{+}

B. A colloidal solution shows Brownian motion of colloidal particles.

C. An ordinary filter paper can stop the flow of colloidal particles.

D. A colloidal solution shows colligative properties.

Ordinary filter paper cannot stop the flow colloidal particles.
An ultra - filter paper is required to filter colloids.

Hardy-Schulze Rule:
Greater the valence of flocculating ion added, greater is its power to cause coagulation. Thus, statement (a) is correct.

Under ultramicroscope, colloidal particles appear to be in a continuous zig-zag motion known as Brownian movement.
Thus, statement (b) is correct.

Colloidal solution shows colligative properties.

Hence, option (c) is the correct answer

16. A colloidal system consisting of a gas dispersed in a solid is called a/an:

- A. aerosol
- B. foam
- C. solid sol
- D. gel

A colloidal system consisting of a gas dispersed in a solid is called a 'solid sol'.

Hence, option (c) is correct.

The Solid State + Solutions + Surface Chemistry

17. Given below are two statements : one is labelled as
Assertion A and the other is labelled as Reason R.
Assertion A : $SO_2(g)$ is adsorbed to a larger extent than $H_2(g)$ on activated charcoal.
Reason R : $SO_2(g)$ has a higher critical temperature than $H_2(g)$.
In the light of the above statements, choose the most appropriate answer from the options given below.

✗ **A.** A is correct but R is not correct

✗ **B.** Both A and R are correct but R is not the correct explanation of A

✗ **C.** A is not correct but R is correct

✓ **D.** Both A and R are correct and R is the correct explanation of A

SO_2 has higher mass and larger surface area. It has higher critical temperature than H_2 and that's why it adsorbed to a larger extent.

Adsorption of gas by charcoal:

Finely divided activated charcoal tends to adsorb several gases like ammonia, sulphur dioxide, chlorine, phosgene, etc. In this case, charcoal acts as an adsorbent while gas molecules act as the adsorbate.
In general, easily liquifable gases such as CO_2, NH_3, Cl_2 and SO_2 are adsorbed to a greater extent than the elemental gases like H_2, O_2, N_2, He etc.

The Solid State + Solutions + Surface Chemistry

18. Which one of the following is correct for the adsorption of a gas at a given temperature on a solid surface ?

- **A.** $\Delta H < 0,\ \Delta S < 0$
- **B.** $\Delta H > 0, \Delta S < 0$
- **C.** $\Delta H > 0, \Delta S > 0$
- **D.** $\Delta H < 0, \Delta S > 0$

Adsorption is the accumulation of molecular species at the surface rather than in the bulk of a solid or liquid.
Generally, there is a unbalanced/residual force on the surface of the particle in which adsorption takes place.
During adsorption there is decrease in residual forces or surface energy.
Thus, the energy is released, so the heat of adsorption is negative. Hence, adsorption is always exothermic.
$\therefore$
$\Delta H = -ve$

Also freedom of movement of gaseous adsorbate particles is restricted due to adsorption. Hence, entropy will decrease during adsorption.
$\Delta S = -ve$

19. Tyndall effect is more effectively shown by :

- **A.** Lyophobic colloid
- **B.** Lyophilic colloid
- **C.** True solution
- **D.** Suspension

Tyndall effect is shown by colloidal solution.
Tyndall effect refers to the scattering of light by colloidal particles. The intensity of the scattered light depends on the difference in the refractive index of the dispersed phase and the dispersion medium. The larger the difference, the greater will be the intensity of the scattered light.

In lyophobic sols, the particles are not as highly solvated as in lyophilic sols. So, the difference in refractive index between the particles and the medium is quite large in lyophobic sols. Therefore, the Tyndall effect is more pronounced in lyophobic sols.

20. The sol given below with negatively charged colloidal particles is :

A. KI added to $AgNO_3$ solution

B. $AgNO_3$ added toKI solution

C. $Al_2O_3.xH_2O$ in water

D. $FeCl_3$ added to hot water

When $AgNO_3$ solution is added to KI solution
$AgNO_3(aq) + KI(aq) \rightarrow AgI(s) \downarrow + AgNO_3(aq)$
AgI gets precipitated.
The precipitated silver iodide adsorbs iodide ions (I^-) from the dispersion medium and negatively charged colloidal sol is formed AgI/I^-

When KI solution is added to $AgNO_3$ solution
$AgNO_3(aq) + KI(aq) \rightarrow AgI(s) \downarrow + AgNO_3(aq)$
AgI gets precipitated.

