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CHM 101 INTRODUCTORY INORGANIC CHEMISTRY SUMMARY

_____, from the very beginning have attempted to systematize the knowledge they gain through their observations and experiments.
Scientists

Scientists, from the very beginning have attempted to systematize the knowledge they gain through their _____ and experiments.
Observations

Scientists, from the very beginning have attempted to systematize the knowledge they gain through their observations and_____.
Experiments

By the mid_____ century more than 60 elements were known
19th

By the mid-19th century, more than _____ elements were already discovered **60**

The elements are divided into _____ and non metals
Metals

The elements are divided into _____and _____
Metals and **non metals**

Metallic elements have the following properties which include

- lustrous
- malleability
- ductility
- conduct heat and electricity
- metallic elements form basic oxides

Non-metallic elements have no characteristic appearance.
True

The following are the properties of non-metals

- They are brittle that is they break easily.
- They are poor conductors of electricity and heat. They form acidic oxides.

Those elements that possess properties intermediate between metals and non-metals are called_____ **metalloids**

In_____, J W Dobereiner observed that there exist certain groups of three elements called TRIADS
1829

In 1829, J W Dobereiner observed certain groups of three elements called _____
TRIADS

J W Dobereiner also observed that elements in triad not only had similar properties, but also the atomic weight of the middle element was approximately an average of the atomic weights of the other two elements of the triad.

A few examples cited by him were: Li, Na, K, Ca, Sr, Ba, S, Se, Te and Cl. Br, I Although, Doberieiner's relationship seems to work only for a few elements, He was the first to point out a systematic relationship among the elements.

In_____, A. de Chanourtois arranged the elements in order of increasing atomic weight on a line which spiralled around a cylinder from bottom to top.
1862

_____ arranged the elements in order of increasing atomic weight on a line which spiralled around a cylinder from bottom to top.
A. de Chanourtois

In_____, John Newlands, an English Chemist reported his "Law of Octaves".
1864

_____, an English Chemist reported his "Law of Octaves".
John Newlands

_____ reported his "Law of Octaves"
John Newlands

John Newlands is an English _____
Chemist

He suggested that if the elements were arranged in order of increasing atomic weight, every eighth element would have properties similar to the first element. For example, he arranged the elements in the following manner.

Table 1.1: Arrangement of Elements according to John Newlands

Element	Li	Be	B	C	N	O	F
At Wt	7	9	11	12	14	16	19
Element	Na	Mg	Al	Si	P	S	Cl
At Wt	23	24	27	29	31	32	35.5
Element	K	Ca	Ti	Cr			
At Wt	39	40	48	32			

J. Newlands _____ was rejected for two reasons.

Law of octaves

Newlands "Law of octaves" was rejected for _____ reasons.
Two

Newlands "Law of octaves" was rejected for two reasons. Firstly, it did not hold good for elements heavier than Ca. Secondly, he believed that there existed some mystical connection between music and chemistry.

Which of these scientists played key role in the development of the periodic law? **Lothar Meyer and Dmitri Mendeleev**

In_____, Lothar Meyer reported that when physical properties like atomic volume, boiling point
1869

_____ obtained semi curve by plotting atomic volume versus atomic weight **Lothar Meyer**

The atomic volume behaviour is periodic.
True

The atomic volume behaviour is _____
Periodic

It goes through circles, dropping from a sharp maximum to a minimum and then sharply rising again. Each of the cycles is called a period. The location of element on the peak or in the troughs has an important correlation with their chemical reactivity.

The elements of the peaks (example alkali metals) are the most reactive. Those in the troughs (example noble metals) are characteristically less reactive.

