UNIT-3

Periodic Table and Periodic Properties

Date 16/09/2020

Note

i) Dobereiners law of triads :- If elements have similar properties are arranged in group of 3 (triad) then the ~~molecular mass~~ atomic weight of the middle element is equal to the average of 1st and last element.

Eg → ① Li Na K

7 23 39 (÷2)

② Ca Sr Ba

40 88 137 (÷2)

③ Cl Br I

35.5 80 127 (÷2)

Limitations

- very few triads were formed
- Elements having dissimilar properties couldnot be grouped

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ii) Newland Law's of Octave :- If elements are arranged in order of increasing atomic weight then the properties of every 8 th element was similar to the 1st, just like the note in music is similar to 1st.

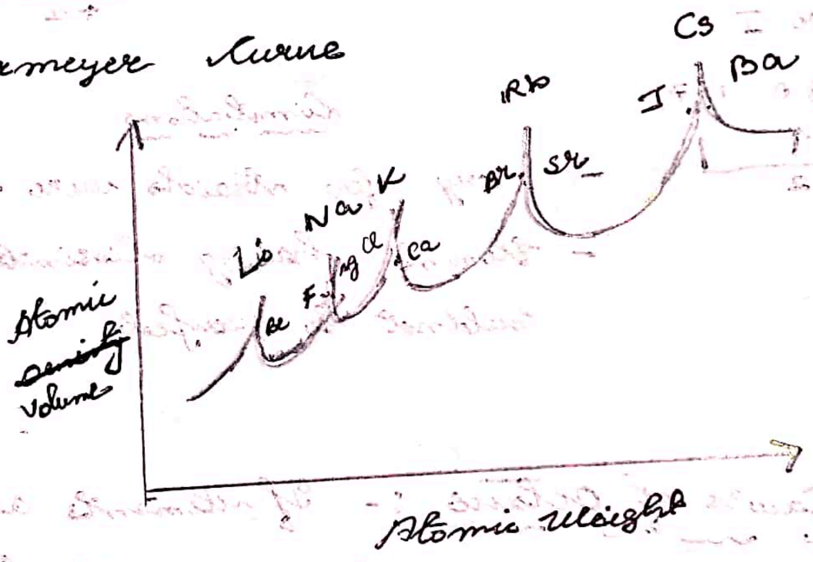
Li	Be	B	C	N	O	F
Na	Mg	Al	Si	P	S	Cl
K	Ca					

Limitation

- After the discovery of nobel gases the resemblance to music (1st and 8th) was lost as mas the 1st element showing property similar to 9th element was observed.

- It was applicable only upto calcium.

(iii) Lotharmeyer curve



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Points

(i) All alkali metals occupied the same position → ie, on top of the peak.

(ii) All alkali earth metals occupied the same position ie, just after the peak.

(iii) All halogens

Merit :- The elements showing similar properties occupied similar position.

Demerit :- L.M.C. could not be useful for any practical application.

(iv) Mendeleev's Periodic Table :

"The properties (physical and chemical) of an element are a periodic function of their atomic masses.

Points

(i) The Mendeleev's Periodic Table, there were 8 columns labelled I, II, III, IV, V, VI, VII, VIII. Later on, noble gases were inserted in Group 0.

(ii) Groups I to VII were further sub divided into A and B. Groups 0 and VIII were not sub-divided. However Group VIII contained 3 elements each that were not in any order.

(iii) Mendleev's Periodic Table had seven periods which were further subdivided into even and odd.

Period 1 → 2 elements → (shortest)

Period 2 & 3 → 8 elements each → (short)

Period 4 → 18 elements → (1st long)

Period 5, 6, → 32 elements → (very long)

Period 7 → incomplete.