The precipitated silver iodide adsorbs Ag^+ions from the dispersion medium and positively charged colloidal sol is formed AgI/Ag^+
Option (b) is correct

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21. A certain element crystallises in a bcc lattice of unit cell edge length $27\ \mathring{A}$. If the same element under the same conditions crystallises in the fcc lattice. The edge length of the unit cell in $\mathring{A}$will be _____ (Round off to the nearest integer.)
[Assume each lattice point has a single atom]
[Assume $\sqrt{3}=1.73, \sqrt{2}=1.41$]

Accepted Answers

33

Solution:

In BCC the relationship between edge length and radius of an atom is given by:

$4r=\sqrt{3}a$

$4r=\sqrt{3}\times 27$

$4r=1.73\times 27\ \mathring{A}=46.71\ \mathring{A}$

In FCC the relationship between edge length and radius of an atom is given by:

$4r=\sqrt{2}\ a \Rightarrow \dfrac{46.71}{1.41}=a\ (\text{edge length})$

$\Rightarrow a=33\ \mathring{A}$

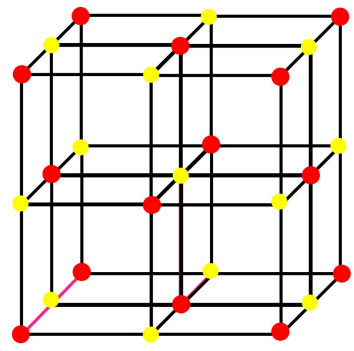
22. The number of octahedral voids per lattice site in a lattice is (Rounded off to the nearest integer)

Accepted Answers

1.00

Solution:

A cubic closed packing (CCP) unit cell comprises atoms placed at all the corners and at the centre of all the faces of the cube. The atom present at the centre of the face is shared between two adjacent unit cells and only half of each atom belongs to an individual cell. It is also referred to as face-centred cubic (FCC).
The total number of octahedral void(s) present in a cubic close packed structure is four. Besides the body centre, there is one octahedral void at the centre of each of the twelve edges. It is surrounded by six atoms, where four atoms belong to the same unit cell (i.e. two on the corners and two on face centres) and two belonging to two adjacent unit cells. Since, each edge of the cube is shared between four adjacent unit cells, so is the octahedral void located on it.
Only one-fourth of each void belongs to a particular unit cell. Thus, in a cubic close packed structure, the octahedral void at the body centre of the cube will be one.
Twelve octahedral voids are located at each edge and are shared by four-unit cells; thus, the number of octahedral voids will be $12 \times \frac{1}{4} = 3$
So, the total number of octahedral voids in cubic closed packed is four.
We know, in CCP structure each unit cell has four atoms. Thus, the number of octahedral voids will be $\frac{4}{4} = 1$



Location of octahedral voids
Atoms in ccp

23. Diamond has a three dimensional structure of C atoms formed by covalent bonds. The structure of diamond has face centred cubic lattice where 50% of the tetrahedral voids are also occupied by carbon atoms. The number of carbon atoms present per unit cell of diamond is_____

Accepted Answers

8

Solution:

Effective atoms of carbon in fcc unit cell $= 8 \times \frac{1}{8} + 6 \times \frac{1}{2} = 4$
Total number of tetrahedral void in fcc unit cell = 8
50% of the tetrahedral voids are also occupied by carbon atoms so number of atoms occupied in 1 unit cell $= 4 \times 1 = 4$

$\therefore$ Total carbon atoms in a unit cell $= 4 + 4 = 8$

24. A copper complex crystallising in a CCP lattice with a cell edge of $0.4518\ nm$ has been revealed by employing X-ray diffraction studies. The density of a copper complex is found to be $7.62\ g\ cm^{-3}$.
The molar mass of copper complex is _____
$g\ mol^{-1}$. (Nearest integer) [Given : $N_A = 6.022 \times 10^{23}\ mol^{-1}$]

