BYJU'S Home Learning Program

Topic covered:

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

Worksheet

1. Which statement is incorrect about Henry's law?
   a. The gas in contact with the liquid should behave as an ideal gas
   b. There should be chemical interaction between the gas and the liquid
   c. The pressure applied should be low
   d. None of these

2. Calculate the solubility of gaseous oxygen in water at a temperature of 293 K when the partial pressure exerted by O_2 is 1 bar. ($K_{H_{O_2}}$ = 34840 barLmol^{-1})
   a. 2.87×10^{-5} molL^{-1}
   b. 1.78×10^{-5} molL^{-1}
   c. 2.01×10^{5} molL^{-1}
   d. 0.98×10^{5} molL^{-1}

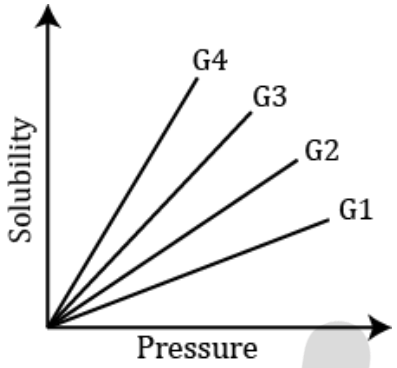
3. Henry's constant value for a gas will:
   a. Increase with increase in temperature.
   b. Decrease with increase in temperature.
   c. Remain constant with change in temperature.
   d. First increase then decrease with increase in temperature.

4. The partial pressure of ethane over a saturated solution containing 6.56×10^{-2} g of ethane is 1 bar. If the solution contains 5.00×10^{-2} g ethane, then what will be the partial pressure of the gas?
   a. 0.762 bar
   b. 7.870 bar
   c. 1.253 bar
   d. 0.078 bar

5. The value of Henry's constant K_H at constant pressure is:
   a. Greater for gases with higher solubility
   b. Greater for gases with lower solubility
   c. Constant for all gases
   d. Independent of solubility

6. The solubility of O_2 in water is 2.2×10^{-4} g in 100 g of H_2O at 20°C when the pressure of O_2 over the solution is 1.2 atm. Calculate the solubility at 20°C, when the pressure of O_2 over the solution is 10 atm.
   a. 1.56×10^{-4} g
   b. 2.15×10^{-2} g
   c. 1.83×10^{-4} g
   d. 1.83×10^{-3} g

7. The variation of solubility of four different gases (G1, G2, G3, G4) in a given solvent with pressure at a constant temperature. The gas that has the lowest value of Henry's law constant is:



   a. G1
   b. G2
   c. G4
   d. G3

8. Among the following, which gas has the lowest Henry's law constant (K_H) value in water at the same temperature?
   a. O_2
   b. H_2
   c. N_2
   d. He

9. Concentration of CO_2 (in mole fraction) in fat when partial pressure of CO_2 is 55 kPa at 25°C is: (Henry's law constant of $CO_2 = 8.6 \times 10^4$torr)
   a. 4.79×10^{-4}
   b. 4.97×10^{-3}
   c. 4.79×10^{-3}
   d. 4.79

10. Which of the following factor(s) will affect the solubility of a gaseous solute in a liquid solvent?
   (i) Nature of solute (ii) Temperature (iii) Pressure
   a. (i) and (iii) at constant temperature
   b. (i) and (ii) at constant pressure
   c. Both a and b
   d. (ii) and (iii) only

11. Which of the following is immiscible in water?
    a. CH_3OH (methanol)
    b. C_7H_8 (toluene)
    c. $LiCO_3$ (lithium carbonate)
    d. $CuSO_4$ (copper sulphate)

12. Low concentration of oxygen in the blood and tissues of people living at high altitudes is due to:
    a. Low atmospheric pressure
    b. High atmospheric pressure
    c. Low temperature
    d. Low temperature and high atmospheric pressure

13. Assertion: Solubility of gases increases with an increase in pressure.
    Reason: Generally, the dissolution of a gas in a liquid is exothermic.
    a. Both A and R are true, and R is the correct explanation of A
    b. Both A and R are true, and R is not the correct explanation of A
    c. A is true but R is false
    d. Both A and R are false

