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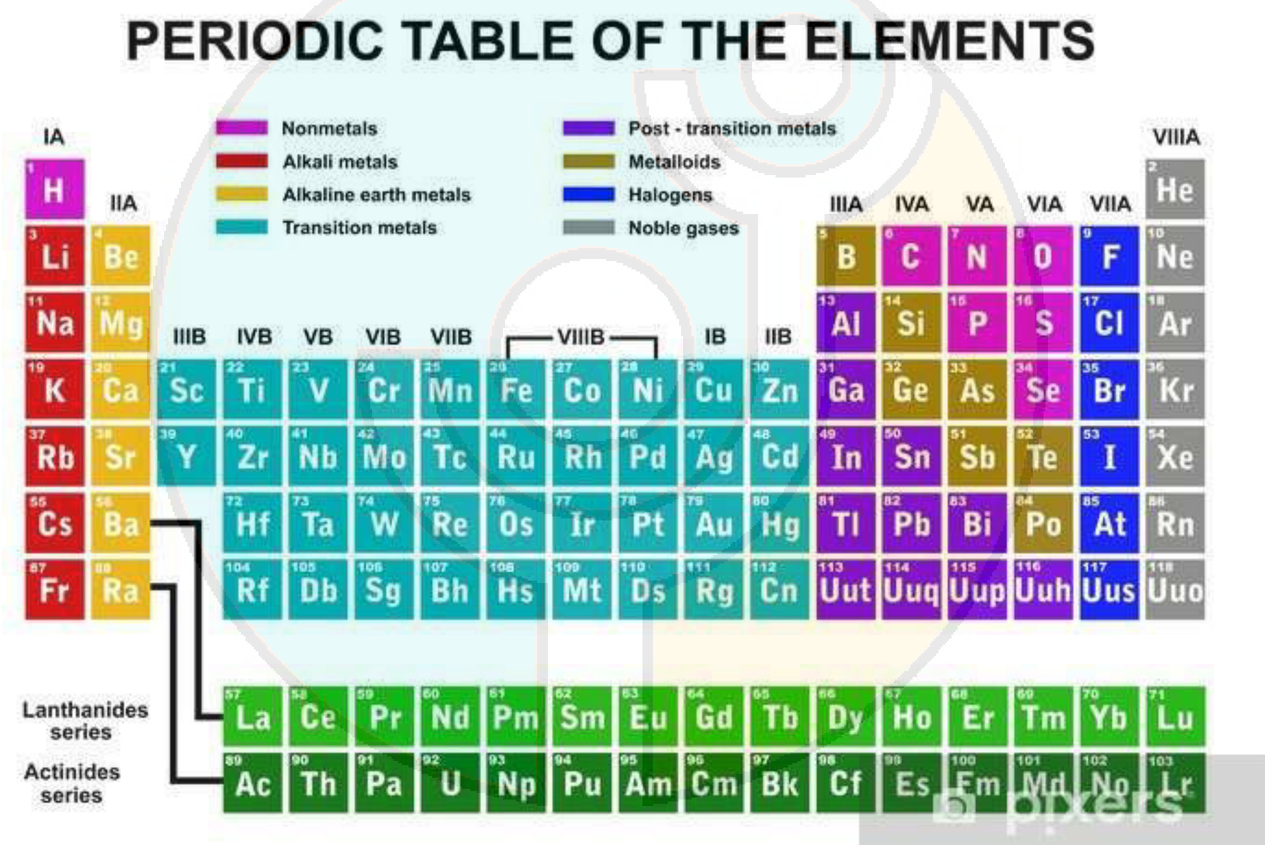
CHEMISTRY

VOLUME - I

HIGHER SECONDARY FIRST YEAR



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UNIT- I

Basic Concepts of Chemistry and Chemical Calculations

1. **Define Relative atomic mass**

$$(Ar) = \frac{\text{Average mass of the atom}}{\text{Unified atomic mass}}$$

2. **Define molar mass.**

Molar mass is defined as the mass of one mole of a substance. The molar mass of a compound is equal to the sum of the relative atomic masses of its constituents

expressed in g mol^{-1}.

3. **Define gram equivalent mass**

$$\textbf{equivalent mass} = \frac{\text{Molar mass (g mol}^{-1})}{\text{Equivalence factor (eq mol}^{-1})}$$

4. **What is limiting reagent.**

when a reaction is carried out using non-stoichiometric quantities of the reactants, the product yield will be determined by the reactant that is completely consumed. It limits the further reaction from taking place and is called as the limiting reagent.

5. **What is classical concept of oxidation and reduction**

As per the classical concept, addition of oxygen (or) removal of hydrogen is called oxidation and the reverse is called reduction.

6. **What do you understand by the term oxidation number.**

It is defined as the imaginary charge left on the atom when all other atoms of the compound have been removed in their usual oxidation states that are assigned according to set of rules.

7. **Write note on electronic concept oxidation and reduction? give an example**

The reaction involving loss of electron is termed oxidation and gain of electron is termed reduction.

For example,

$Fe^{2+} \rightarrow Fe^{3+}$ + e. (loss of electron-oxidation).