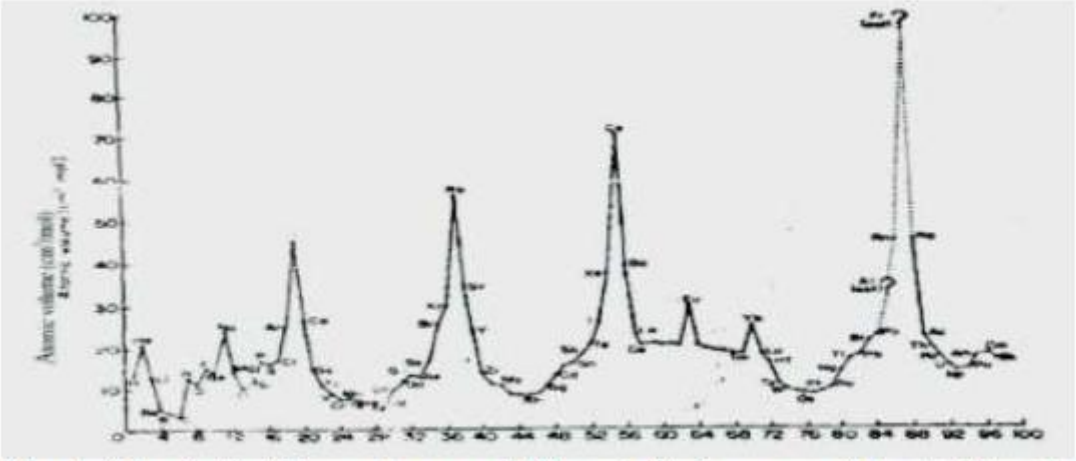


Fig. 1.1 Periodic Dependence of Atomic Volume on Atomic Number

_____ used chemical properties like valence and formulae of hydrides, chloride, and oxides of the elements to illustrate the periodic law.
Mendeleev

According to _____ periodic law, if the elements are arranged sequentially in the order of increasing atomic weight, a periodic repetition that is periodicity in properties is observed.
Mendeleev's

According to Mendeleev's periodic law, if the elements are arranged sequentially in the order of_____ a periodic repetition that is periodicity in properties is observed.
increasing atomic weight

According to Mendeleev's _____law, if the elements are arranged sequentially in the order of increasing atomic weight a periodic repetition that is periodicity in properties is observed.
Periodic

_____ arranged elements in horizontal rows and vertical columns in order of increasing atomic weight
Mendeleev

The validity of Mendeleev periodic law was dramatically and conclusively proven by the _____ of three out of the more than ten elements predicted by Mendeleev. **Discovery**

Lecoq de Boisbaudran called the element gallium and said its density was 4.7x103

_____ discovered that Mendeleev was right that the density of gallium was 5.8 x103 kg
Lecoq de Biosbaudran

Who discovered scandium?
Lars Fredrick Nilson

The element germanium was discovered by who?
Winkler

_____ discovered that the properties of any element are an average of the properties of its neighbours in the periodic table.
Mendeleev

Mendeleev arranged elements in order of _____ atomic
Increasing

The periodic table of today has many similarities with that formed by Mendeleev **True**

Between_____, Mendeleev improves the arrangement of elements in his periodic table.
1869 -1907

The concept of atomic number was discovered by _____
Henry Moseley

The concept of atomic number in _____
1913

Mendeleev's Periodic Law states that: "the properties of elements are periodic functions of their atomic numbers".

The arrangement of the elements in order of their increasing atomic number removes most of the anomalies of Mendeleev's periodic table.

The arrangement of the elements in order of their increasing atomic number removes most of the _____ of Mendeleev's periodic table.
Anomalies

_____ of an element have the same atomic number
Isotopes

Today, _____ elements (from 1 to 109) have been discovered
109

In the Mendeleev periodic table, elements are arranged in _____ horizontal rows and eight vertical columns.
Seven

In the modern form of Mendeleev periodic table, elements are arranged in seven horizontal rows and _____ vertical columns.
Eight

NB: Normal and transition elements belonging to A and B subgroup of a group were placed in one and the same column of the table.

IUPAC is an acronym for_____
International Union of Pure and Applied Chemistry

American and Soviet scientists claimed credit for discovering element_____. **104**

American and _____ claimed credit for discovering element 104 **Soviet scientists**

The Americans named it _____ and the Soviet scientist named it Kurchotovium.
Rutherfordium

The Americans named it rutherfordium and the Soviet scientist named it_____.
Kurchotovium

Table 2.1: Numerical Root for Atomic Number of Element

0	1	2	3	4	5	6	7	8	9
nil	un	bi	tri	quad	pent	hex	Sept	oct	enn

Table 2.2: The Systematic Names and Symbols of Elements having Z = 101 to 106 Derived by Application of IUPAC Nomenclature *Rules*

Atomic Number	Systematic Names	Symbol	Trivial Name
101	Unnilunium	Unu	Mendelevium
102	Unnilbium	Unb	Nobelium
103	Unniltrium	Unt	Lawrencium
104	Unnilquadium	Unq	-
105	Unnilpentium	Unp	-
106	Unnilhexium	Unh	-

