Chapter 8: Electron Configuration and Chemical Periodicity

* The direction of e^- spin is Represented by m_s [either $+\frac{1}{2}$, $-\frac{1}{2}$]

Property of Electron

→ Pauli's exclusion principle: no two electrons in the same atom can have the same four Quantum number

* Energy of atomic orbitals are affected by :-

1 - nuclear charge (Z)
2 - Shielding by other electrons

مهم •
• كلما زادت شحنة النواة
تزيد قدرتها على جذب الالكترونات
وتقل طاقة المدارات الخارجية

Revise slide 7

* Z_{eff} : effective nuclear charge

اقل من شحنة النواة الحقيقية بسبب حجب الالكترونات الداخلية

→ Electrons in the same energy level shield eachother
→ Electrons in the inner energy level shield the outer electrons very effectively

* Penetration - increases attraction
  - decreases shielding

→ Energy :- $s < p < d < f$

Electron Configuration :- $n\,l$ **
(s, p, d, f)

* aufbau principle → e^- placed in the lowest energy sublevel

* Hund's Rule → orbitals of equal energy
The lowest energy electron Configuration has the max. num of unpaired electrons

n: orbital size (energy)
l: orbital shape
m_l: orbital orientation
m_s: Direction of e^- spin

* an orbital can hold a maximum of two electrons

- A partial orbital diagram :- shows only the highest en[ergy] sublevels being filled

* Electron Configurations and Group :-

Same Group → Same outer electron Configuration
→ Same chemical behavior

1s
2s 2p
3s 3p 3d
4s 4p 4d 4f
5s 5p 5d 5f
6s 6p 6d
7s 7p

2S more stable Than 2p (penetration)

n+l is Constant diagonally

	* Noble gas	* what Comes after
2	He	2s
10	Ne	3s
18	Ar	4s
36	Kr	5s
54	Xe	6s
86	Rn	7s

* Categories of Electrons

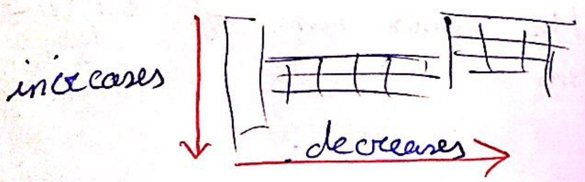
Inner electrons (core)
→ The common electrons between atom and previous noble gas + filled orbitals

Outer electrons
- has highest Energy

Valence Electrons
- involved in forming Compounds
  - for main group → outer electrons
  - transition elements → outer electrons + e⁻ at any (n-1)d
    so ns + (n-1)d electrons

* Trends in Atomic size:

1. Atomic size ↑ ← n ↑
2. Zeff ↑ — Atomic size ↓



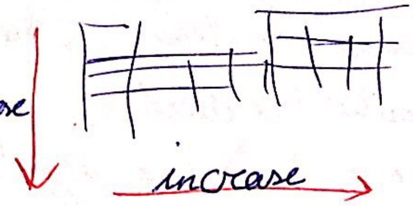
Anions has lower Zeff Than Cations and ~~lower~~ higher Atomic Size

Trends in ionization Energy (Always positive)

↳ energy required for the Complete removal of 1 mol of electrons from 1 mol of gaseous atoms or ions

→ High IE: anions

→ low IE: Cations



* Trends in Electron Affinity

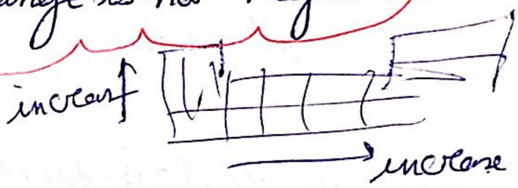
EA_1 is negative
EA_2 is always positive

↳ Energy change that occurs when 1 mol of electrons is added to 1 mol of gaseous atoms or ions

→ low EA : Cations

→ High EA : anions

Change is not Regular



* Behavior patterns for IE and EA

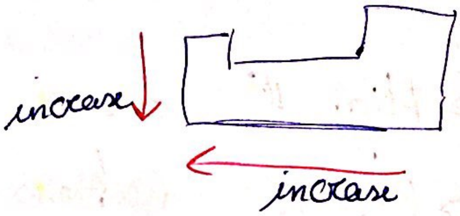
Reactive nonmetals ← Groups 6A, 7A
- high IE
- highly negative EAs
- form negative ions

Reactive metals ← Groups 1A 2A
- low IE
- negative EAs (slightly)
- form positive ions

Noble gases ← Group 8A
- very high IEs
- slightly positive EAs
- Don't lose or gain electrons

Metallic Behavior

- Shiny Solids
- moderate → high melting points
- good conductors → heat, electricity
- Can easily be shaped
- loses electrons → form cations
- * easily oxidized



Main group
- Strong reducing agents
- form ionic oxides → basic in aqueous Solution

→ ## Acid_Base Behavior of oxides

* Main-group Nonmetals form → Covalent oxides

* ~ ~ metals → ionic oxides

* acidic in aqueous solution

* Some metals and metalloids form amphoteric oxides Ex: Al_2O_3 with HCl and NaOH