Cu^{2+}+ 2e. $\rightarrow$ Cu (gain of electron-reduction)

8. **What do you understand by the term mole.**

i) One mole is the amount of substance of a system, which contains as many elementary particles as there are atoms in 12 g of carbon-12 isotope. The elementary particles can be molecules, atoms, ions, electrons or any other specified particles.

ii) term mole to represent 6.022 x 10^{23} entities

9. **The balanced equation for a reaction is given below**

2x+3y $\rightarrow$ 4l + m

When 8 moles of x react with 15moles of y, then

i) Which is the limiting reagent?

ii) Calculate the amount of products formed.

iii) Calculate the amount of excess reactant left at the end of the reaction.

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$$2x + 3y \rightarrow 4l + m$$

2 moles of x react with 3 moles of y

8 moles of x is supposed to react with 3/2 x 8 moles of y = 12 moles

Since we have 15 moles of y, it means y is in excess

i) The limiting reagent is x 2 moles of x produce 4 moles of l and 1 mole of m

ii) 8 moles of x will produce 2x8 = 16 moles of l

8 moles of x will produce 1/2 x 8 moles of l = 4 moles

iii) Excess reactant is y Excess y = 15 moles - 12 moles = 3 moles

10. **Hydrogen peroxide is an oxidising agent. It oxidises ferrous ion to ferric ion and reduced itself to water. Write a balanced equation.**

$$\overset{-1}{H_2O_2} + Fe^{2+} \rightarrow Fe^{3+} + H_2\overset{-2}{O}$$

$$\underset{(1e^- \times 2)}{\uparrow} \qquad \underset{1e^-}{\downarrow}$$

$$1\,H_2O_2 + 2Fe^{2+} \rightarrow Fe^{3+} + H_2O$$

$$\Rightarrow \quad H_2O_2 + 2Fe^{2+} + 2H+ \rightarrow 2Fe^{3+} + 2H_2O$$

UNIT 2

Quantum Mechanical Model of Atom

1. **Which quantum number reveal information about the shape, energy, orientation and size of orbitals?**

Size & energy : Principal Quantum Number(n)

Shape & energy : Azimuthal Quantum Number(l)

Orientation : Magnetic Quantum Number(m)

2. **How many orbitals are possible for n =4?**

The total number of possible orbitals associated with the 4th energy level

For n = 4 Therefore the Number of orbitals = n^2

$= 4^2 = 16$

Explanation :- As we know that the Fourth shell has 4 subshell.

Hence for each and every subshell, By using the formula (2l+1)"

For s subshell $\Rightarrow$ 1 orbitals {as l =0 }

For p subshell $\Rightarrow$ 3 orbitals {as l = 1}

For d subshell $\Rightarrow$ 5 orbitals {as l = 2}

For f subshell $\Rightarrow$ 7 orbitals {as l =3 }

Hence the total number of orbitals is 16 .

3. **write two Limitation of Bohr's atom model**

i) It is applicable only to species having one electron such as hydrogen

ii) It was unable to explain the splitting of spectral lines in the presence of magnetic field (Zeeman effect) or an electric field (Stark effect).

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4. State Heisenberg's uncertainty principle

"It is impossible to **accurately** determine both the position as well as the momentum of a microscopic particle **simultaneously**.

$$\Delta x . \Delta p = h/4\pi$$

where, Δx and Δp are uncertainties in determining the position and momentum, respectively.

5. Write note on time independent Schrodinger equation.

$$\hat{H}\Psi = E\Psi$$

Where ψ is called Hamiltonian operator,

ψ - is the wave function denoted as ψ (x,y,z)

E - is the energy of the system

6. State Pauli Exclusion Principle

"No two electrons in an atom can have the same set of values of all four quantum numbers."

7. State Hund's rule of maximum multiplicity.

It states that electron pairing in the degenerate orbitals does not take place until all the available orbitals contains one electron each.

8. State Aufbau principle ('building up')

'In the ground state of the atoms, the orbitals are filled in the order of their increasing energies.

That is the electrons first occupy the lowest energy orbital available to them'.

10. Explain (n + l) rule

It states that, the lower the value of (n + l) for an orbital, the lower is its energy. If two orbitals have the same value of (n +l), the orbital with lower value of n will have the lower energy.

Orbital	Value of n	Value of *l*	Value of (n + *l*)	
1s	1	0	1 + 0 = 1	
2s	2	0	2 + 0 = 2	
2*p*	2	1	2 + 1 = 3	2*p* (*n* = 2) has lower energy than
3s	3	0	3 + 0 = 3	3s (*n* = 3)
3*p*	3	1	3 + 4 = 4	3*p* (*n* = 3) has lower energy than
4s	4	0	4 + 0 = 4	4s (*n* = 4)
3*d*	3	2	3 + 2 = 5	3*d* (*n* = 3) has lower energy than
4*p*	4	1	4 + 1 = 5	4*p* (*n* = 4).

11. Give the electronic configuration of Mn^{2+} and Cr^{3+}

When 3 electrons are removed, it becomes Cr^{3+}.

i) The atomic number of Mn is 25 and has the electronic configuration of [Ar] $3d^5 4s^2$.

