Chemistry

DONA

Noble

Fall-2018

Isolation of inert gas from air (flowchart):

Noble gas mixture containing He, Ne, Ar, Kr, Xe brought in contact with coconut charcoal maintained at −100°C.

- **Ar, Kr and Xe ~~adsorbed~~ adsorbed**
  - Connected with another coconut charcoal maintained at liquid air temperature
    - **Argon diffuses and adsorbed in fresh charcoal**
      - heat → **Argon Evolved**
    - **First coconut-charcoal Kr and Xe in adsorbed state**
      - Temperature raised to −90°C
        - **Krypton evolved**
        - **Xenon remains in adsorbed state**
          - heat → **Xenon evolved**
- **Unadsorbed He and Ne.**
  - Brought in contact with charcoal at −180°C
    - **Neon adsorbed**
      - heat → **Neon evolved**
    - **Unadsorbed Helium**

(*) Uses of Helium :

① It is non-inflammable and light gas. So, it is used for filling balloons.

② It is also used in gas cooled nuclear reactors, and used as cryogenic agent for carrying out various experiments at low temperature

③ It is used as a diluent for oxygen in modern diving apparatus because of it's very low solubility in blood.

④ Mixture of Helium and Oxygen is also used in the treatment of respiratory diseases such as asthma.

⑤ Used in tube lights, vaccum drying etc.

⑥ Helium is used for inflating tyres of large aeroplanes.

(*) Uses of Argon :

① Used for filling electric bulbs.

② With oxygen, argon is used for welding to create an inert atmosphere. It is widely used for welding of aluminium and stainless ~~stet~~ steel.

③ Used in laboratory for handling substances and that are air sensitive.

④ Geiger-Counters are also filled with argon.

Spring-2018 → Same ques. (Flowchart of seperation or isolation of inert gas, uses of He and Ar).

Fall - 2020

(*) Uses of Argon

(*) Uses. of Radon:

1. Used in radiotherapy of malignant growth.
2. Used in the non-surgical treatment of cancer
3. Cure arthritis
4. Used in earthquake predictions.

Spring - 2018

(*) Uses of Argon.

(*) Noble gases are not chemically inert:

The chemical activity and valence of an elements depends upon the electronic configuration., particularly the type, the number and the arrangement of the electrons in the outermost energy level. We know, the number of electrons of outermost level of inert gas is 8.

But it is 2 for helium. And due to very high ionization energy, zero electron affinity and the absence of vacant d-orbitals in valence shell He and Ne are chemically inert.

Whereas Ar, Kr and Xe are reactive due to low ionization potentials and pressence of vacant d-orbitals in valence shell. Xe is more active than Ar and Kr because of lowest ionization energy. Xe only combines with strong electronegative elements like F and O ~~are~~ but not with less electronegative elements like Cl or N. Krypton forms only one known stable neutral molecule KrF_2.

Therefore, inert gases are not chemically inert though some are.

Spring-2017

(*) What are inert gases?

Ans: The elements of group 0 or 18 (group VIII A) of the periodic table are known as inert gases as they do not react with other substances and exist only in the free state. These are also known as Noble ~~gases~~ or Rare gases as they remains aloof from other elements and also their presence in the atmosphere is extremely small in amount (about 1% only). They have a electron configuration ns^2np^6 ~~ext~~ except He.

(*) Uses of inert gases:

Spring-2015

(*) Uses of ~~Argon an~~ Radon and Neon:

Fall-2014

Exple of formation of compounds of inert gases.

Krypton forms one known stable neutral molecule KrF_2.