Accepted Answers

106 106.0 106.00

Solution:

Given: the density of a copper complex =
$7.62\ g\ cm^{-3}, N_A = 6.022 \times 10^{23}\ mol^{-1}, a = 0.4518\ nm, Z = 4$
We know the $d = \frac{Z \times M}{a \times N_A}$
CCP lattice has a fcc structure:
For a fcc unit cell, atoms are present at corners as well as face centres :
Number of atoms in unit cell $= \left(8 \times \frac{1}{8}\right) + \left(6 \times \frac{1}{2}\right) = 4$

$$7.62 = \frac{4 \times M}{(0.4518 \times 10^{-7})^3 \times 6.022 \times 10^{23}}$$

$M = 105.8\ g/mol$

25. When 12.2 g benzoic acid is dissolved in 100 g of water , the freezing point of solution was found to be -0.93^0C $\left(K_f\left(H_2O\right)=1.86\ K\ \ kg\ \ mol^{-1}\right)$. The number (n) of benzoic acid molecules associated (assuming 100% association) is

Accepted Answers

2 2.0 2.00

Solution:

$\Delta T_f = iK_f m$
m is molality
ΔT_f is depression in freezing point
K_f is cryoscopic constant
i is van't Hoff factor
$\text{Molecualr mass of } C_6H_5COOH = 122\ g/mol$

$$0.93 = i \times 1.86 \times \frac{12.2 \times 1000}{122 \times 100}$$

i=0.5

$$n\left(C_6H_5COOH\right) \rightarrow \left(C_6H_5COOH\right)_n$$

$$i = \frac{\text{Total number of particles after association}}{\text{Total number of particles before association}}$$

$$0.5 = \frac{1}{n}$$
$$n = 2$$

26. At 363 K , the vapour pressure of A is $21\ kPa$ and that of b is $18\ kPa$. 1 mol of A and 2 moles of B are mixed . Assuming that this solution is ideal , the vapour pressure of the mixture in kPa rounded off to the Nearest Integer is

Accepted Answers

19 19.0 19.00

Solution:

An ideal solution is prepared by mixing 1 mol of A and 2 moles of B

Using Raoult's law
P_t is total pressure of solution
χ_A, χ_B are mole fractions of A and B in liquid phase
P_A^0, P_B^0 are vapour pressures of A and B in pure state

$$P_t = \chi_A P_A^0 + \chi_B P_B^0$$

$$P_t = \frac{1}{3} \times 21 + \frac{2}{3} \times 18 = 19\ kPa$$

27. The elevation of boiling point of $0.10\ m$ aqueous $CrC1_3.xNH_3$ solution is two times that of $0.05\ m$ aqueous $CaCl_2$, solution. The value of x is _____
[Assume 100% ionisation of the complex and $CaCl_2$, coordination number of $Cr\ is\ 6$, and that all NH_3 molecules are present inside the coordination sphere]

Accepted Answers

5 5.0 5.00

Solution:

Molality of $CaCl_2$ solution$= 0.05\ m$

$\Delta T_b = iK_b\ m = 3 \times K_b \times 0.05 = 0.15\ K_b$

Moltality of $CrCl_3.xNH_3 = 0.10\ m$

$\Delta T_b' = i\ K_b\ \times 0.10;\ \Delta T_b' = 2\Delta T_b$

$i\ K_b \times 0.10 = 2 \times 0.15\ \times K_b$
$\Rightarrow i = 3$

Since, Co-ordination number of $Cr\ is\ 6$.