Note

Merits	Demerits
(i) It was the first systematic classification.	(i) Position of Hydrogen was not fixed.
(ii) Discovering of Hydrogen didnot disturb the position of other elements	(ii) He interchanged the position of some elements based on their properties instead of atomic weight. (K, Ar) eg
(iii) Left gaps for undiscovered elements and predicted their properties ~~......~~ accurately.	(iii) VIII Group → 3 elements without any order.
(iv) He was able to correct valency / Atomic weight of certain element.	(iv) f-block element were placed separately below main table.
	V) The position of isotopes should be different.

Note
ϕ 17

Modern Periodic Table

→ Henry Mosley.

"The physical and chemical properties of the elements are periodic function of their atomic number."

x-ray diffraction

$\sqrt{v}$ vs Z and he got straight lines.

$$\sqrt{v} = a(Z-b)$$

$\Rightarrow y = mx + c)$, a, b are constant.

$E = h\nu$

$= E \frac{Z^2}{n^2}$

$\nu \propto Z^2$

Points

i) The Modern Periodic table has 18 groups and 7 periods.

ii) The Modern Periodic table has been divided into p block, s block, d block and f block.

iii) The s and p blocks are called as normal elements or representative elements.

iv) ~~The~~ d block elements are known as transition elements.

v) f block elements are known as inner transition elements.

vi) Electronic Configuration (General)

's' → ns^{1-2}

'p' → $ns^2 np^{1-6}$

'd' → $ns^{0-2} (n-1)d^{1-10}$

'f' → $ns^{2} (n-1)d^{0-1} (n-2)f^{1-14}$

'n' → periodic Number

Eg →

i) Sr

we know, $s \rightarrow ns^{1-2}$

∴ $Sr \rightarrow 5s^2$

ii) Na

we know, $s \rightarrow ns^{1-2}$

$Na \rightarrow 3s^1$

iii) As

we know, $p \rightarrow ns^2 np^{1-6}$

∴ $As \rightarrow 4s^2 4p^3$

iv) S

we know, $p \rightarrow ns^2 np^{1-6}$

$S \rightarrow 3s^2 3p^4$

v) Fe,

we know, $d \rightarrow ns^{0-2} (n-1)d^{1-10}$

∴ $Fe \rightarrow 4s^2 3d^6$

Exception

$Cu \rightarrow 3d^{10} 4s^1$

$Pd \rightarrow 4d^{10}$

Q.1) Sb
→ $ns^2\ np$ —
→ $5s^2\ 5p^3$

Q.2) TI
→ $ns^2\ np$
→ $6s^2\ 6p^1$

3) TC
→ $4d^5\ 5s^2$

4) MO
→ $ns^{1\text{-}2}\ np$ —
→ $5s^1\ 4d^5$

5) HO
→ $6s^2\ 5d^1\ 4f^{10}$

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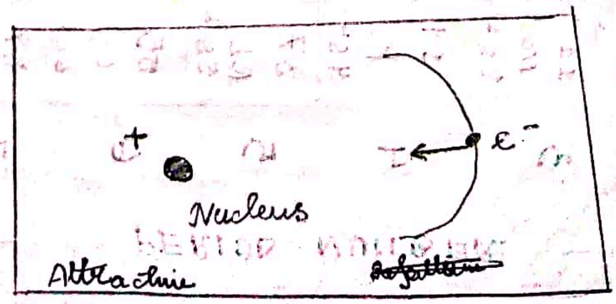
Periodic Properties

1) Zeff (Z effective):- The outer electron face attraction from the nucleus and face repulsion (shielding) from the inner e^-. Thus the effective ~~outer~~ attractive force on the outer electron are different from Z. The effective attractive force is called as Zeff.