When 2 electrons are removed, Mn^{2+} ion is obtained and has an electronic configuration of

$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}$ Or, $[Ar]^{18}\ 3d^{10}$.

(i) The atomic number of Cr is 24 and the electronic configuration is [Ar] $3d^5 4s^1$

When 3 electrons are removed, it becomes Cr^{3+}.

The electronic configuration of **Cr^{3+}: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^3$ Or $[Ar]^{18}\ 3d^3$**

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11. Calculate the energy required for the process

$$He^{+} (g) \rightarrow He^{2+} (g) + e^-$$

The ionisation energy for the H atom in its ground state is - 13.6 ev atom^{-1}.

$$E_n = \frac{-13.2}{n^2} x Z^2$$

$$E_n = \frac{-13.2}{2^2} x (2)^2 = -56.4$$

$$E_\infty = \frac{-13.2}{(\infty)^2} x (2)^2 = 0$$

UNIT 3

Periodic Classification Of Elements

1. What is the basic difference in approach between Mendeleev's periodic table and modern periodic table ?

Mendeleev's Periodic Law states that the physical and chemical properties of elements are periodic functions of their atomic weights. On the other hand, the Modern periodic Law states that the physical and chemical properties of elements are periodic functions of their atomic numbers

2. Define screening effect (or) shielding effect.

The inner shell electrons act as a shield between the nucleus and the valence electrons. This effect is called shielding effect.

3. What is effective nuclear charge ?

The net nuclear charge experienced by valence electrons in the outermost shell is called the effective nuclear charge.

$$Z_{eff} = Z - S$$

4. What are isoelectronic ions? Give examples.

Isoelectronic refers to two atoms,ions or molecules that have the same electronic structure and same number of valence electrons.

example: Ne , F^- and Na^+ and Mg^{2+}.all have same no. of electrons.

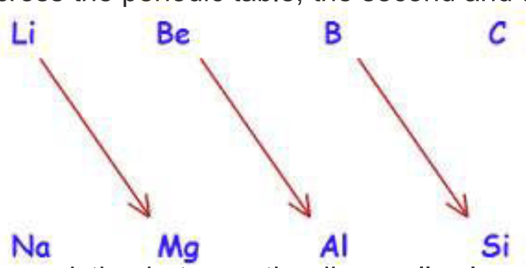
6. Why halogens act as oxidising agents?

Halogens can acts as Strong oxidizing agents because of **high electronegativity** and **high electron affinity** which makes them to take electrons very much readily takes electrons from other elements and oxidise other elements.

Decreasing order of Oxidising strength among halogens is : F > Cl > Br > I

7. Explain the diagonal relationship.

On moving diagonally across the periodic table, the second and third period elements show certain similarities.



The similarity in properties existing between the diagonally placed elements is called diagonal relationship.

8. Explain the periodic trend of ionisation potential.

In the period:- In the period from left to right ionisation potential increases because

1) Nuclear Charge increases from left to right in the period.

2)Atomic size decreases

3) Hence In the period from left to right energy required to remove the valence electrons from an atom increases.

In the group: -from top to bottom ionisation potential of elements decreases because-

1)atomic size goes on increases from top to bottom in the same group.

2)Hence attraction force between the nucleus and valence electron decreases.

3) Thus lesser energy is sufficient to remove the valence electrons from an atom.

9. State the trends in the variation of electronegativity in group and periods.

Electronegativity decreases moving from top to bottom down a group and increases moving from left to right across a period.

Down a group:

i) The size of an atom increases as we move down the group because a new shell is added and electron gets added up.

ii) As, the size of an element increases, the valence electrons gets away from the nucleus. So, the attraction between the nucleus and the shared pair of electrons decreases.

Across a period:

i)The size of an atom decreases as we move across the period because the electrons get added to the same shell and the nuclear charge keeps on increasing.

Thus the electrons get more tightly held by the nucleus.

ii) As, the size of an element decreases, the valence electrons come near to the nucleus.

So, the attraction between the nucleus and the shared pair of electrons increases

10. Give the general electronic configuration of lanthanides and actinides?

i) The electronic configuration of the lanthanoids is $4f^{1-14}\ 5d^{0-1}\ 6s^2$

ii) General electronic configuration of actinoids is $5f^{1-14}\ 6d^{0-1}\ 7s^2$

11. Mention any two anomalous properties of second period elements.

i) Small size of these atoms.

ii) High electronegativity.

iii) Large charge/radius ratio.

These elements also have only 4 valence orbitals available (2s and 2p) for bonding as compared to the 9 available (3s, 3p, and 3d) to the other members of the respective groups, so their maximum covalency is 4.

12. The quantum mechanical treatment of the hydrogen atom gives the energy value:

$$E_n = \frac{-13.6}{n^2}\ \text{eVatom}^{-1}$$

i) use this expression to find ΔE between n = 3 and m = 4

ii) Calculate the wavelength corresponding to the above transition.