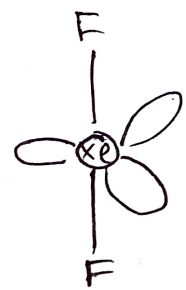
Xe combines with elements of strong electronegativity ~~elem~~ like F ~~and~~ or O,

XeF_2: Ground state: [↑↓] [↑↓|↑↓|↑↓] [| | | |]

$5s^2$ $5p^6$ 5d (empty)

Excited state: $\underbrace{[↑↓]\ [↑↓|↑↓|↑\,]\ [↑}_{sp^3d}\,| | | |]$

Linear



[আরও কিছু slide-এ আছে]

$C_6H_{12}O_6$ — 2810 KJ/mol

Solution (Dilute)

Fall-20

* **Raoult's Law:** The relative lowering of the vapour pressure of a dilute solution is equal to the mole fraction of the solute present in dilute solution. It can be expressed as

$$\frac{P - P_s}{P} = \frac{n}{n+N}$$

* **Relation of vapour pressure between dilute solution and solvent ~~of~~:**

~~The vapour pressure of pure solvent is caused by the number of molecules evaporating from its surface.~~

The vapour pressure of ~~the~~ a solution can be determined by the number of molecules of the solvent present at any time in the surface which is proportional to the mole fraction. That is,

$$P_s \propto \frac{N}{n+N}$$

where, P_s = Vapour pressure of ~~solvent~~ solution

~~where~~ N = moles of solvent.

and n = moles of solute.

or, $P_s = K \frac{N}{n+N}$ [Here K is proportionality factor] —— (i)

In case of pure solvent, $n=0$ and so,

Mole fraction of solvent $= \frac{N}{n+N} = \frac{N}{0+N} = 1$

Now, from equation (i), we get, $P = K$.

P is the vapour pressure of solvent

Putting the value of K in equation (i),

$$P_s = P \frac{N}{n+N}$$

$$\Rightarrow \frac{P_s}{P} = \frac{N}{n+N}$$

$$\Rightarrow 1 - \frac{P_s}{P} = 1 - \frac{N}{n+N}$$

$$\Rightarrow \frac{P - P_s}{P} = \frac{n}{n+N}$$

Therefore, Raoult's Law is $\frac{P-P_s}{P} = \frac{n}{n+N}$

(*) Given, molality of glucose = 0.0222 m.

K_f, molal freezing point-depression constant = 1.86 °C/m.

K_b, " boiling " increase constant = 0.51 °C/m

We know,

$$\text{Freezing point, } \Delta T_f = \frac{K_f \times w/m}{W/1000} = \frac{K_f \times \text{mol-solute}}{\text{kg-solvent}}$$

$$= K_f \times \text{molal value}$$

$$= (1.86 \times 0.0222)\ °C.$$

$$= 0.0413\,°C.$$

$$\text{Boiling point, } \Delta T_b = K_b \times \text{molal value}$$

$$= (0.51 \times 0.0222)\ °C$$

$$= 0.0113\,°C.$$

(*) molality = ?

Mole fraction of ~~solvent~~ solute (glucose) = 0.150 mole.

" " " solvent (water) = 0.850 mole.

$$\text{We know, Molality} = \frac{\text{Mole fraction of Solute} \times 1000}{\text{Mole fraction of solvent} \times \text{Molar mass of solvent}}$$

$$= \frac{0.150 \times 1000}{0.850 \times 18}$$

$$= 9.80 \text{ mol/Kg}$$

Spring - 2019

* **Raoult's law statement:** (আগের Page)

* **Why lowering of vapour pressure occur:**

The vapour pressure of the pure solvent is caused by the number of molecules evaporating from its surface. When a non-volatile solute is dissolved in solution, the pressence of solute molecules in the surface blocks a fraction of the surface where no evaporation can take place. This causes the lowering of the vapour pressure.

* Given, solution of $H_2SO_4\,(aq)$

Molar mass of $H_2SO_4 = 98$ g/mol

(4) Given, H_2SO_4, Molar mass, $M = 98$ gm/mol

percentage of H_2SO_4 by mass $= 35.4\%$. ~~$= 0.354$.~~

~~Mole of solute $= (0.354 \times 98) = 34.692$ moles.~~

That means in 100 gm solution there is 35.4 g solute (w).