$$Z_{eff} = Z - \sigma$$

Z ↓ Atomic no.
σ ↳ screening / shielding constant



net attractive = attractive - repulsive

Periodic Table

1 H $1s^1$

d- transition elements

f- Inner transition elements

PERIOD NUMBER	GROUP NO 1 IA	2 IIA	3 IIIA	4 IVA	5 VA	6 VIA	7 VIIA	8	9 ← VIII	10 →	11 IB	12 IIB	13 IIIB	14 IVB	15 VB	16 VIB	17 VIIB	18 0
1																		2 He $1s^2$
2	3 Li $2s^1$	4 Be $2s^2$											5 B	6 C	7 N	8 O	9 F	10 Ne
3	11 Na $3s^1$	12 Mg $3s^2$											13	14	15	16	17	18
4	19 K $4s^1$	20 Ca $4s^2$	21 Sc $3d^1 4s^2$	22 Ti $3d^2 4s^2$	23 V $3d^3 4s^2$	24 Cr $3d^5 4s^1$	25 Mn $3d^5 4s^2$	26 Fe $3d^6 4s^2$	27 Co $3d^7 4s^2$	28 Ni $3d^8 4s^2$	29 Cu $3d^{10} 4s^1$	30 Zn $3d^{10} 4s^2$	31 Ga $4s^2 4p^1$	32 Ge $4s^2 4p^2$	33 As $4s^2 4p^3$	34 Se $4s^2 4p^4$	35 Br $4s^2 4p^5$	36 Kr $4s^2 4p^6$
5	37 Rb $5s^1$	38 Sr $5s^2$	39 Y $4d^1 5s^2$	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
6	55 Cs $6s^1$	56 Ba $6s^2$	57 La* $5d^1 6s^2$	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
7	87 Fr $7s^1$	88 Ra $7s^2$	89 Ac** $6d^1 7s^2$	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Uuu	112 Uub	113 —	114 Uuq	—	Uuh	—	—

58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu
90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr

* Lanthanoids
$4f^n 5d^{0-1} 6s^2$

** Actinoids
$5f^n 6d^{0-2} 7s^2$

Note

$Z_{eff} = Z - \sigma$

- To determine σ (sigma) we use slater rules.

→ Steps to determine σ are as follows:-

Step-1) Write the Electronic configuration in groups as shown (sp) (d) (f)

(1s) (2s2p) (3s3p) (4s4p) (4d) (4f) ....

Step-2)

s/p	d/f
i) All other electrons in the same group exert 0.35 of shielding	i) All other electrons in the same group provide 0.35 in shielding.
ii) All electron in (n-1) shell exert 0.85 of shielding.	ii) All other electrons to the left of the group exert 1.
iii) All electron that are (n-2) and deffer provide 1 of shielding.	

Common point :- All electrons to the right of the group donot provide any shielding.

Step-3) Exception :- If Zeff is being found out for ($1s^2$) then σ for the other e^- is 0.30.

Step 4) Find out the total σ and subtract from Z to find out Zeff.

Example

i) Fe → $(1s^2)(2s^2 2p^6)(3s^2 3p^6)(3d^6)(4s^2 4p^0)(4d^0)$

∴ Z_{eff} outermost = Z − S

4s → $26 - \{1 \times 0.35 + 14 \times 0.85 + 10 \times 1\}$

$= 26 - \{22.20\}$

$= 3.80$

10.35
11.70
22.20

3d → $26 - \{5 \times 0.35 + 18 \times 1\}$

3s/3p → $26 - \{7 \times 0.35 + 8 \times 0.85 + 2 \times 1\}$

2s/2p → 26 − {

ii) Br → $(1s^2)(2s^2 2p^6)(3s^2 3p^6)(3d^{10})(4s^2 4p^5)$

∴ Z_{eff} →

4s/4p → $35 - \{6 \times 0.35 + 18 \times 0.85 + 10 \times 1\}$

3d → $35 - \{9 \times 0.35 + 18 \times 1\}$

3s/2p → $35 - \{7 \times 0.35 + 8 \times 0.85 + 2 \times 1\}$

2s/2p → $35 - \{7 \times 0.35 + 0.85 \times 2\}$

1s → $35 - \{1 \times 0.3\}$

iii) H → 1 − 0

iv) He → $2 - \{1 \times 0.3\}$

$= 1.3$