14. When a saturated solution of sodium chloride is heated, it:
    a. Remains saturated
    b. Becomes unsaturated
    c. Becomes supersaturated
    d. Achieves an equilibrium state

15. A supersaturated solution is a metastable solution whose concentration
    a. is equal to the solubility of the substance in the solvent
    b. is less than the solubility
    c. exceeds the solubility
    d. continuously changes

16. At 300K, 40 mL of $O_3(g)$ dissolves in 100 g of water at 1.0 atm. What is the mass of ozone dissolved in 400 g of water at a pressure of 4.0 atm at 300 K?
    a. 0.1 g
    b. 1.2 g
    c. 0.48 g
    d. 4.8 g

17. 1 kg of water under a nitrogen pressure of 1 atmosphere dissolves 0.02 g of nitrogen at 293 K. Calculate the Henry's law constant:
    a. 7.7×10^4 atm
    b. 7.7×10^3 atm
    c. 2×10^{-5} atm
    d. 2×10^{-2} atm

18. According to Henry's law, the partial pressure of gas (P_g) is directly proportional to the mole fraction of gas in liquid solution, $P_{gas} = K_H . X_{gas}$, where K_H is Henry's constant. Which of the following is incorrect?
    a. K_H is a characteristic constant for a given gas-solvent system
    b. Higher the value of K_H, lower is the solubility of the gas for a given gas pressure
    c. K_H has temperature dependence
    d. K_H decreases with an increase in temperature

19. Which of the following is/are possible unit of Henry's law constant?
    a. L atm
    b. mol atm L^{-1}
    c. atm
    d. atm/L

20. From this data:

Gas	Critical temperature (^{0}F)
Carbon dioxide	87.5
Oxygen	181.5
Nitrogen	232.6
Argon	188

    Which of the given gases is more soluble in water?
    Use ($M_{carbon\ dioxide}$ = 44 g, M_{Oxygen} = 32 g, $M_{Nitrogen}$ = 14 g and M_{Argon} = 40 g)
    a. Carbon dioxide
    b. Oxygen
    c. Nitrogen
    d. Argon

21. Air contains O_2 and N_2 in the ratio of 1: 4. Calculate the ratio of solubility in terms of mole fractions of O_2 and N_2 dissolved in water at the atmospheric pressure and room temperature at which Henry's constant for O_2 and N_2 are 3.3×10^7 torr and 6.6×10^7 torr respectively.
    a. 1:4
    b. 1:2
    c. 2:1
    d. 4:1

22. If 27 g of acetylene, C_2H_2, dissolves in 1 L of acetone at 1 atm pressure, what is the Henry's law Constant? What is the solubility in acetone if the partial pressure of (C_2H_2) is 12.5 atm?
    a. 27 g/L atm, 337.5 g/L
    b. 30 g/L atm, 450 g/L
    c. 25 g/L atm, 400 g/L
    d. 24 g/L atm, 250 g/L

23. A certain soft drink is bottled so that a bottle at 25°C contains CO_2 gas at a pressure of 5 atm over the liquid. If the partial pressure of CO_2 in the atmosphere is 4×10^{-4} atm, calculate the equilibrium concentrations of CO_2 in the soda both before and after the bottle is opened. The Henry's law constant for CO_2 in the aqueous solution is 3.1×10^{-2} mol/L atm at 25°C.
    a. 0.16 mol/L, 1.2×10^{-5} mol/L
    b. 0.20 mol/L, 1.6×10^{-5} mol/L
    c. 0.24 mol/L, 2.0×10^{-5} mol/L
    d. 0.28 mol/L, 2.4×10^{-5} mol/L

24. The solubility of a gas in a liquid generally increases with:
    a. An increase in temperature
    b. The amount of liquid taken
    c. A decrease in temperature
    d. Reduction of gas pressure

25. The largest value of Henry's law constant for the liquid solvent H_2O will be obtained in which of the following cases?
    a. He at 300 K
    b. O_2 at 300 K
    c. He at 400 K
    d. O_2 at 400 K

Answer Key

Question Number	1	2	3	4	5
Answer Key	(b)	(a)	(a)	(a)	(b)

Question Number	6	7	8	9	10
Answer Key	(d)	(c)	(a)	(c)	(c)

Question Number	11	12	13	14	15
Answer Key	(b)	(a)	(b)	(b)	(c)

Question Number	16	17	18	19	20
Answer Key	(d)	(a)	(d)	(c)	(a)

Question Number	21	22	23	24	25
Answer Key	(b)	(a)	(a)	(c)	(c)

Solutions

1. (b)
   It is applicable when a reaction between a gas and a liquid does not take place.