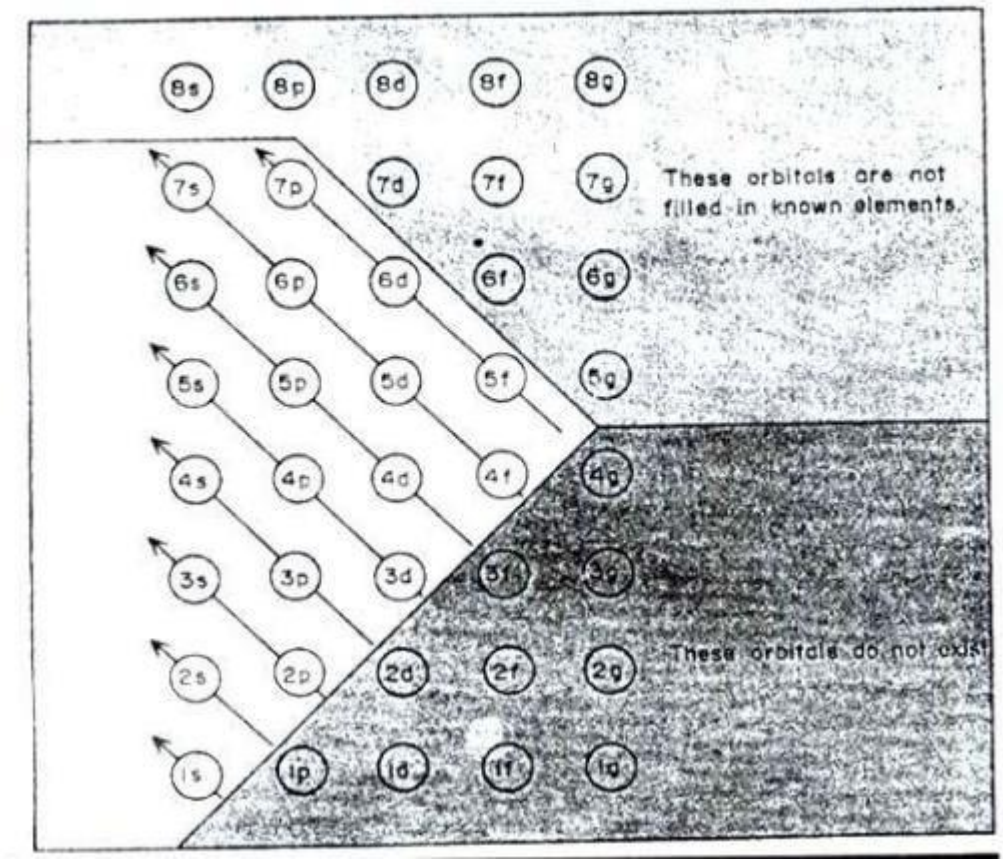
The _____ gave rise to the periodic arrangement of the element according to their atomic numbers **periodic law**

The periodic law gives rise to the periodic arrangement of the element according to their _____ **atomic numbers**

The electronic configuration of atoms can be predicted with the help of Aufbau or the building up process.

The electronic configuration of the atom in the ground state is then derived by adding electrons one at a time to the orbitals of the lowest energy in the sequence shown by arrows in Table 3.1.

Table 3.1: Order or Filling of Atomic Orbitals in Polyelectronic Atoms



Filling of electrons in orbitals is also governed by Pauli's Exclusion Principle and Hund's rule.

According to _____Principle, no two electrons in the same atom can have the same value of n, 1 and mi

Pauli Exclusion

_____states that, as far as possible in a given atom in the ground state, electrons in the same sub shell will occupy different orbitals and will have parallel spins. **Hund's rule**

Carbon in the ground state has the configuration 1S2 2S2 2Px1 2Py1 rather than 1S2 2S2 2Px2 .

Which period is the smallest of all the periods of the table?

Period 1

Hydrogen (Z = 1) and helium (Z = 2) are the two elements belonging to the period. The electronic configuration of hydrogen and helium are 1s1 and 1s2

Period 2contain elements from lithium (Z = 3) to neon (Z F 10).

