The effect of pressure on the solubility of gas

☒ External pressure has no influence on the solubility of liquids and solids but it affects the solubility of gases.

Henry's law → Solubility of a gas in a liquid is proportional to the pressure of a gas.

Henry's law: $C \alpha P$

$C = K.P$

C → Concentration (mole/liter).

P → pressure of a gas (Atm.).

K → Constant depend on temperature.

✓ Unit of K → (mole/Liter . Atm)

Note that

☒ When the pressure of gas is equal to 1 atm, the concentration is numerically equal to K.

☒ If several gases are present, p is partial pressure.

☒ The amounts of gas that will dissolve in a solvent depend on how frequently the gas molecules collide with the liquid surface and become trapped with the condensed phase.

Most gases obey Henry's law, but there are some exceptions.

☒ If the dissolved gas is react with water, higher solubility can be result.

Ex: $NH_3 + H_2O \leftrightarrow NH_4^+ + OH^-$

↳ Solubility of ammonia is higher than expected

Ex: $CO_2 + H_2O \leftrightarrow H_2CO_3$

↳ Solubility of carbon dioxide is higher than expected

Ex: dissolution of molecular oxygen in blood.

Examples on Hennery's law

1-The solubility of nitrogen gas at 25°C and 1Atm. is $6.8*10^{-4}$ mole/liter what is the concentration of nitrogen dissolved in H_2O under atmospheric condition?

Solution

$C=6.8*10^{-4}$ $P=1atm.$

$C = K.P$

$6.8*10^{-4} = K*1$

$K = 6.8*10^{-4}$ mole/liter. atm

The solubility of nitrogen at atmospheric condition

$C = 6.8*10^{-4}*0.78 = 5.3*10^{-4}$ mole/liter

2- Calculate the molar concentration of oxygen in water at 25°C for a partial pressure of 0.22 atm. ($K=1.3*10^{-3}$ mole/l.atm)

Solution

$K=1.3*10^{-3}$ mole/l.atm $P=0.22$ atm

$C = K.P$

$C = 0.22*1.3*10^{-3} = 0.286*10^{-3}$ mole/liter

Choose

1) External pressure…………. the solubility of liquids and solid.

    A)   affect

    C)   decrease

    B)   <u>Has no effect on</u>

    D)   increase

2) External pressure has effect on …….

    A)   solid

    C)   <u>gas</u>

    B)   liquid

    D)   All of the above

3) The unit of K "Henry's constant" is……..

    A)   mole.L/atm

    C)   <u>mole/L.atm</u>

    B)   atm.mole/L

    D)   Pascal

4) In this equation $CO_2+H_2O \leftrightarrow H_2CO_3$ the solubility of CO_2 is……….expected.

    A)   lower than

    C)   not change

    B)   <u>higher than</u>

    D)   Smaller than

5) If the dissolved gas react with water………solubility can be result.

    A)   <u>higher</u>

    C)   equal

    B)   lower

    D)   Smaller

6) The solubility of nitrogen gas at 25°C and a nitrogen pressure of 522 mmHg is $4.7*10^{-4}$ mole/L. what is the value of the Henry's law constant in mole/L.atm?

A) <u>$6.8*10^{-4}$ mole/L.atm</u>   C) $3.2*10^{-4}$ mole/L.atm

B) $4.7*10^{-4}$ mole/L.atm   D) $9*10^{-7}$ mole/L.atm

solution

1 atm → 760 mmHg

?? atm → 522 mmHg

$P = \frac{522}{760} = 0.686$ atm

$C = P.K$

$4.7*10^{-4} = K*0.686$

$K = \frac{4.7*10^{-4}}{0.686} = 6.8*10^{-4}$

7) The solubility of CO_2 in gas

A) <u>increase with increasing pressure</u>   C) decreasing with increasing gas pressure

B) increase with decreasing gas pressure   D) is not dependent on pressure

8) At 10°C one volume of water dissolve 3.1 volume of Cl_2 gas at 1 atm pressure, what is the Henry's law constant in mole/L.atm?

A) 3.8   C) 3.1

B) 0.043   D) <u>0.13</u>