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i) use this expression to find ΔE between n = 3 and m=4

$$E_n = \frac{-13.6}{n^2}\ eVatom^{-1}$$

$$n=3 \quad E_3 = \frac{-13.6}{3^2}\ eVatom^{-1} = -1.51\ eV\ atom^{-1}$$

$$n=4 \quad E_4 = \frac{-13.6}{4^2}\ eVatom^{-1} = -0.85\ eV\ atom^{-1}$$

$$\Delta E = (E_4 - E_3) = (-0.85) - (-1.51) = -0.85 + 1.51) = 0.66\ eVatom^{-1}$$

ii) (1eV = 1.6 x 10^{-19} J)

$$\Delta E = 0.66 \text{ x } 1.6 \text{ x } 10^{-19} J$$

$$\Delta E = 1.056 \times 10^{-19} J$$

$$\Delta E = h\nu,$$

$$h\nu = 1.056 \times 10^{-19} J \quad (\nu = \frac{c}{\lambda})$$

$$\Delta E = \frac{hc}{\lambda} = 1.056 \times 10^{-19} J$$

$$\therefore \lambda = \frac{hc}{1.06 \times 10^{-19} J} = \frac{6.626 x 10^{-34} Js\ x 3 x 10^8 ms^{-1}}{1.056 \times 10^{-19} J} = 1.882\ x 10^{-6} m$$

UNIT 4

Hydrogen

1. write note on water-gas shift reaction

The carbon monoxide of the water gas can be converted to carbon dioxide by mixing the gas mixture with more steam at 400^oC and passed over a shift converter containing iron/copper catalyst. This reaction is called as ***water-gas shift reaction***. $CO + H_2O \rightarrow CO_2 + H_2$

2. write any two uses of heavy water.

i) It is used as moderator in nuclear reactors.

ii) It is also used as a coolant in nuclear reactors as it absorbs the heat generated.

iii) It is commonly used as a tracer to study organic reaction mechanisms and mechanism of metabolic reactions.

3. How do you convert parahydrogen into ortho hydrogen ?

i) The para-form can be catalytically transformed into ortho-form using platinum or iron.

ii) Alternatively, it can also be converted by passing an electric discharge,

iii) heating above 800^oC and mixing with paramagnetic molecules such as O_2, NO, NO_2 or with nascent/atomic hydrogen.

4. write note on water gas reaction?

In an another process, steam is passed over a red-hot coke to produce carbon monoxide and hydrogen is also called syngas (Synthetic gas) $C + H_2O \xrightarrow{1000^oC} CO + H_2$

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5. Mention the uses of Hydrogen.

i) Atomic hydrogen and oxy-hydrogen torches are used for cutting and welding.

ii) Liquid hydrogen is used as a rocket fuel.

iii) Hydrogen is also used in fuel cells for generating electrical energy.

6. What is meant by 100 volume hydrogen peroxide?

A 30 % solution of hydrogen peroxide is marketed as '100-volume' hydrogen peroxide indicating that at S.T.P., 100 ml of oxygen is liberated by 1 ml of this solution on heating.

7. How many hydrogen bonded water molecule(s) are present in $CuSO_4.5H_2O$?

In $CuSO_4.5H_2O$, there is one hydrogen bonded water molecule which is outside the coordination sphere. The other four molecules of water are coordinated

8. H_2O_2 acts as an oxidizing agent as well as reducing agent. Why?

In H_2O_2, oxygen has -1 oxidation state which lies between maximum (0 or +2 in OF_2) and minimum -2. Therefore, oxygen can be oxidized to O_2 (zero oxidation state) acting as reducing agent or can be reduced to H_2O or OH- (-2 oxidation state) acting as an oxidizing agent.

9. What causes the temporary and permanent hardness of water?

Temporary hardness is due to presence of soluble bicarbonates of calcium and magnesium.
On the other hand, permanent hardness is due to presence of chlorides and sulphates of calcium and magnesium.

10. How heavy water is is obtained from ordinary water?

Heavy water is obtained from ordinary water by repeated electrolysis in the presence of 3% NaOH.

11. Write the chemical reactions to show the amphoteric nature of water

Water is amphoteric in nature and it behaves both as an acid as well as a base. With acids stronger than itself (eg., H_2S) it behaves as a base and with bases stronger than itself (eg. NH3) it acts as an acid.

(i) As a base: $H_2O(l) + H_2S(aq) \rightarrow H_3O^+(aq) + HS^-(aq)$

(ii) As an acid: $H_2O(l) + NH_3(aq) \rightarrow$ OH-(aq) +NH4+(aq)

12.. Why is hydrogen peroxide stored in wax-lined plastic coloured bottles?

The decomposition of H_2O_2 occurs readily in the presence of rough surface (acting as catalyst).

It is also decomposed by exposure of light. Therefore, waxlined smooth surface and coloured bottles retard the decomposition of H_2O_2.

13. Concentrated sulphuric acid cannot be used for drying H_2. Why?

Conc. H_2SO_4 on absorbing water from moist H_2 produces so much heat that H2 catches fire.

