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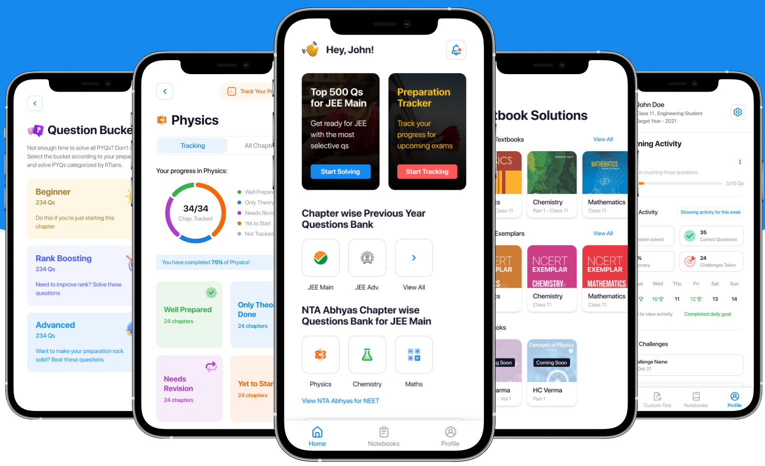

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Periodic Properties

PROUT'S HYPOTHESIS

Hydrogen is the fundamental substance to produce atoms of all elements, because the atomic weights of all elements are simple multiple of atomic weight of hydrogen.

DOBEREINER'S TRIADS

According to Dobereiner when elements of same properties are kept in the increasing order of atomic weights, the atomic weight of middle element is equal to the mean atomic weight of remaining two elements. Such a group of elements is called Dobereiner's triad.

Triad of atoms			Mean of first and fast element
Li	Na	K	$\frac{7+39}{2}=23$

NEWLAND'S RULE OF OCTAVE

If the elements are arranged in the increasing order of atomic weights, on starting with an element, the first element will exhibit similarities with the eighth element

LOTHAR MAYER'S VOLUME CURVES

(a) The graphs drawn by plotting the atomic volumes against atomic weights are known as Lothar Mayer volume curves.

(b) The alkali metals have highest atomic volumes.

(c) Alkaline earth metals (Be, Mg, Ca, Sr, Ba, etc) which are relatively a little less electropositive. Occupy positions on the descending part of the curve.

(d) Halogens and the noble gases (except helium) occupy positions on the ascending part of the curve.

(e) Transition elements have very small volumes and therefore these are present at the bottoms of the curve.

MENDELEEF'S PERIODIC LAW

According to Mendeleef's periodic law, the physical and hcemical properties of elements are peiodic function of their atomic weights.

MODERN PERIODIC LAW AND MODERN PEIODIC TABLE

(a) Mosley proved that the square root of frequency (v) of the rays. which are obtained from a metal on showering high velocity electrons is proportional to the nuclear charge of the atom. This can be represented by the following expression.

(b) $\sqrt{v}=a(Z-b)$ where Z is nuclear charge on the atom and a and b are constants.

(b) The nuclear charge on an atom is equal to the atomic number.

(c) According to modern periodic law. "The properties of elements are the periodic functions of their atomic numbers".

MODERN PERIODIC TABLE

(a) One the basis of the modern periodic law, many scientist collectively proposed a long form of periodic table.

(b) In the periodic table the horizontal lines are periods and the vertical lines are groups.

(c) The periodic table has a total of seven periods and 18 groups. But according to CAS system, the number of groups is 16, because the eighth group has been divided into three groups.

(d) There are two elements in the first period eight elements in each of the second and third periods, eighteen elements in each of the fourth and fifth period, thirty two elements in the sixth period and seventh period is incomplete.

(e) The first period is very short period, second and third are short period fourth and fifth are long periods sixth is the longest period, while the seventh is incomplete period.

(f) The lanthanides (Elements from atomic numbers 58 to 71) and actinides (elements from atomic numbers 90 to 103) are included in the sixth and seventh periods though these have been kept outside the periodic table.