_____has the electronic configuration of [He] 2S2 2P6
Neon

There are _____ period in the Periodic table
Seven

Elements of the periodic table have been divided into four blocks s, p, d and f

The elements of the periodic table have been divided into _____blocks **Four**

Alkali and alkaline earth metals of groups (1A) and 2(11A) belong to the_____ **s-block**

The d-Block elements are also called_____ **transition elements**

The f-block elements are collectively referred to as _____ elements **Inner-transition**

Elements of 4f series which follow lanthanium in the periodic table are known as _____
Lanthanides

Elements of 5f series following actinium are called_____.
Actinides

f-block elements are also known as _____elements.
inner transition

The Pauli Exclusion principles which states that no two electrons in the same atom can have the same value of all four quantum numbers

The Hund's rule which states that as far as possible in a given atom in the ground state, electrons in the same sub shell will occupy different orbitals and will have parallel spins

The n+1 rule, which states that in building up electronic configuration of the elements the sub shell with the lowest value of n =1 fills first
The Aufbau principle which assumes that there exist a set of empty hydrogen like orbitals into which electrons can be added

_____ are the measure of the size of the atom.
Atomic radii

_____ can be defined as one half of the distance between the nuclei of two like atoms bonded together by a single covalent bond.
Covalent radius

The bonding which exists within a non metal molecule is largely _____ **Covalent**

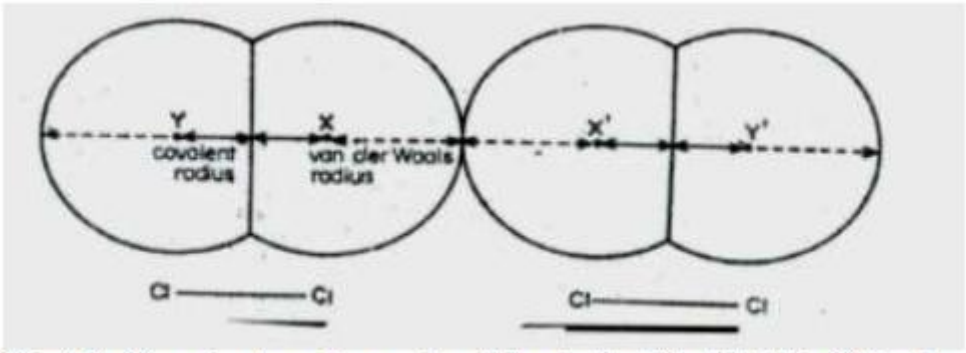


Fig 4.1 Covalent and van der Waals Radii of Solid Chlorine

_____ is defined as one-half of the distance between the nuclei of two adjacent metal atoms in the close packed crystal lattice.
Metallic radius

The types of metal lattices include the following

- Hexagonal
- Cubic close packed
- Body-centred cubic

The number of nearest neighbours of a metal atom in a lattice is known as the _____of the metal.

coordination number

Metallic radii are generally larger than the corresponding covalent radii. **True**

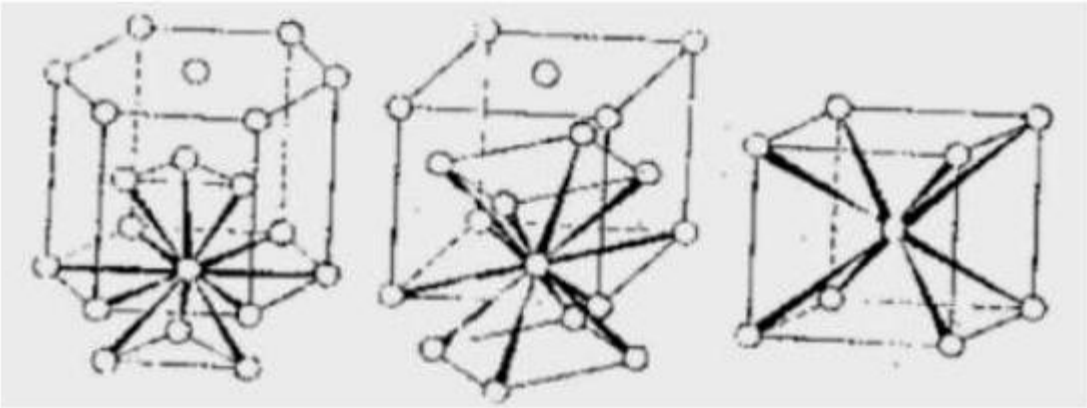


Fig. 4.2 Types of Metal Lattices: (a) Hexagonal;(b) Cubic close packed (c) Body-centred cubic

Metallic crystal lattices are stronger than the van der Waals forces.
True

_____ is defined as the distance between the nucleus of an ion and the point up to which the nucleus has influence on the electron cloud.
Ionic radius

_____ be defined as the distance of the closest approach from the centre of ion by anther ion.
Ionic radius

Ionic radii are of two types, cation radii and anion radii.