$\therefore$ the complex is $[Cr(NH_3)_5Cl)Cl_2$

$\therefore\ x = 5$

28. The osmotic pressure of a solution of $NaCl\ is\ 0.10\ atm$ and that of a glucose solution is $0.20\ atm$. The osmotic pressure of a solution formed by mixing $1\ L$ of the sodium chloride solution with $2\ L$ of the glucose solution is $x \times 10^{-3}\ atm.\ x$ is _____. (nearest integer)

Accepted Answers

167 167.0 167.00

Solution:

$$For\ NaCl : \pi_1 = iC_1RT \Rightarrow C_1 = \frac{0.10}{2\ RT} \quad (i = 2)$$

$$\text{For Glucose} : \pi_2 = C_2RT \Rightarrow C_2 = \frac{0.20}{RT} \quad (i = 1)$$

When $1L$ of $NaCl$ solution and $2\ L$ glucose solution are mixed.

$$\therefore\ C_1' = \frac{0.10}{2RT} \times \frac{1}{3} and\ C_2' = \frac{0.20}{RT} \times \frac{2}{3} = \frac{0.40}{3\ RT}$$

$$\therefore\ \pi_{Total} = iC_R'T + iC_2'RT = 2 \times \frac{0.10}{6} + \frac{0.40}{3} = \frac{0.50}{3}$$

$$\boxed{\pi_{Total} \simeq 167 \times 10^{-3}\ atm}$$

29. CO_2 gas adsorbs on charcoal following Freundlich adsorption isotherm. For a given amount of charcoal, the mass of CO_2 adsorbed becomes 64 times when the pressure of CO_2 is doubled. the value of n in the Freundlich isotherm equation is $x \times 10^{-2}$. The value of x (Round off to the Nearest integer)

Accepted Answers

17 17.00 17.0

Solution:

According to Freundlich adsorption isotherm:

$$\frac{x}{m} = kp^{\frac{1}{n}} \quad \ldots (i)$$

When pressure in doubled,

$$64\frac{x}{m} = k(2p)^{\frac{1}{n}} \quad \ldots (ii)$$

Dividing eq (ii) by eq(i):

$$64 = \frac{(2p)^{\frac{1}{n}}}{(p)^{\frac{1}{n}}} = (2)^{\frac{1}{n}}$$

$$64 = (2)^{\frac{1}{n}}$$

$$\frac{1}{n} = 6$$

$$n = \frac{1}{6} = 16.67 \times 10^{-2} = 17 \times 10^{-2}$$

$$x = 17 \text{ (Nearest integer)}$$

30. CH_4, is adsorbed on $1\ g$ charcoal at $0^{\circ}C$ which follows the Freundlich adsorption isotherm. $10.0\ mL\ of\ CH_4$, is adsorbed at $100\ mm\ of\ Hg$, whereas $15.0\ mL$ is adsorbed at $200\ mm\ of\ Hg$. The volume of CH_4, adsorbed at $300\ mm\ of\ Hg$ is $10^x\ mL$. The value of x is_____$\times 10^{-2}$. (Nearest integer) $[Use\ log_{10}2 = 0.3010,\ log_{10}3 = 0.4771]$

Accepted Answers

128 128.0 128.00

Solution:

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According to Freundlich adsorption isotherm:
$\frac{x}{m} = kP^{\frac{1}{n}}$
x is the mass of the gas adsorbed on mass m of the adsorbent. P is the pressure of the gas
Mass of the gas is proportional to the volumeof gas adsorbed
Condition 1:
$\frac{10}{1} = k \times 100^{\frac{1}{n}} \; ..(i)$
Condition 2:
$\frac{15}{1} = k \times 200^{\frac{1}{n}} \; ..(ii)$
Condition 3: (Let V mL be adsorbed at 300 mm Hg)
$\frac{V}{1} = k \times 300^{\frac{1}{n}} \; ..(iii)$
Dividing (ii) by (i)
$1.5 = 2^{\frac{1}{n}}$
$\frac{1}{n} = \frac{\log 3 - \log 2}{\log 2}$
$\frac{1}{n} = 0.585$
Dividing (iii) by (i)
$\frac{V}{10} = 3^{\frac{1}{n}}$
$\log\left(\frac{V}{10}\right) = \frac{1}{n} \times \log 3$
$\log\left(\frac{V}{10}\right) = 0.585 \times 0.4771$
$\log\left(\frac{V}{10}\right) = 0.279$
$\left(\frac{V}{10}\right) = 10^{0.279}$
$V = 10^{1} \times 10^{0.279}$
$V = 10^{1.279}$
Comparing with 10^{x}
$x = 1.279 \approx 128 \times 10^{-2}$
The answer is 128