Group	Number of Elements
(a) IA group a Qr. gr. 1	7 (H, Li, Na, K, Rb, Cs Fr) Alkali metals
(b) IIA group Qr. gr 2	6 (Be, Mg, Ca, Sr, Ba, Ra) Alkaline earth metals
(c) IIIA group Qr. gr. 13	5 (B, Al, Ga, In, TI) Boron family
(d) IV A group Qr. gr. 14	5 (C, Si, Ge, Sn, Ob) Carbon family
(e) V A group Qr. gr. 15	5 (N, P, As, Sb, Bi) Nitrogen family (Pnicogens)
(f) VI A group Qr. gr. 16	5 (O, S, Se, Te, Po) Oxygen family (chalcogens)
(g) VII A group Qr. gr. 17	5 (F, Cl, Br, I, At) - Halogen family
(h) Zero group Qr. gr. 18	6 (He, Ne, Ar, Kr, Xe, Rn) Inert gases
(i) III B group Qr. gr. 3	32 (Sc, Y, La,Ac and 14 lanthanide elements and 14 actinide elements Lanthanold and Actenoid elements are of group III B, which could not be accomodated in one column and therefore written separately outside the periodic table.
(j) IV B group Qr. gr. 4	4 (Ti, Zr, Hf, Ku)
(k) V B group Qr. gr. 5	4 (V, Nb, Ta, Ha)
(l) VI B group Qr. gr. 6	3 (Cr, Mo, W)
(m) VII B group Qr. gr. 7	3 (Mn, Tc, Re)
(n) VIII (3) group 8, 9, 10	9 (Fe, Co, Ni, Ru, Rh, Pd, Os, Ir, Pt)
(o) IB group - 11	3 (Cu, Ag, Au)
(p) II B group - 12	3 (Zn, Cd, Hg)

s-BLOCK ELEMENTS

(a) The elements of the periodic table in which the last electron enters in s-orbital, are called s-block elements.

(b) s-Orbital can accomodate a maximum of electrons.

(c) Their general outermost configuration are ns^1 and ns^2 respectively, where n = (1 to 7)

p - BLOCK ELEMENTS

(a) The elements of the periodic table in which the last electron gets filled up in the p-orbital, called p-block elements.

(b) A p-orbital can accommodate a maximum of six electrons. Therefore, p-block elements are dividedinto sixgroups which are group 13, 14, 15, 16, 17 and 18.

(c) The general outermost configuration of p-block elements are $ns^2\ p^{1\text{-}6}$.

(d) There are nine gaseous elements (Ne, Ar, Kr, Xe, Rn, F_2, Cl_2, O_2 and N_2) belonging to p-block. Gallium (Ga) and bromine (Br) are liquids.

d - BLOCK ELEMENTS

(a) The elements of the periodic table in which the last electron gets filled up in the d orbital, called d-block elements.

(b) The d block elements are placed in groups name 3, 4, 5, 6, 7, 8, 9, 10, 11, 12.

(c) Properties of d-block elements are transition between the properties of s and p-block elements that is why these elements are known as transition elements,

(d) The general configuration of these elements is ns^{1-2}, $(n-1)d^{1-10}$ where n = 4 to 7.

(e) All of these elements are metals

(f) Out of all the d block elements mercury is the only liquid.

f - BLOCK ELEMENTS

(a) The elements of the periodic table in which the last electron gets filled up in the f-orbital called as f-block elements.

(b) The f block elements are from atomic number 58 to 71 and from 90 to 103.

(c) The lanthanides occur in nature in low abundance and therefore these are called as rare earth elements.

(d) There are 28 f block elements in the periodic table.

(e) The elements from atomic number 58 to 71 are called lanthanides because comes after lanthanum (57). The elements from 90 to 103 are called actinides because comes after actinium (89).

DETERMIATION OF PERIOD NO. :

Write the electronic configuration and check the highest shell number. It will represent its period number.