So, rest is solvent, mass of solvent $= (100 - 35.4)$

$$= 64.6\text{ g}$$

$$= 64.6 \times 10^{-3}\text{ kg}.$$

The number of moles of solute, $n = \frac{w}{M} = \frac{35.4}{98}$

$$= 0.3612\text{ moles}$$

Now, molality $= \frac{\text{number of moles of solute}}{\text{mass of solvent}}$.

$$= \frac{0.3612}{64.6 \times 10^{-3}}\text{ mol/kg}$$

$$= 5.59\text{ mol/kg}. = 5.59\text{ molal}.$$

(Ans).

Colligative Properties :

① Lowering of the Vapour Pressure
② Elevation of the Boiling Point.
③ Depression of the freezing Point.
④ Osmotic Pressure.

Why they called so?

They are named as colligative properties as they are closely related to each other through a common explanation. All of the 4 properties depend only on the number of solute particles present in solution. They do not depend on size ~~of~~ or chemical nature of the particles. Also each of them are related so, if one property is measured, the others can be calculated.

Reverse Osmosis:

If the external pressure to the solution is greater than the osmotic pressure, solvent flows from the more concentrated side to the other one. This is known as reverse osmosis.

Derivation of $\pi V = inRT$:

$\pi V = inRT$ is known as van't Hoff equation.

(P.T.O)

From Boyle's law we get,

Pressure $\propto$ Concentration.

Let π be osmotic pressure

C " concentration.

$\pi \propto C$.

$\Rightarrow \pi \propto \frac{1}{V}$ —— (1) (at constant temperature)

From Charles law we get,

$\pi \propto$ Temperature. (at constant concentration) —— (II)

Let, absolute Temperature be T.

Combining the two laws, (I) and (II),

We get, $\pi \propto T/V$

$\Rightarrow \pi V = RT$ [For 1 mole of solute]

So, for n mole of solute,

$\pi V = nRT$.

(Derived).

(*) Given, $V = 200\ mL = 0.2 L$

$w = 2.47 g$.

$\pi = 8.63\ mmHg = \left(\frac{8.63}{760}\right) atm = \cancel{0.01135\ atm}$

$T = 21°C = 21 + 273 = 294\ K$

$R = 0.0821$ litre-atm.

We know, $\pi V = nRT$

$$\Rightarrow \pi V = \frac{w}{M} RT$$

$$\Rightarrow M = \frac{wRT}{\pi V}$$

$$= \frac{2.47 \times 0.0821 \times 294 \times 760}{0.2 \times \cancel{0.01135}\ 8.63}$$

$$= 26,251.86$$

Fall-2018

(*) Raoult's law (আবার)

(*) Derivation of $P = P^{\circ} X_1$:

Here, P is vapour pressure of solution

P° is ~~va~~ " " " solvent

X_1 " mole fraction of "

We know, $P \propto N$ (no. of moles of solvent).

$$\Rightarrow P \propto \frac{N}{n+N}.$$

$$\Rightarrow P \propto K \frac{N}{n+N} \quad \text{------} \quad (1) \qquad [K \text{ is constant}]$$

Where solute, $n=0$, P will be equal to P_0

$$P_0 = K \frac{N}{0+N} = K.$$

$$\Rightarrow P_0 = K.$$

Putting the value of K in equation (1), we get,

$$P = P_0 \frac{N}{n+N}$$

or, $\frac{P}{P_0} = \frac{N}{n+N}$

or, $P = P_0 X_1$ $\left[\because X_1 = \frac{N}{n+N}; \text{mole fraction of solvent}\right]$

$\therefore P = P_0 X_1$ (Derived)

* Given, ~~concentration of~~
percentage by mass $= 37.7\%$
Density $= 1.19$ g/mL

let, the mass of the solution be 100 g.
weight ~~mass~~ of HCl be 37.7 g (solute)

We know, $\text{Density} = \frac{\text{mass}}{\text{volume}}$

$$\Rightarrow \text{volume} = \frac{100}{1.19} \text{ mL} = \frac{100}{1.19 \times 1000} \text{ L}$$

Now, molarity $= \dfrac{\text{Weight}}{\text{Molecular mass} \times \text{Volume}}$

