BYJU'S Home Learning Program

Topic covered:

- **Solutions (Session - 2) - NEET**

Daily Practice Problems

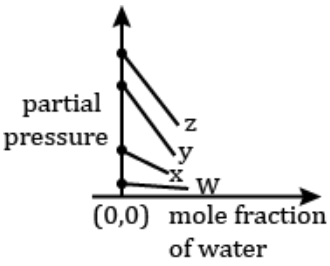
1. At equilibrium, the rate of dissolution of a solid solute in a volatile liquid solvent is:
   a. Less than the rate of crystallization
   b. Greater than the rate of crystallization
   c. Equal to the rate of crystallization
   d. Zero

2. K_H (kbar) for Ar(g), CO_2(g), HCHO(g) and CH_4(g) are 40.39, 1.67, 1.83×10^{-5} and 0.413 respectively. Arrange these gases in the order of their increasing solubility:
   a. $HCHO < CH_4 < CO_2 < Ar$
   b. $HCHO < CO_2 < CH_4 < Ar$
   c. $Ar < CO_2 < CH_4 < HCHO$
   d. $Ar < CH_4 < CO_2 < HCHO$

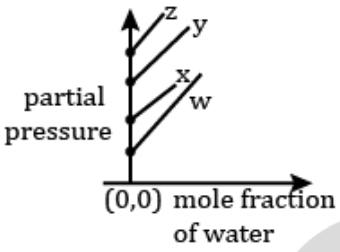
3. **STATEMENT-1**: Solubility of a gas in a liquid solution (as per Henry's law) is a function of the partial pressure of the gas at a constant temperature.
   STATEMENT-2: Mole fraction of the gas in a solution (as per Henry's law) is proportional to the partial pressure of the gas at constant temperature.
   STATEMENT-3: As per Henry's law, a higher value of K_H at a given partial pressure and temperature indicates a lower solubility of the gas in the liquid.
   a. TTT
   b. FTT
   c. FTF
   d. TFT

4. For a solution of the gases w, x, y and z in water at 298 K, the Henry's law constants (K_H) are 0.5, 2, 35 and 40 kbar, respectively. The correct plot for the given data is:

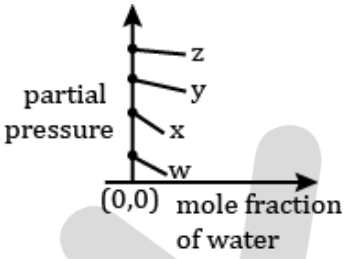
a.



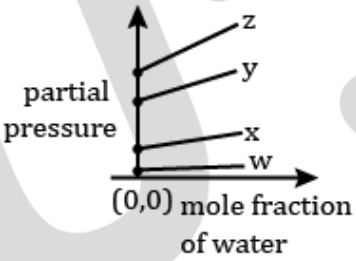
b.



c.



d.



5. If m_1, mass of gas A is soluble at pressure P_1 and m_2, mass of the same gas is soluble at pressure P_2 at fixed temperature and $P_1 > P_2$, then the ***incorrect*** statement is:
   a. Henry's law constant is the same for P_1 and P_2
   b. $m_1 > m_2$
   c. $\frac{m_1}{m_2} = \frac{P_1}{P_2}$
   d. When a graph is plotted between the solubility and the pressure of the gas, the slope in case of m_2, P_2 is greater than in the case of m_1, P_1.

6. The Henry's law constant for the solubility of N_2 gas in water at 298 K is 1×10^5 atm. The mole fraction of N_2 in air is 0.8. The number of moles of N_2 dissolved in 10 moles of water at 298 K and 5 atm pressure is:

   a. 4×10^{-4}
   b. 4×10^{-5}
   c. 5×10^{-4}
   d. 4×10^{-6}

7. Henry's law constants (in torr) for O_2 and N_2 are:
   $K_{H_{O_2}} = 3.3 \times 10^7, K_{H_{N_2}} = 6.51 \times 10^7$

   Calculate the ratio of $\frac{X_{O_2}}{X_{N_2}}$ i.e., the ratio of mole fractions of O_2 and N_2 dissolved in water at 25^0C, assuming the same partial pressure of the gases over the solution:

   a. 2.62
   b. 0.92
   c. 0.42
   d. 1.97

8. Which of the following compounds do not dissolve in benzene?
   i. Naphthalene
   ii. Anthracene
   iii. Sodium chloride
   iv. Sugar

   a. (i) and (iii)
   b. (i) and (iv)
   c. (iii) and (iv)
   d. (i) and (ii)