DETERMINATION OF GROUP NO.

(1) Write the electronic configuration (2) Predict its block

Case I : If it is s-block element calculate electrons in ns subshell. It will be it's group no.

e.g. Ca(20) : $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2$

Period = 4 group 2

Case II : If it is d-block element, calculate electrons present in ns and (n–1) d-subshell. It will be its group no.

Cr (24) : $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^1\ 3d^5$

Period = 4, Group = 1 + 5 = 6

Case III : If it is p-block element, calculate no of electrons in ns, np-subshell and to this add 10. It will be its group no.

S(16) : $1s^2\ 2s^2\ sp^6\ 3s^2\ 3p^4$

Period = 3 ; group = 2 + 4 + 10 = 16

Case IV : If it is f-block elements, then they are always in group -3.

EFFECTIVE NUCLEAR CHARGE

(a) In a polyelectronic atom, the internal electrons decrease the nuclear attraction on the electrons of the outermost orbit.

(b) Therefore, only a part of the nuclear charge is effective on the electrons of the outermost orbit. Thus, the inner electrons protect or shield the nucleus and thereby decreases the effect of nuclear charge towards the electrons of the outermost orbit.

(c) Thus the part of the nuclear charge works agianst outer electrons, is known as effective nuclear charge.

$Z^* = Z - \sigma$; $Z^* =$ effective nuclear charge

s = shielding constant and Z = actual nuclear chage

Note :

(i) Development of prositive charge increases Z* and development of negative charge decrease Z* and Vice Versa.

(ii) Z* increase along the period.

(iii) For nth shell order of screeing effect for any outerelectron is s > p > d >f.

ATOMIC RADIUS

The distance of the outermost orbit from the nucleus of an atom is called atomic radius.

SINGLE BOND COVALENT RADIUS, SBCR

The Homonuclear diatomic molecules

$d_{A-B} = r_A + r_B$ or $2r_A$ $r_A = \frac{d_{A\ A}}{2}$

VANDER WAALS RADIUS

Average of the Half of the distance between the nuclei of two non bonded atoms in solid state called as vanderwaall radius.

PERIODICITY IN ATOMIC RADIUS

(a) In a period : The number of orbit remains same on going from left to right in a period while effective nuclear charge increases. That's why atomic radius decreases along the period.

(b) In a group : The atomic radii increase on going downwards in a group because the number of orbits also increase on going from top to bottom in a group.

IONIC RADIUS

Ionic radius is the distance between the nucleus and the limit of the electron cloud scattered around the nucleus.

Cationic Radius

The size of a cation is smaller in comparison to the size of its corresponding atom. This is because of the fact that an atom on losing electrons/s effective nuclear charge increases.

$$\text{size of cation} \propto \frac{1}{\text{Amount of positive charge or } Z_{eff}}$$

Anionic Radius

Development of negative charge increases size of atom because of the following two reasons.

(1) Effective nuclear charge is decreased.

(2) Inter electronic repulsion in outer most shell is increased.

SIZE OF ISOELECTRONIC SERIES

The species, which have same number of electrons but different nuclear charges, constitute an isoelectronic series. Among various isoelectronic species greater the positive charge, smaller is the size and greater the negative charge greater is the size.

IONISATION POTENTIAL

(a) The energy required to remove the most loosely bound electron from the outermost orbit of an isolated gaseous atom is called as ionisation potential (IP). This ionisation is an endothermic or energy absorbing process.

(b) An electron cannot be removed directly from an atom in solid state. For this purpose, the solid state is converted to gaseous state and the energy required for this is called sublimation energy.

(c) $$A \xrightarrow{I^{st}\ IP} A^{+1} \xrightarrow{II^{nd}\ IP} A^{+2} \xrightarrow{III^{rd}\ IP} A^{+3}$$

Ist IP < IInd IP < IIIrd IP because as the electrons go out of the atom, the ionic size goes on decreasing and the effective nuclear charge goes on increasing.