There are _____ types of ionic radii
Two

Factors affecting the atomic radii are Principal Quantum Number and Effective Nuclear Charge

_____ is the amount of positive charge felt by the outer electrons in an atom. **Effective nuclear charge Z***

The energy required to remove the least strongly bond electron from an isolated gaseous atom in its ground state is known as the_____.
ionisation energy

This process can be represented by the following equation:



the factors that affect ionisation energies Periodicity
in Ionisation Energy across Periods
Trends in Ionisation Energy down the Groups
Trends in Successive Ionisation Energies

_____ of an atom is a measure of its ability to accept an electron to form an anion.
Electron affinity

_____ is defined as the energy released or absorbed when an electron is added to the gaseous atom in its ground state.
Electron affinity

It can be represented by the following equation in which EA represents electron affinity of X.



Factors affecting electron affinities are

- Atomic Radius
- Effective Nuclear Charge
- Electronic Configuration

Mulliken defined electronegativity as the mean value of first ionisation energy and first electron affinity.

According to Alfred Rochow, electronegativity is equated to the force of attraction between an atom and the electron separated by a distance equal to the covalent radius of the atom.

_____ is a measure of the attraction that an atom has for electrons in a bond it has formed with another atom.

Electronegativity

Atoms of an element which have the same atomic number but different mass number are called _____

Isotopes

Hydrogen has _____ different isotopes

Three

Hydrogen has three different isotopes having mass numbers 1, 2, and 3 called ordinary hydrogen or Protium 1H, deuterium (D) or 2H and Tritium (T) or 3H

Ordinary hydrogen has no neutrons, deuterium has one and tritium has two neutrons in the nucleus

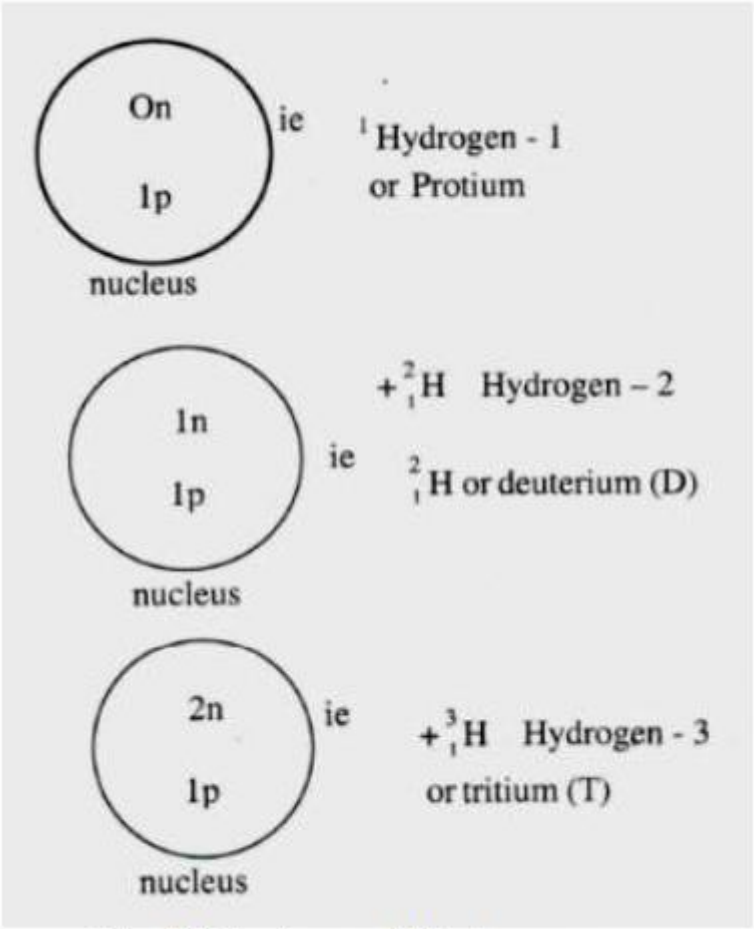


Fig. 3.1 Isotopes of Hydrogen

Deuterium is also called_____.

heavy hydrogen

Naturally occurring hydrogen contains _____% deuterium.