14. Why is dihydrogen gas not preferred in balloons?

Dihydrogen gas is combustible in nature. Therefore, it may react with oxygen highly violently. Thus, it is not used in balloons

15. Mention the uses of hydrogen peroxide

1) For bleaching silk, wool, hair and leather 2) As rocket fuel

16. List the uses of Deuterium

i) It is used as tracer element to study the mechanisms of organic reactions.

ii) High speed deuterium is used in Artificial radio activity

It is used in the preparation of heavy water which used as Moderators in nuclear reactor

UNIT 5

Alkali and Alkaline Earth Metals

1. Why are halides of beryllium polymeric?

The halides of Be are electron deficient as their octets are incomplete.Therefore, to complete their octets, the halides polymerize

2. Why are alkali metals not found free in nature?

Alkali metals are highly reactive and therefore, are not found free in nature, they are present in the combined state in the form of halides, oxides, silicates,nitrates, etc.

3. Mention the uses of plaster of paris

The largest use of plaster of paris is in the building industry as well as plasters.

It is used for immobilising the affected part of organ where there is a bone fracture or sprain.

It is also employed in dentistry, in ornamental work and for making casts of statues and busts.

4. Name the chief factors responsible for anomalous behaviour or lithium.

Tthe anomalous behaviour of lithium is because of its:

(i) Small size of atom and ion,

(ii) High ionization enthalpy, and

(iii) Absence of d-orbitals in its Valence shell

5.. Beryllium and magnesium do not give colour to flame whereas other alkaline earth metals do so why?

Beryllium and magnesium atoms in comparison to other alkaline earth metals are comparatively smaller and their ionisation enthalpies are very high. Hence, the energy of the flame in not sufficient to excite their electrons to higher energy levels. These elements, therefore, do not give any colour in Bunsen flame.

6. Define the term ‘desert rose’s.

Gypsum crystals are sometimes found to occur in a form that resembles the petals of a flower. This type of formation is referred to as ‘desert rose’.

7. What is Alabaster?

Alabaster is a variety of gypsum, that is highly valued as an ornamental stone. It has been used by the sculptors for centuries.Alabaster is granular and opaque

9. Alkali metals dissolve in liquid ammonia and given deep blue solution.Explain the magnetic behaviour of these solution?

The blue colour of the solution is due to the ammoniated electron whichabsorbs energy in the visible region of light and thus imparts blue colour to the solution. The solutions are paramagnetic

and on standing slowly liberate hydrogen resulting in the formation of an amide.

$$M^+ + e^- + NH_3 \rightarrow MNH_2 + \frac{1}{2} H_2$$

10. Why is Li_2CO_3 decomposed at a lower temperature whereas Na_2CO_3 at higher temperature?

Li+ ion is very small in size. It is stabilized more by smaller anions such as oxide ion rather than large anions such as carbonate. Therefore Li_2CO_3 decomposes into Li_2O on mild heating. On the other hand, Na+ ion is larger in size. It is stabilized more by carbonate ion than oxide ion. Hence, Na_2CO_3 does not undergo thermal decomposition easily.

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11. In what ways lithium shows similarities to magnesium in its chemical behaviour?

Li resembles Mg mainly due to similarity in sizes of their atoms and ions.

The main points of similarity are:

Both are quite hard.

1 Both LiOH and $Mg(OH)_2$ are weak bases.

2 Carbonates of both on heating decompose to produce oxides and carbondioxide.

3 Both react with nitrogen to give ionic nitrides.

12. Which elements of alkaline earth metals family do not give characteristic flame colouration?

Be and Mg

13. Explain Biological importance of Na and K

i) Sodium ions participate in the transmission of nerve signals.

ii) Sodium ions also regulate flow of water across the cell membranes and in

transport of sugars and amino acids into the cells.

iii) Potassium ions are the most abundant cations within cell fluids, where they activate many enzymes, participate in oxidation of glucose to produce ATP.

iv) Potassium ions in combination with sodium ions are responsible for transmission of nerve signals.

v) The functional features of nerve cells depend upon the sodium potassium ion gradient that is estab lished in the cell

14. Why are alkali metals soft and have low melting points?

Alkali metals have only one valence electron per metal atom. As a result, the binding energy of alkali metal ions in the close-packed metal lattices are weak. Therefore, these are soft and have low melting point.

UNIT 6

Gaseous State

1. What are the 4 measurable characteristics of a gas?

Measurable Properties of Gases

(1) The characteristics of gases are described fully in terms of four parameters or measurable properties:

(i) The volume, V, of the gas. (ii) Its pressure, P.

(iii) Its temperature, T. (iv) The amount of the gas (i.e., mass or number of moles).

2. Define Compressibility factor Z.

The deviation of real gases from ideal behaviour is measured in terms of a ratio of PV to nRT. This is termed as compressibility factor. Mathematically,

$$Z = \frac{PV}{nRT}$$

3. What is Boyle temperature or Boyle point?

The temperature at which a real gas obeys ideal gas law over an appreciable range of pressure is called Boyle temperature or Boyle point.

4. Why do astronauts have to wear protective suits when they are on the surface of moon?

Astronauts have to wear protective suits on space because there is no air to breathe there or no oxygen for them to breathe. The outer space is also cold especially on the moon because it has no atmosphere.

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5. When ammonia combines with HCl, NH_4Cl is formed as white dense fumes. Why do more fumes appear near HCl?