FACTORS AFFECTING IONISATION POTENTIAL

(a) Atomic Size :

$$\text{Ionisation potential} \propto \frac{1}{\text{atomic size}}$$

(b) Effective Nuclear Charge

$$\text{Ionisation potential} \propto \text{Effective nuclear charge}$$

(c) Shielding Effect :

$$\text{Ionisation potential} \propto \frac{1}{\text{shielding effect}}$$

(d) Stability of half filled and fully orbitals : The atoms whose orbitals are half-filled (p^3, d^5, f^7) or fully-filled (s^2, p^6, d^{10}, f^{14}) have greater stability than the others. Therefore, they required greater energy to for removing out electron. However stability of fully filled orbitals is greater than that of the half filled orbitals

$$\text{I.P. of fully} - \text{filled orbitals} > \text{I.P. of half} - \text{filled orbitals}$$

(e) Penetration power :

$$\text{Ionisation potential} \propto \text{penetration power}$$

PERIODIC TABLE AND IONISATION POTENTIAL

In a period : The value of ionisation potential normally increase on going from left to right in a period, because effective nuclear charge increases and atomic size decreases.

Exceptions

(1) In any period, elements of group 2 have higher I.P. them neighbouring elements because of high stabilityof subshell and more penetration of s-subshell

(2) In any period, elements of group 15 have higher IP than neighbouring elements because of higher stability of half filled p-subshell.

(3) The increasing order of the values of ionisation potential of the third period elements is
Na < Al < Mg < Si < S < P < Cl < Ar

(4) For 2nd ionisation potential in second period decreasing order is
Li > Ne > O > F > N > B > C > Be

In a group

(1) The value of ionisation potential normally decreases on going from top to bottom in a group mainly because of atomic size increase.

(2) The value of ionisation potential is oscillating in group 13.

(3) The values of ionisation potential of noblegases are extremely high.

ELECTRONEGATIVITY

(a) The measure of the capacity of tendency of an atom to attract the shared pair of electrons of the covalent bond towards itself is called electronegativity of that atom.

(b) Electronegativity is a relative value that indicates the tendency of an atom to attract shared electrons more than the other atom bonded to it. Therefore it does not have any unit.

PERIODIC TABLE AND ELECTRONEGATIVITY

Atomic size decreases on going from left to right in a period thus electronegativity increases. Atomic size increases on going from top to bottom in a group thus electronegativity decreases.

(a) Inert Gases : The electronegativity value of inert gases is zero, because they do not form covalent bonds.

(b) In a period, the electronegativity value of halogen is maximum, while the electronegativity value of alkali metal is minimum.

(c) F has maximum electronegativity value in the periodic table, while Cs has minimum electronegativity.

EXCEPTIONS:

(a) The elements of group II B i.e., Zn, Cd and Hg show increases in electronegativity value on going from top to bottom in the group.

(b) the elements of group IIIA, i.e. Al to Tl show increase in electronegativity value on going from top to bottom in the group.

(c) The elements of group IV A, show no change in electronegativity value on going from top to bottom in the group from Si on words.

NATURE OF OXIDES

If difference of the two electronegativites ($X_0 - X_A$) is 2.3 or more then oxide will be basic in nature. Similarly if value of $X_0 - X_A$ is lower than 2.3 then the compound will be first amphoteric then acidic in nature.

Oxide	Na_2O	MgO	Al_2O_3	SiO_2	P_2O_5	SO_3	Cl_2O_7
(X_o-X_A)	2.6	2.3	2.1	1.8	1.5	1.1	0.5
Nature	Strong basic	Basic	Amphoteric	Weak acidic	Acidic	Strong acidic	Strongest acidic

Basic character of oxides $\propto$ Difference of electronegativities of element and oxygen
Therefore basic character decreases in the period and acidic character increases.
(1) Larger the oxidation number of element, larger is the acidic strength e.g. $N_2O < N_2O_3 < N_2O_4 < N_2O_5$.
(2) Larger the size, lesser is the acidic strength $N_2O_5 > P_2O_5 > As_2O_5$

NATURE OF HYDROXIDES

According to Gallis if electronegativity of A in a hydroxide (AOH) is more than 1.7 then it will be acidic in nature whereas it will be basic in nature if electronegativity is less than 1.7.