$= \dfrac{37.7 \times 1.19 \times 1000}{36.5 \times 100}$

$= 12.29\ M.$

Again, mass of solvent $= (100 - 37.7) = 62.3\ g = 62.3 \times 10^{-3}\ kg$

Number of moles of solute, $n = \dfrac{w}{M} = \dfrac{37.7}{36.5} = 1.0328\ mol$

Now, Molality $= \dfrac{\text{number of moles of solute}}{\text{mass of solvent}}$

$= \dfrac{1.0328}{62.3 \times 10^{-3}}\ mol/kg$

$= 16.57\ mol/kg.$

$\therefore$ Molarity $= 12.29M$; Molality $= 16.57\ mol/kg$. (Ans)

(*) A colligative property of solutions ~~that~~ is a property that depends only upon the number of solute particles, not upon their identity.

There are four colligative properties:

1. Lowering of Vapour Pressure
2. Elevation of Boiling Point
3. Depression of Freezing Point.
4. Osmosis.

(*) Suitable colligative Property for determining molar mass of a solute:

Osmotic pressure is preffered for the determination of molar masses of macromolecules such as proteins and polymers. Generally, it is not widely used as it is less accurate and difficult to carry out. but is suitable when it comes to high molecular weights.

Again from Van't Hoff's equation $\pi V = nRT$,

we can see that Molar mass of a solute is inversely proportional to the osmotic pressure.

As in $\pi V = \frac{w}{M} RT$.

or, $\pi \propto \frac{1}{M}$ $\left[\because \begin{array}{l} \pi = \text{osmotic pressure} \\ M = \text{Molar mass} \end{array} \right]$

Spring -2018

* **Molarity**: It is the number of moles of solute present in one litre of solution.
The equation is $n = \dfrac{\text{weight}}{\text{Molecular Mass}}$.

* **Mole fraction**: It is a unit of concentration which is mainly the number of moles of a specific component in the solution divided by the total number of moles in the given solution.
The equation is $X = \dfrac{X_A}{X_A + X_B}$.
Here, x is mole fraction, X_A is mole number of a component and X_B is mole number of another component

* Fall-2018-এর HCl-এর math-টি same without change.

* **Raoult's law of Elevation of boiling point**:
The elevation of boiling point is directly proportional to the lowering of vapour pressure.
$\Delta T \propto P - P_s$, where, ΔT is elevation of boiling point and $P - P_s$ is the lowering of vapour pressure
where P is vapour pressure of solvent
and P_s " " " " solution.

(*) Relationship of $\Delta T_b = K_b \times m$:

Here, ΔT_b = Elevation of boiling point

K_b = molal boiling point elevation constant

m = concentration in molality.

We get from Raoult's law of elevation of boiling point,

$$\Delta T \propto p - p_s \quad \text{———} \quad (i)$$

Since p is constant for same solvent at a fixed temperature, from (i) we get,

$$\Delta T \propto \frac{p - p_s}{p} \quad \text{———} \quad (ii)$$

For dilute solution,

$$\frac{p - p_s}{p} \propto \frac{n}{N}$$

$$\text{or, } \frac{p - p_s}{p} \propto \frac{w}{m} \cdot \frac{M}{W} \quad \text{———} \quad (iii)$$

where, w is weight of solute

m is molecular mass of solute

W is weight of ~~solution~~ solvent

M is molecular mass of ~~solution~~ solvent.

Now, M is constant, so in (iii),

$$\frac{p - p_s}{p} \propto \frac{w}{Wm} \quad \text{———} \quad (iv)$$

From (II) and (IV)

$$\Delta T \propto \frac{w}{m} \times \frac{1}{W}$$

$$\Delta T = K_b \times \frac{w}{m} \times \frac{1}{W} \quad [K_b \text{ is the constant}]$$

We know,

$$\text{Molality} = \frac{\text{number of moles of solute}}{\text{Mass of solvent in kg.}} , \text{ or, } m = \frac{n}{W}$$

Now, $\Delta T = K_b \times \frac{w}{m} \times \frac{1}{W}$

$\Rightarrow \Delta T = K_b \times n \times \frac{1}{W}$

$\Rightarrow \Delta T = K_b \times m.$

(Derived).