This reaction is used for the test of detection of HCl and NH_3. During that Reaction, NH_3 gas combines with the acidic gas HCl which in results form the salt called as Ammonium chloride which is appeared as dense fumes.

6. Of two samples of nitrogen gas, sample A contains 1.5 moles of nitrogen in a vessel of volume of 37.6 dm3 at 298K, and the sample B is in a vessel of volume 16.5 dm3 at 298K.Calculate the num ber of moles in sample B.

$n_A = 1.5$ mol $\quad n_B = ?$

$V_A = 37.6\ dm^3 \quad V_B = 16.5\ dm^3$

(T = 298 K constant)

$$\frac{V_A}{n_A} = \frac{V_B}{n_B}$$

$$n_A = \left(\frac{n_A}{V_A}\right) V_B$$

$$= \frac{1.5\ mol}{37.6\ dm^3} \times 16.5\ dm^3$$

$$= 0.66\ mol$$

7. Sulphur hexafluoride is a colourless, odourless gas; calculate the pressure exerted by 1.82 moles of the gas in a steel vessel of volume 5.43 dm^3 at 69.5 °C, assuming ideal gas behaviour.

n = 1.82 mole

$V = 5.43\ dm^3$

T = 69.5 + 273 = 342.5

P = ?

$$PV = nRT$$

$$P = \frac{nRT}{V}$$

$$P = \frac{1.82\ mol \times 0.821\ dm^3\ atm\ mol^{-1}\ K^{-1} \times 342.5\ K}{5.43\ dm^3}$$

$$P = 94.25\ atm$$

8. Argon is an inert gas used in light bulbs to retard the vaporization of the tungsten filament. A certain light bulb containing argon at 1.2 atm and 18°C is heated to 85°C at constant volume. Calculate its final pressure in atm.

$P_1 = 1.2$ atm

$T_1 = 18^0\ C + 273 = 291\ K$

$T_2 = 85^0\ C + 273 = 358\ K$

$P_2 = ?$

$$\frac{P_1}{T_1} = \frac{P_2}{T_2}$$

$$P_2 = \left(\frac{P_1}{T_1}\right) \times T_2$$

$$= \frac{1.2\ atm}{291\ K} \times 358\ K$$

$$P_2 = 1.48\ atm$$

9. A combustible gas is stored in a metal tank at a pressure of 2.98 atm at 25°C. The tank can with stand a maximum pressure of 12 atm after which it will explode. The building in which the tank has been stored catches fire. Now predict whether the tank will blow up first or start melting? (Melting point of the metal = 1100 K).

$$T_1 = 298\ K; P_1 = 2.98\ atom; T_2 = 1100\ K; P_2 = ?$$

$$\frac{P_1}{T_1} = \frac{P_2}{T_2} \Rightarrow P_2 = \frac{P_1}{T_1} \times T_2$$

$$= \frac{2.98\ atm}{298\ K} \times 1100\ K = 11\ atm$$

At 1100 K the pressure of the gas inside the tank will become 11 atm. Given that tank can withstand a maximum pressure of 12 atm, the tank will start melting first.

10. Define Grahams Law of Diffusion.

The rate of diffusion or effusion is inversely proportional to the square root of molar mass.

11. Gases don't settle at the bottom of a container.

Gases are less denser and have negligible intermolecular force of attraction. They move freely here and there and moreover elastic collision occurs in them due to which energy is conserved. As there is now loss of energy they dont settle down.

12. **Gases diffuse through all the space available to them.**

This means that gases always spread out in all directions to fill the container into which they are placed. This spreading out of gases to fill all the available space is called diffusion. They can be compressed easily. This means that a given volume of gas can be squeezed into a smaller volume.

13. State Boyle's

At a given temperature the volume occupied by a fixed mass of a gas is inversely proportional to its pressure.

$$P \propto \frac{1}{V} \qquad PV = k\ (\text{constant})$$

14. Define John Dalton law

Stated that "the total pressure of a mixture of non-reacting gases is the sum of partial pressures of the gases present in the mixture"

15. Derive ideal gas Ideal gas equation.

Boyle's law $P \propto \frac{1}{V}$

Charles law $V \propto T$

Avogadro fs law $V \propto n$

Combined all gas laws $V \propto \frac{nT}{P}$

$$V = R\frac{nT}{P}$$

PV = nRT (ideal gas equation)

R - universal gas constant

16. For real gases the relation between p, V and T is given by van der Waals equation

$$\left(P + \frac{an^2}{V^2}\right)(V - nb) = nRT$$

The constants *a* and *b* are van der Waals constants and their values vary with the nature of the gas.

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17. Define Joule-Thomson effect.

This phenomenon of lowering of temperature when a gas is made to expand adiabatically from a region of high pressure into a region of low pressure is known as Joule-Thomson effect.

18. What are ideal gases? In what way real gases differ from ideal gases.

i) Real gases have small attractive and repulsive forces between particles and ideal gases do not.

ii) Real gas particles have a volume and ideal gas particles do not.

iii) Real gas particles collide in-elastically (loses energy with collisions) and ideal gas particles collide elastically.