9. Which of the following gases are highly soluble in water?
   i. HCl
   ii. SO_2
   iii. NH_3
   iv. H_2

   a. (i) and (ii)
   b. (i), (ii) and (iii)
   c. (i), (ii) and (iv)
   d. All

10. The value of K_H for carbon dioxide at a temperature of 293 K is 1.6×10^3 atm L mol^{-1} . At what partial pressure would the gas have a solubility (in water) of 2×10^{-5} M?

    a. 0.032 atm
    b. 0.32 atm
    c. 0.028 atm
    d. 0.28 atm

Answer Key

Question Number	1	2	3	4	5	6	7	8	9	10
Answer Key	(c)	(c)	(a)	(a)	(d)	(a)	(d)	(c)	(b)	(a)

Solutions

1. (c)
   Crystallisation is the process of formation of solid crystals precipitating from a solution.
   In an unsaturated solution, the rate of dissolution of a solute in a volatile liquid solvent is greater than the rate of crystallisation.
   In a supersaturated solution, the rate of dissolution of a solute in a volatile liquid solvent is less than the rate of crystallisation.

2. (c) $P = K_H\chi$
   At a constant pressure, the solubility of gases in liquids decreases as the value of K_H increases.

3. (a)
   According to Henry's law, at a constant temperature, the solubility of a gas in a liquid is directly proportional to the partial pressure of the gas present above the surface of liquid or solution.
   Also, the common form of Henry's law is "the partial pressure of the gas in the vapour phase (P) is proportional to the mole fraction of the gas in the solution", where we consider mole fraction as a measure of solubility.
   $P = K_H\chi$
   From the equation, it is obvious that higher the value of K_H of a gas, lower will be its solubility, at a given partial pressure and temperature.

4. (a)
   From Henry's law,
   $P_{gas} = K_H\chi_{gas}$
   $= K_H(1 - \chi_{H_2O})$
   $P_{gas} = K_H - K_H\chi_{H_2O}$
   Compare the above equation with the equation of a straight line, $y = mx + c$.
   While plotting P_{gas} against the mole fraction of H_2O, the slope will be $-K_H$.

5. (d)
Henry's law constant is remains constant for a gas at a fixed temperature.
According to Henry's law,
$P = K_H\chi$
Where, χ is mole fraction of gas
K_H is Henry's law constant
P is partial pressure of gas over solution
If partial pressure of a gas is higher, then the solubility of the gas will be greater.
$P_1 > P_2$ So $m_1 > m_2$
Graph of solubility vs partial pressure
$S_1 = K_H P_1$ and $S_2 = K_H P_2$
On comparing with $y = mx + c$; slope is K_H for both cases and we know that K_H remains constant for a gas at a fixed temperature. As the slope is the same for both cases, option (d) is incorrect.

6. (a)
$P_{N_2} = X_{N_2} \times P_{Total} = 0.8 \times 5 = 4$ atm
According to Henry's law:
$P_{N_2} = K_H \times x_{N_2}$
$$4 = 1 \times 10^5 \times \frac{n_{N_2}}{n_{N_2} + n_{H_2O}}$$
$$4 = 1 \times 10^5 \times \frac{n_{N_2}}{n_{N_2} + 10}$$
$$4 \times 10^{-5} = \frac{n_{N_2}}{n_{N_2} + 10}$$
$$\Rightarrow \frac{n_{N_2}}{n_{N_2}+10} << 1$$
So, we can assume that,
$n_{N_2} \ll 10$
$$4 \times 10^{-5} = \frac{n_{N_2}}{10}$$
$$n_{N_2} = 4 \times 10^{-4}$$

7. (d)
Let the partial pressure of the gases be P so,
According to Henry's law,
$P = K_H\chi$
$P = 3.3 \times 10^7 (\text{torr}) \times \chi_{O_2}$ (i)
$P = 6.51 \times 10^7 (\text{torr}) \times \chi_{N_2}$ (ii)
On dividing (i) by (ii)
$$\frac{\chi_{O_2}}{\chi_{N_2}} = 1.97$$

8. (c)
Polar solutes dissolve in polar solvents and non-polar solutes dissolve in non-polar solvents.
In general, a solute dissolves in a solvent if the chemical interactions are similar in both solute and solvent or we may say 'like dissolves like'.

9. (b)
Due to polarity and H-bonding, a gas becomes highly soluble in water when it reacts or ionizes in water. HCl ionises in water, SO_2 and NH_3 react with water.

10. (a)
Here, the unit of K_H is $atmLmol^{-1}$ and the solubility is in molarity
So, the Henry's law is used in a modified form as,
$P = K_H \times C$
Substituting the given values $K_H = 1.6 \times 10^3$ $atmLmol^{-1}$ and $C = 2 \times 10^{-5}$ M
$P = K_H \times C$
$= (1.6 \times 10^3\ atmLmol^{-1}) \times (2 \times 10^{-5}\ M)$
$= 0.032$ atm