0.0156

_____ is used as a moderator in nuclear reactions

Deuterium oxide

Naturally occurring hydrogen contains nearly _____ % tritium.

10-15

Ortho and _____ are two different forms of hydrogen molecule.

Para

_____ and Para are two different forms of hydrogen molecule.
Ortho

_____ is an equilibrium mixture of Ortho and Para hydrogen.
Hydrogen gas

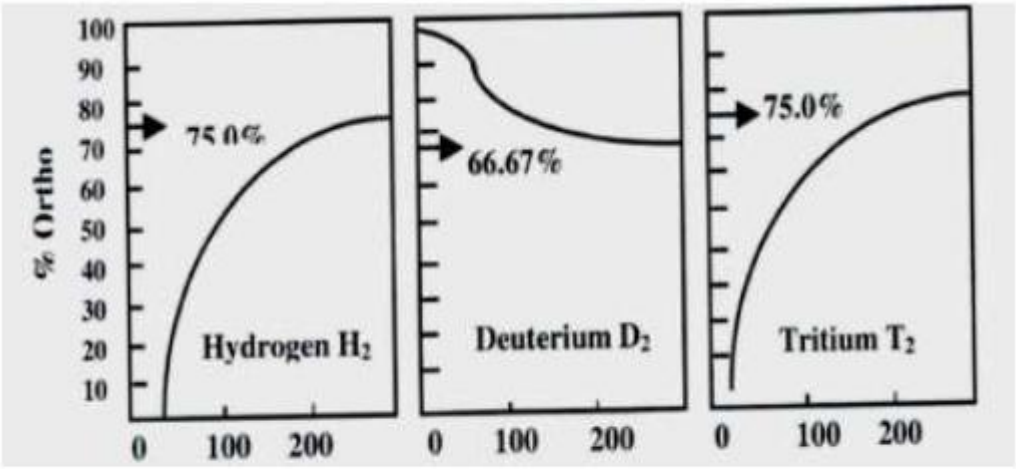


Fig. 3.3 Ortho-Para Equillibria for H_2, D_2 and T_2

Para hydrogen is more stable at lower temperatures.
True

Physical properties Ortho and Para hydrogen are similar.
True

_____ is a natural abundant source for the manufacture of hydrogen.
Water

Water can be reduced to hydrogen either chemically or_____. **Electrically**

The mixture of CO and H2 is known as _____
Water gas

The mixture of CO and H2, known as water gas is also called _____ **Synthesis gas**

The properties of Hydrogen are the following

- Hydrogen is the lightest element known.
- It is colourless
- Odourless and tasteless gas.
- The hydrogen molecule is thermally stable
- Atomic hydrogen is a powerful reducing agent
- It combines with alkali metals to form hydrides
- It reduces sulphur to hydrogen sulphide

The lightest known element is _____
Hydrogen

The uses of hydrogen include the following

- The largest single use of hydrogen is in the syntheses of ammonia
- Hydrogen is used in the hydrogenation of vegetable of oils and the manufacture of methanol.
- Hydrogen gas is used in fuel cells in space crafts

In a fuel cell, electrical energy is generated by the reaction of hydrogen leaf in a process called_____
Cold combustion

_____ hydrogen is used as a rocket fuel
Liquid

Decomposition of water by solar energy in presence of catalysis is known as photochemical decomposition of water.

The three classes of hydrides

- Ionic or salt like or salric hydrides
- Covalent or molecule hydrides
- Metallic or non-stoichiometric hydrides