For example	NaOH and	ClOH
Electronegativity (X_A)	0.9	3.00
Nature	Basic	Acidic

If the value is more than $X_0 - X_H$, then that hydroxide will be basic otherwise it will be acidic.

SOME IMPORTANT POINTS

(1) Triad rule – Dobereiner
(2) Octet rule – Newland
(3) Study of atomic volume – Lothar Mayer
(4) Inventor of atomic number – Moseley
(5) Godfather of periodic table – Mandeleef
(6) Maker of modern periodic table – Bohr
(7) Mg is bridge element, which joins metals of IIA and II B groups
(8) Elements after atomic number 92 are transuranic elements.
(9) Artificial element is Tc^{43}.
(10) Liquid non-metal – Br
(11) Liquid metal – Hg, Ga, Cs, Fr
(12) Solid volatile non-metal – lodine
(13) Lightest metal – Li
(14) Heaviest metal – Ir
(15) Hardest metal – W
(16) Nobel metals – Pc, Pt, Au, Ag
(17) Element does found on earth – Al
(18) Gaseous elements – 11 (He, Ne, Ar, Kr, Xe, Rn, H_2, N_2, O_2, Cl_2, F_2)
(19) Liquid elements – 5(Br, Hg, Ga, Cs, Fr)
(20) Submetals – 5(B, Si, As, Te, At)
(21) Inert gases – 6
(22) Lowest electronegativity : C_s
(23) Highest electronegavity : F
(24) Highest ionisation potential : He
(25) Lowest ionisation potential : Cs
(26) Highest electron affinity : Chlorine (Cl)
(27) Least electropositive element : Fluorine (F)
(28) Most reactive solid element : Li
(29) Most reactive liquid element : Cs
(30) Most stable element : Te
(31) Largest atomic size : Cs
(32) Most electropositive element : Cs ; Fr
(in stable element) (in all element)
(33) Group containing maximum no. of gaseous elements in periodic table : Zero gp; next to zero gp is VII gp or halogen gp (F_2 and Cl_2)

(34) Total number of gaseous elements in periodic table	:	11 (H_2 , He, N_2, O_2, F_2 Ne, Cl_2 Ar, Kr, Xe, Rn)
(35) Total number of liquid elements in periodic table	:	4 (Ga, Br, Cs, Hg) (Fr and Eka are also liquid)
(36) Volatile d-block elements	:	Zn, Cd, Hg
(37) Most abundant element on earth	:	Oxygen followed with Si
(38) Most stable carbonate	:	Cs_2CO_3
(39) Strongest alkali:		Cs(OH)
(40) Element kept in water	:	P
(41) Elements kept in kerosene oil	:	Na, K, l, Cs
(42) Liquid non metal	:	Br_2
(43) Bridge metals	:	Na, Mg
(44) Noble metals	:	Au, Pt
(45) Lightest elemment	:	H
(46) Poorest conductor of current	:	Pb (metal), S (non metal)
(47) Most abundant gas	:	N_2
(48) Lightest solid metal	:	Li
(49) Heaviest solid metal	:	Os (highest density 22.6 g/cm^3)
(50) natural explosive	:	NCl_3
(51) Dry ice	:	CO_2
(52) First Nobel prize of chemistry was given to	:	vant Hoff

- Core charge- Atomic number – Kernel of electron
- Penultimate shell – shell present inside one shell (n – 1) from outermost shell, is called penultimate shell.
- Prepenultimate shell – Shell present inside two shells (n- 2) from outermost shell, is called prepenultimate shell.