(*) Reverse Osmosis — Def.

(*) ~~Given,~~ Osmotic pressure, $\pi = ?$

~~when~~ given, $w = 2.5g$; M of glucose $= 180$ g/mol.

$V = 100g = 0.1$ Liter.

$T = 27 + 273 = 300K.$

$R = 0.0821$ liter-atm.

We know, $\pi V = nRT.$

$$\Rightarrow \pi = \frac{wRT}{MV} = \frac{2.5 \times 0.0821 \times 300}{180 \times 0.1}$$

$$= 3.42 \text{ atm}$$ (Ans).

Spring-2017

4a

(*) Molarity definition.

Normality: It is one of the expressions used to measure the concentration of a solution. It is the number of gram ~~of a~~ or mole equivalent of solute present in one liter of a solution.

(*) Given,

$w = 10.6 \text{ g}$ (of Na_2CO_3)

Mass of solvent $= 2000\text{g} = 2$ liter.

Density of the solution $= \frac{\text{Mass}}{\text{Volume}}$.

$\Rightarrow$ Volume of the solution $= \frac{\text{Mass}}{\text{density}}$

$= \_\_\_\_\_\_$

[এই math নিয়ে আমি confused নিজেরা করবি আমাকেও দিবি

- Love, Dona.]

4/b Ideal Solution:

A solution that obey Raoult's law which means the relative lowering of the vapour pressure of ~~a~~ that solution is equal to the mole fraction of the solute present in that ~~sout~~ solution is known as Ideal solution.

[state + derive Raoult's law]

4/c Derive Van't Hoff's equation – ($\pi V = nRT$).

Math: Given, 5% of solution of ~~glucose~~ urea

Molar mass ← MW or mol-wt = 60.

$$\text{so, } n = \frac{5}{MW} = \frac{5}{60} = 0.083$$

$$T = 0^{\circ}C = 0 + 273 = 273K$$

$$R = 0.0821 \text{ liter-atm},$$

$$V = 100\,ml = 1 \times 10^{-1}\,L$$

We know,

$$\pi V = nRT$$

$$\Rightarrow \pi = \frac{0.083 \times 0.0821 \times 273}{1 \times 10^{-1}}$$

$$= 18.67 \text{ atm (Ans)}$$

4/d Molal elevation constant of benzene is 2.67°C that means it is the elevation in the boiling point of ~~benzene~~ a solvent when one mole of benzene solute is dissolved in it per kilogram of that solvent.

We know, from Raoult's Law of elevation of boiling point that,

$$\Delta T = K_b \frac{w}{mM}$$

$$\text{or, } \Delta T = K_b \cdot \text{molality}.$$

$$\text{or, } K_b = \frac{\Delta T}{\text{molality}} \cdot (\text{Ans})$$

Spring-2016

2/a (*) Osmosis: The movement of solvent molecules through a semi-permeable membrane from a region of low solute concentration to a region of high solute concentration is called osmosis.

(*) Osmotic pressure: The external pressure applied to the solution in order to stop the osmosis of solvent into solution seperated by a semipermeable membrane is osmotic pressure.

* **Reverse osmosis:** If the ~~osm~~ external pressure to the solution is greater than the osmotic pressure, solvent flows from the more concentrated side to the other one, it is called reverse osmosis.

* **Application of Osmosis and reverse osmosis:**

Reverse osmosis: ① Used to obtain pure water from salty water.
② Used widely in food industry.
③ Removes bacteria and brine in meat.
④ In dialysis machine.

Osmosis:
① To preserve fruit and dehydrate it.
② To preserve meat by drawing salt into the meat.

2/b: **Osmotic pressure Laws:**

① The osmotic pressure of a solution at a given temperature is directly proportional to its concentration.

② The osmotic pressure of a solution of a given concentration is directly proportional to the absolute temperature.

$\boxed{2/c:}$

Given, $w = 0.184 g$

$\pi = 56 \text{ cm(Hg)} = 56/76 = 0.736 \text{ atm}$

$T = 30°C = 30+273 = 303 K.$

$V = 100 g = 0.1 L$

$R = 0.0821$ liter-atm.