19. Can a Van der Waals gas with a = 0 be liquefied? explain.

i) If the van der Waals constant (a) = 0 for a gas, then it behaves ideally i.e there are no intermolecular forces of attraction. So, it cannot be liquified.

ii) So, it cannot be liquified. If a = 0, then the product of Pc and $27b^2 = 0$ which means that either Pc = 0 or b = 0 which is not possible. Therefore, the gas cannot be liquefied.

20. Suggest why there is no hydrogen (H_2) in our atmosphere. Why does the moon have no atmosphere?

A large planet such as Jupiter has enough gravity to hold on to most of its hydrogen and helium, which is why these elements dominate the atmospheres of gas giants. But the gravity of Earth isn't strong enough, so Earth's early atmosphere of helium and free hydrogen evaporated into space.

21. Aerosol cans carry clear warning of heating of the can. Why?

Aerosol cans carry a clear warning of heating of the can because on heating the kinetic energy of particles increases and after collision with wall they create high pressure that can leads to explosion.

22. Why do astronauts have to wear protective suits when they are on the surface of moon?

Spacesuits are specially designed to protect astronauts from the cold, radiation and low pressure in space. They also provide air to breathe. Wearing a spacesuit allows an astronaut to survive and work in space

23. **Would it be easier to drink water with a straw on the top of Mount Everest?**

i) I believe it would be almost impossible to drink water from a straw at the top of Mount Everest.

ii) The water would freeze and become ice at that height of more than 8000 meters above sea level.

iii)Temperature are less than 0 degrees at that height.

iv) Higher the altitude, lesser the atmospheric pressure and lower the temperature.

UNIT 7

Thermodynamics

1. Define Zeroth law of thermodynamics .

When two systems are separately in equilibrium with a third system, they are in equilibrium with each other.

2. State First law of thermodynamics

“Energy can neither be created nor destroyed, but may be converted from one form to another”.

$$\Delta U = q + w$$

3. Define various statement ofSecond law of thermodynamics

Entropy statement:

Entropy is a measure of the molecular disorder (randomness) of a system.

It is defined as, $dS = dq_{rev} / T$

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Kelvin-Planck statement:

It is impossible to construct a machine that absorbs heat from a hot source and converts it completely into work by a cyclic process without transferring a part of heat to a cold sink.

Clausius statement:

It is impossible to transfer heat from a cold reservoir to a hot reservoir without doing some work

4. State the first law of thermodynamics.

states that the entropy of pure crystalline substance at absolute zero is zero.

$$\lim_{T \to 0} S = 0$$ for a perfectly ordered crystalline state.

5. Define Gibbs Free Energy (G)

G is expressed as G = H - TS, H - enthalpy , S- entropy, T - temperature in kelvin

free energy change of a process is given by the relation is **$\Delta G = \Delta H - T\Delta S$.**

6. State Hess's law .

'It states that the enthalpy change of a reaction either at constant volume or constant pressure is the same whether it takes place in a single or multiple steps.

7. Predict the feasibility of a reaction when

i) both ΔH and ΔS positive $\Rightarrow$ Non-feasible

ii) both ΔH and ΔS negative $\Rightarrow$ Non-feasible

iii) ΔH decreases but ΔS increases $\Rightarrow$ feasible

8. Define enthalpy of combustion.

change in enthalpy of a system when one mole of the substance is completely burnt in excess of air or oxygen. It is denoted by ΔH_C.

9. What is lattice energy?

Lattice energy is defined as the amount of energy required to completely remove the constituent ions from its crystal lattice to an infinite distance.

10. The equilibrium constant of a reaction is 10, what will be the sign of ΔG? Will this reaction be spontaneous?

From the expression, $\Delta G^0 = -2.303\ RT\log K_{eq}$ ΔG^0 for the reaction,

$\Delta G^0 = (2.303)\ (8.314\ JK\text{-}1mol^{-1})\ (300\ K)\ \log 10$

$\Delta G^0 = -5744.14\ Jmol^{-1}$

$\Delta G^0 = -5.744\ kJ\ mol^{-1}$ **When ΔG^0 negative the process is spontaneous**

11. Define enthalpy of neutralization

'The change in enthalpy when one gram equivalent of an acid is completely neutralised by one gram equivalent of a base or vice versa in dilute solution.

12. Calculate the work done when 2 moles of an ideal gas expands reversibly and isothermally from a volume of 500 ml to a volume of 2 L at 25°C and normal pressure.

n = 2 moles	V_i = 500 ml = 0.5 lit
V_f = 2 lit	T = 25^{0}C = 298 K

$$w = -2.303\ nRT\log\left(\frac{V_i}{V_f}\right)$$

$$w = -2.303 \times 2 \times 8.314 \times 298 \times \log\left(\frac{2}{0.5}\right)$$

$w = -2.303 \times 2 \times 8.314 \times 298 \times \log(4)$

$w = .2.303 \times 2 \times 8.314 \times 298 \times 0.6021$

$w = -6871\ J$

$w = -6.871\ kJ$

13. Define molar heat capacity(*cm*).

It is defined as 'The amount of heat absorbed by one mole of the substance to raise its temperature by 1 kelvin'.