2. (a)
   According to Henry's law,
   $P = K_H C$
   Substituting values of $K_{H_{O_2}} = 34840$ barLmol^{-1} and P = 1 bar
   $\Rightarrow C = \frac{P}{K_H} = \frac{1}{34840} = 2.87 \times 10^{-5}$ molL^{-1}

3. (a)
   According to Henry's law, the solubility of a gas in a liquid is directly proportional to the pressure of gas, $P \propto \chi$
   $P = K_H \chi$
   K_H depends only on the nature of the gas, nature of the liquid and the temperature.
   As the temperature increases, the value of K_H increases.

4. (a)
   According to Henry's law, partial pressure p ∝ concentration of the gas in ethane
   So, $\frac{p_1}{p_2} = \frac{c_1}{c_2} \Rightarrow \frac{1}{p_2} = \frac{6.56 \times 10^{-2}}{5.00 \times 10^{-2}}$, $p_2 = 0.762$ bar

5. (b)
   According to Henry's law, the solubility of a gas in a liquid is directly proportional to the partial pressure of gas.
   $P = K_H . \chi$, where K_H is Henry's constant and χ is the solubility of gas in liquid.
   At constant pressure:
   $K_H \propto \frac{1}{\chi}$
   For a highly soluble gas, the value of K_H is very low and for gases with a low solubility the value of K_H is very high.

6. (d)

Henry's law = $P = K_H\chi$
As the temperature is fixed, value of K_H will be constant.
Or
$\frac{P_1}{P_2} = \frac{\chi_1}{\chi_2} = \frac{n_1}{n_2} = \frac{w_1}{w_2}$
So, putting values of P_1, P_2 and w_1,
we get $w_2 = 1.83 \times 10^{-3}$ g

7. (c)
The variation of solubility of four different gases (G1, G2, G3, G4) in a given solvent with pressure at constant temperature is shown in the plot.
At constant pressure, the gas having maximum solubility has the minimum value of Henry's law constant. Hence K_H will be lowest for G4.

8. (a)
We know that among the four given gases, O_2 has the maximum solubility in water, hence lowest value of K_H.

9. (c)
According to Henry's law,
Concentration $\times K_H =$ Pressure
$$\text{Concentration} = \frac{\text{Pressure of } CO_2}{K_H}$$
Given, $P_{CO_2} = 55$ kPa $= 55$ x10^3 Pa
Convert Pascal to torr, 760 torr $= 1.013 \times 10^5$ Pa
$$55 \text{ x}10^3 \text{ Pa} = \frac{760 \times 55 \times 10^3}{1.013 \times 10^5} = 412.63 \text{ torr}$$
$$\chi_{CO_2} = \frac{412.53 \text{ torr}}{8.6 \times 10^4 \text{ torr}}$$
$$= 4.79 \times 10^{-3}$$

10. (c)
Solubility of a gaseous solute in a fixed volume of liquid solvent will depend on the nature of the solute gas and the temperature when the pressure is constant **or** on the nature of the solute gas and the pressure when temperature is constant.

11. (b)
C_7H_8 (toluene) is non-polar and therefore immiscible in water.

12. (a)

Low concentration of oxygen in blood at high altitudes is due to low atmospheric pressure as pressure is directly proportional to the solubility of oxygen according to Henry's law.

13. (b)
Henry's law says that the solubility of gases is directly proportional to the pressure but the second statement is not the correct explanation.

14. (b)
On heating, NaCl can be dissolved further and hence the solution becomes unsaturated.

15. (c)
Supersaturated solution is a solution that contains more of the dissolved solute than what could be dissolved by the solvent under normal circumstances.

16. (d)
$C = K_H P$

$\frac{C_1}{C_2} = \frac{P_1}{P_2}$

Let's consider x mL of ozone dissolved in 400g of water at 4 atm pressure.