We know,

$$\pi V = nRT.$$

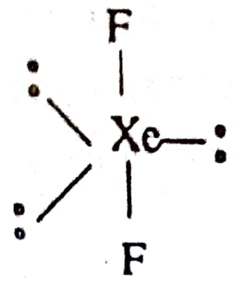
$$\Rightarrow \pi V = \frac{w}{M} RT$$

$$\Rightarrow M = \frac{wRT}{\pi V} = \frac{0.184 \times 0.0821 \times 303}{0.736 \times 0.1}$$

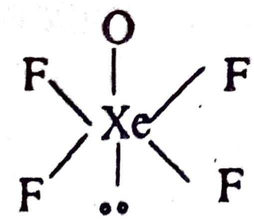
$$= 62.190 \ M.$$

(Ans)

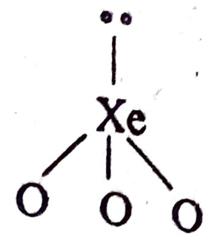
Other compounds of Xe are formulated as follows :



(XeF_2)
sp^3d



($XeOF_4$)
sp^3d^2



(XeO_3)
p^3d

Uses of the Inert Gases

1. Uses of Helium :

(a) Because of its lightness and non-inflammability, helium is used for filling observation balloons.

(b) Helium is less soluble than nitrogen in the blood. Hence mixture of helium and oxygen are used by sea divers. This overcomes the disadvantage of using air at high pressure for respiration, because the nitrogen of air gets dissolved in the blood at high pressure and on surfacing the pressure is released but the dissolved nitrogen forms a pathological condition known as *bends* due to the formation of bubbles of nitrogen in the blood giving sudden pain.

(c) Mixtures of helium and oxygen are also used in the treatment of respiratory diseases such as asthma.

(d) Helium is used for inflating tyres of large aeroplanes.

(e) It is also used as an inert atmosphere for the melting and welding of easily oxidizable metals.

(f) Liquid helium produces lowest temperature and is used for scientific research.

(g) It is used in tube lights, vacuum drying etc.

2. Uses of Neon :

(a) Neon is used in neon lamps and signs. When an electric current is passed through neon under low pressure, it emits a brilliant orange-red glow which penetrates through mists and fogs. This is, therefore, used as beacon lights for air pilots.

(b) Neon is now-a-days extensively used in advertisement signs by coloured lights and in fluorescent tubes. The colour of neon in a lamp or tube may be changed by mixing with argon and mercury vapour and by using tubes made of glasses of special compositions. Lights of different shades can thus be obtained.

(c) Neon is used in television sets, radio-photography, sound movies etc. where ready responses to changes in electrical potential are required.

(d) Neon is also used for stimulation of growth of plants and flowers in the green houses.

3. Uses of **Argon** :

(a) Argon is used in gas-filed electric bulbs. It lowers the heat conductivity and complete chemical inertness makes it preferable to nitrogen. Thus the volatilization of tungsten filament is reduced and prolongs the life of the lamp. Ordinary tube lights contain a mixture of argon and mercury vapour

(b) With oxygen argon is used in welding to create an inert atmosphere. Argon is now widely used for welding of aluminium and stainless steel.

(c) Geiger-Counters are also filled with argon.

4. Uses of **Krypton and Xenon** :

(a) Krypton-xenon photographic flash tube has been developed for taking high speed photographic exposures. In cinematography, krypton flash is used to produce intense light.

(b) Krypton mixed with neon gives blue light in the electric tubes.

(c) Xenon imparts green colour to the electronic tube lights.

(d) Krypton is used in ionization chambers for cosmic ray measurements.

(e) Xenon has recently been used for making Bubble Chambers for detecting γ-rays, neutrons and other nuclear particles.

5. Uses of **Radon** :

Radon differs from other inert gases in its radioative properties. Because of this property radon is used in the radiotherapy of malignant growth. It is particularly suitable in the non-surgical treatment of cancer. Radon is much more radioactive than radium and the therapeutic preparation of radon in small tubes is technically known as *seeds*.