Ionic hydrides are formed by heating metals in hydrogen at _____ K.
973

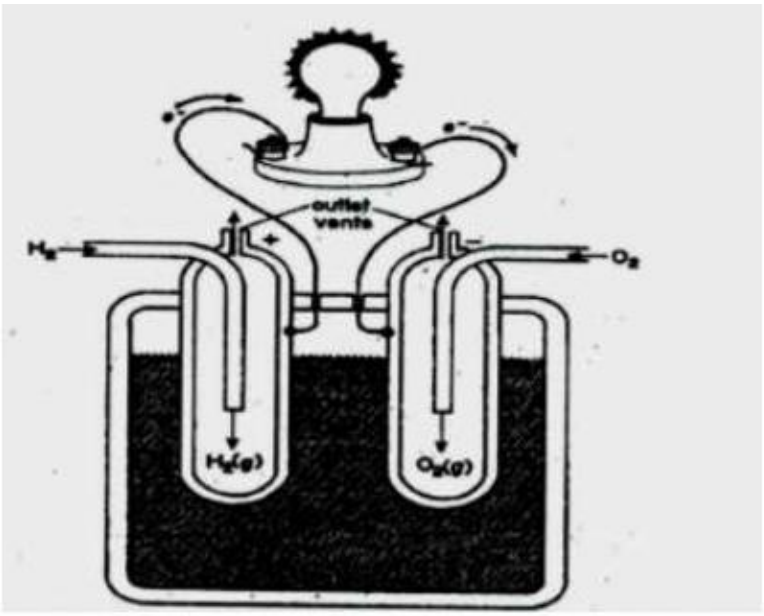


Fig. 4.2 A Hydrogen-Oxygen Fuel Cell with KOH Electrolyte and Porous Carbon Electrodes

When heated, hydrogen reacts with many transition metals (lantharindes and actinides) to form_____.

metallic hydrides

_____ can be defined as the attractive force which binds hydrogen atom of one molecule with electronegative atom of another molecule

Hydrogen bond

There are _____ types of hydrogen bonding.

Two

The two types of hydrogen bonding are Intermolecular hydrogen bonding and Intra-molecular hydrogen bonding

The elements of Group 1 and 2 are called the S-block elements

Group 1 elements consist of Li, Na, K, Rb, C and Fr are called _____ **Alkali Metals**

_____ is the most abundant metal in sea water

Sodium chloride

_____ is obtained by the reduction of its chloride with sodium vapour.

Potassium

_____ is used in liquid detergents.

Potassium hydroxide

_____ is used in breathing apparatus

Potassium superoxide

_____ is used along with charcoal and sulphur in gun powder. **Potassium nitrate**

Potassium is a major component of plant fertilizers, where it is used in form of chloride and nitrate salts.

_____ can be defined as mass per unit volume.

Density

_____ is the most abundant metallic element in sea water

Sodium

Lepidolite is an ore of _____

Lithium

Ionisation energy increases from lithium to _____ **francium**

Lithium is the highest of all the metallic elements

Ionic character of alkali metal halides _____ down the group.

Decreases

Solubility of alkali metal fluorides in water _____ down the group **Increases**

Melting and boiling points of alkali metals _____ down the slope.

Decrease

Alkali metals reacts with sulphur to form two types of sulphides; simple sulphides of Na2S and polysulphides like Na2S, where n — 2, 3, 4, or 6.

Lithium reacts with carbon to form _____ **ionic carbides**

The alkali salt's stability is dependent upon the_____.
enthalpy of formation

When a metal is surrounded by solvent molecules, the phenomenon is called _____of the metal ion.
Solvation

When the solvent is water the phenomenon is now called_____.
Hydration

_____ is solvation with water as the solvent.
Hydration

All the alkali metals are highly soluble in liquid ammonia giving a _____ colour.
deep blue

Electrons associated with the solvent are known as_____.
Solvated Electrons

A complex compound can be defined as a compound with a central atom or ion surrounded by a group of ions of molecules called _____
Ligands

Lithium carbonate decomposes at _____ K
950

Decomposition of sodium carbonate takes place below _____K.
1050

_____ is the second most abundant metallic element next only sodium (chloride) in sea water.
Magnesium

_____ is found in the bones of animals and human beings.
Calcium

_____ is extremely scarce (10 -10 %) and it is a radioactive element.
Radium

_____ is found in the green (chlorophyll) plants.
Magnesium

Magnesium is found in the green (chlorophyll) plants.

Beryllium is obtained by the electrolysis of molten_____ **beryllium chloride**.

_____ is extracted from fused calcium chloride using a graphite anode and iron cathode.
Calcium

Calcium is extracted from fused calcium chloride using a graphite anode and_____.
iron cathode

Beryllium is used for making atomic fuel containers because _____ it absorbs very few neutrons and does not become radioactive.

The first ionisation energy of alkaline earth metals is more than that of corresponding alkali metals.
True

The ionization energy of alkaline earth metals _____ on moving down the group.
Decreases

Electropositive character and the reducing property (tendency to lose elections) _____on moving down the group
Increase

Hydration and lattice energies decrease with increase in size of metal ions.

Barium peroxide, BaO_2 is formed by passing air over heated BaO, at 800K.

Magnesium peroxide, MgO_2 is obtained only in the crude form by using hydrogen peroxide but no peroxide of beryllium is known.

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