$\frac{\frac{x}{400}}{\frac{40}{100}} = \frac{4.0atm}{1.0atm}$

$\frac{x}{160} = 4.0$

X = 640mL or 0.640 L

We know that,

$n = \frac{PV}{RT}$

$= \frac{4.0 \text{ x } 0.640}{0.0821 \text{ x } 300K}$

$= 0.10$ mol

Mass of Ozone $= 48$ g/mol x 0.10mol $= 4.8$ g

17. (a)

For water, 1 kg = 1 L

Moles of nitrogen = $\frac{0.02}{28}$

Moles of water = $\frac{1000}{18}$

mole fraction of $N_2(\chi) = \frac{\text{moles of } N_2}{\text{moles of } N_2 + \text{moles of } H_2O} = \frac{\frac{0.02}{28}}{\frac{0.02}{28} + 55.56} = 1.285 \times 10^{-5}$

According to Henry's law,

$P = K_H . \chi$

$1 \text{ atm} = K_H \times 1.285 \times 10^{-5}$

$K_H = 7.7 \times 10^4 \text{ atm}$

18. (d)

K_H is different for different gas - solvent systems.

For a given partial pressure of a gas, if the value of K_H increases, the value of the mole fraction and solubility decreases.

K_H is directly proportional to the temperature. As the temperature increases, K_H also increases.

19. (c)

Henry's Law constant has the dimensions of pressure.

20. (a)

Generally, the gases which can be easily liquefied are more soluble in solvents.

The critical temperature signifies the force of attraction between the molecules. The higher the critical temperature, higher is the intermolecular force of attraction and easier is the liquefaction of the gas. So CO_2 is more soluble in water than the other given gases.

21. (b)

$P(O_2) = K_H(O_2) \times \chi(O_2)$ .....(1)

$P(N_2) = K_H(N_2) \times \chi(N_2)$ .....(2)

Divide both 1 and 2

$$\frac{\chi(O_2)}{\chi(N_2)} = \frac{P(O_2) \times K_H(N_2)}{P(N_2) \times K_H(O_2)}$$

$$\frac{\chi(O_2)}{\chi(N_2)} = \frac{0.2\ P_T \times 6.6 \times 10^7\ \text{torr}}{0.8\ P_T \times 3.3 \times 10^7\ \text{torr}}$$

$$\frac{\chi(O_2)}{\chi(N_2)} = \frac{1}{2}$$

22. (a)

According to Henry's law:

$P = K_H.S$

$S = \frac{1}{K_H}.P$

$K_H' = \frac{1}{K_H}$

$S_{gas} = K_H' \times P_{gas}$ ..... (i) Here K_H' is termed as Henry's constant

We will use this equation since the unit of K_H' is given as g/Latm

Given: S_{gas} = 27.0 g/L

On substituting,

$K_H' = \frac{27\ g/L}{1\ atm} = 27$ g/Latm

When pressure is increased to 12.5 atm then from eq. (i)

$S_{gas} = 27\left(\frac{g}{L}\right) \times 12.5 = 337.5\ \frac{g}{L}$

23. (a)

According to Henry's law:

$P = K_H . S$

$S = \frac{1}{K_H} . P$

$K_H' = \frac{1}{K_H}$

$S_{gas} = K_H' \times P_{gas}$

We will use this equation for solving because the unit of K_H' is given as mol/L atm.

$S(CO_2) = K_H \times P\ (CO_2)$

$K_H = 3.1 \times 10^{-2}$ mol/L atm

S(CO_2) of unopened bottle

$P(CO_2) = 5$ atm

$S(CO_2) = 3.1 \times 10^{-2}$ mol/L atm $\times$ 5 atm

= 0.16 mol/L

S(CO_2) of opened bottle

in the opened bottle, the CO_2 in the soda eventually reaches equilibrium with the atmospheric CO_2, so

$P(CO_2) = 4 \times 10^{-4}$ atm

$S(CO_2) = K_H \times P(CO_2)$

$= 3.1 \times 10^{-2}$ mol/L atm $\times 4 \times 10^{-4}$ atm

$= 1.2 \times 10^{-5}$ mol/L

24. (c)

Dissolution is an exothermic process.

25. (c)

Higher the K_H, lower will be the solubility. He gas has lower intermolecular interaction with water than O_2 and at higher temperature solubility will be lesser. The maximum value of K_H will be obtained in the case of He at 400 K