14. Derive the relation between ΔH and ΔU for an ideal gas. Explain each term involved in the equation.

$H = U + PV$

In the initial state : $H_1 = U_1 + PV_1$ 1

In the final state: $H_2 = U_2 + PV_2$............ .2

change in enthalpy is 2 and 1

$(H_2 - H_1) = (U_2 - U_1) + P(V_2 - V_1)$

$\Delta H = \Delta U + P\Delta V$ 3

As per first law of thermodynamics,

.

$\Delta U = q + w$

$\Delta H = q + w + P\Delta V$

$w = - P\Delta V$

$H = q_p - P\Delta V + P\Delta V$

$H = q_p$

q_p- is the heat absorbed at constant pressure and is considered as heat content

For reactants (initial state) : $PV_i = n_i RT$ ———— 4

For products (final state) : $PV_f = n_f RT$ ———— 5

combine equation 5 and 4 $P(V_f - V_i) = (n_f - n_i) RT$

$P\Delta V = \Delta n(g) RT$ 5

Substituting in 6 in 3 **$\Delta H = \Delta U + \Delta n_{(g)}.RT$ 7**

15. List the characteristics of internal energy.

1. It is an extensive property.
2. It is a state function
3. Change in internal energy is . $U = U_f - U_i$
4. In cyclic process , $U = 0$.
5. $U = U_f - U_i = -ve\ (U_f < U_i)$
6. $U = U_f - U_i = +ve\ (U_f > U_i)$.

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16. List the application of the bomb calorimeter.

It is used to determine the amount of heat released in a combustion reaction

It is used to determine the calorific value of food

It is used in food processing and explosive testing industries.

17. Define the calorific value of food. What is the unit of calorific value?

The amount of heat produced when one gram of a substance is completely burnt, is called as Calorific value of food. Its unit = $J\ kg^{-1}$

18 List the characteristics of Gibbs free energy.

1) Free energy is defined as G = (H-TS) 'G' is a state function.
2) G-Extensive property. ΔG- become intensive property , when the system is closed.
3) G has a single value for the thermodynamic state of the system.
4) $\Delta G < 0$ - spontaneous ,
   $\Delta G = 0$ – equilibrium,
   $\Delta G > 0$ - non- spontaneous
5) $\Delta G = \Delta H - T\Delta S$.
   $\Delta H = \Delta E + P\Delta V$ and $\Delta E = q - w$. But $T\Delta S = q$
   $\Delta G = q - w + P\Delta V - q$.
   network. $\Delta G = - w + P\Delta V$

19. What are spontaneous reactions? What are the conditions for the spontaneity of a process?

A reaction that occurs under the given set of conditions without any external driving force is called a spontaneous reactions.

conditions for the spontaneity of a process

i) If the enthalpy change of a process is negative, then the process is exothermic and may be spontaneous.(ΔH is negative)

ii) If the entropy change of a process is positive, then the process may occur spontaneously. (ΔS is positive)

iii) The gibbs free energy which is the combination of the above two ($\Delta H - T\Delta S$) should be negative for a reaction to occur spontaneously, i.e. the necessary condition for a reaction to be spontaneous is $\Delta H - T\Delta S < 0$

20. Relationship between standard free energy change (ΔG^o) and equilibrium constant (K_{eq}):

Lets consider a general equilibrium reaction

$$A + B \rightleftharpoons C + D$$

$$\Delta G = \Delta G^o + RT \ln Q$$

Q is reaction quotient

$$\Delta G^o = - RT \ln K_{eq}$$

This equation is known as Vanft Hoff equation.

$$\Delta G^o = .2.303\ RT \log K_{eq}$$

We also know that

$$\Delta G^o = \Delta G^o - T\Delta S^o = - RT \ln K_{eq}$$

21. Relation between Cp and Cv for an ideal gas:

From the definition of enthalpy H = U + PV ....(1)

for 1 mole of an ideal gas PV = nRT ....(2)

By substituting (1) in (2) H = U + nRT .... (3)

Differentiating the above equation with respect to T

$$\frac{\partial H}{\partial T} = \frac{\partial U}{\partial T} + nR\frac{\partial T}{\partial T} \qquad \text{ie. } C_p = \left(\frac{\partial H}{\partial T}\right)_p \qquad C_v = \left(\frac{\partial U}{\partial T}\right)_v$$

$C_p = C_v + nR$ (1)

$C_p - C_v = nR$ .....(4)

22. Calculation of ΔU and ΔH

For one mole of an ideal gas, we have

$$C_V = \frac{dU}{dT}$$

$dU = C_V.dT$

For a finite change, we have

$dU = C_v.\Delta T$

$dU = C_v\ (T_2 - T_1)$

and for n moles of an ideal gas we get

$dU = nC_v\ (T_2 - T_1)$

Similarly for n moles of an ideal gas we get

$dH = nC_p\ (T_2 - T_1)$

23.Write any three applications of bomb calorimeter

1. Bomb calorimeter is used to determine the amount of heat released in combustion reaction.
2. It is used to determine the calorific value of food.
3. Bomb calorimeter is used in many industries such as metabolic study, food processing, explosive testing etc.

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