→ ## Electron Configurations of Main-Group ions :-

Def: Isoelectronic: an atom that has a noble gas electron configuration

Ex: Na^+ $[He]2s^2 2p^6$ = [Ne] isoelectronic with Ne

Pseudo-noble gas Configuration :-

عندما نفقد البعض الكتروناته من المدارات الأعلى طاقة :-

مثل :-

① Sn [Kr] $5s^2$ $4d^{10}$ $5p^2$

→ Sn [Kr] $4d^{10}$ + $4e^-$

Empty ns, np sublevels and a filled (n-1) d

② or filled ns and (n-1) d sublevels → $2e^-$ + Sn^{+2} ([Kr] $5s^2 4d^{10}$)

Sn^{4+} or Sn^{2+} اذا عكسنه لن يكون نوعان من الأيونات

* Magnetic properties of Transition Metal Ions

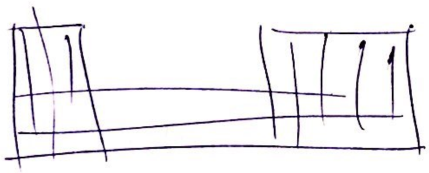
→ If the atom has an unpaired electron It is attracted by a magnetic field (para-magnetism)

→ By contrast, an atom with no paired electrons is not attracted by a magnetic field (diamagnet-)

Ionic Size vs Atomic Size

larger $\xleftarrow{\text{anion}}$ atom $\xrightarrow{\text{cation}}$ smaller +

Ionic Radius increases ↓



* Note: Cation size decreases as charge increases

If you have an isoelectronic series: (Same electron Configuration)
→ The size decreases with increasing nuclear charge.

$3^- > -2 > -1 > 1^+ > 2^+ > 3^+$

Notes:

* Energy state is affected by: (1) n value and (2) electron-electron Repulsion

* for the number of orbitals $= n^2$
  - 〃 〃 max number of electrons $= 2n^2$

* lanthanids → 4f orbitals are filled, period 6 } inner transition
* actinides → 5f 〃 〃 〃, period 7 } inner transition

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* Atomic size for Transition elements:
  - Period 5 > Period 4 — Period 5 ≈ Period 6
  - Increases a bit down a Column
  - left to right : decrease

ملاحظة : الحوكة IB لا يجوز عندك 12 الكترون خارجين

حالات شاذة في الطاقة الأولية :
في المجموعة ٢ و ٨ طاقة B , O أقل

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* Elements on the left of periodic table forms Cations
* 〃 〃 〃 right 〃 〃 〃 〃 anions
* 〃 〃 〃 Top 〃 〃 〃 〃 anions
* 〃 〃 〃 bottom 〃 〃 〃 〃 Cations

راجعي توزيع ال Cu و Cr , Mo
+ Q 63

Periodic Chart of the Elements

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- Atomic size
- Ionization Energy
- Metallic Behavior

more Acidic

(الشحنة للنواة تزيد) decreases

Increases

Increase

حالة شاذة

P-Block
lose np electrons Before ns electrons

S-block
loses all electrons with the highest n-value

increases (شحنة النواة تقل)

decreases

increase

more Basic

Atomic size Remains almost unchanged

d-Block
lose ns electrons before (n-1)d electrons

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1 H 1.0079																1 H 1.0079	2 He 4.00260
3 Li 6.941	4 Be 9.01218											5 B 10.81	6 C 12.011	7 N 14.0067	8 O 15.9994	9 F 18.998403	10 Ne 20.179
11 Na 22.98977	12 Mg 24.305											13 Al 26.98154	14 Si 28.0855	15 P 30.97376	16 S 32.06	17 Cl 35.453	18 Ar 39.948
19 K 39.0983	20 Ca 40.08	21 Sc 44.9559	22 Ti 47.90	23 V 50.9414	24 Cr 51.996	25 Mn 54.9380	26 Fe 55.847	27 Co 58.9332	28 Ni 58.70	29 Cu 63.546	30 Zn 65.38	31 Ga 69.72	32 Ge 72.59	33 As 74.9216	34 Se 78.96	35 Br 79.904	36 Kr 83.80
37 Rb 85.4678	38 Sr 87.62	39 Y 88.9059	40 Zr 91.22	41 Nb 92.9064	42 Mo 95.94	43 Tc (97)	44 Ru 101.07	45 Rh 102.9055	46 Pd 106.4	47 Ag 107.868	48 Cd 112.41	49 In 114.82	50 Sn 118.69	51 Sb 121.75	52 Te 127.60	53 I 126.9045	54 Xe 131.30
55 Cs 132.9054	56 Ba 137.33	57 *La 138.9055	72 Hf 178.49	73 Ta 180.9479	74 W 183.85	75 Re 186.207	76 Os 190.2	77 Ir 192.22	78 Pt 195.09	79 Au 196.9665	80 Hg 200.59	81 Tl 204.37	82 Pb 207.2	83 Bi 208.9804	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra 226.0254	89 †Ac (227)	104 (260)	105 (260)													

*Lanthanides

58 Ce 140.12	59 Pr 140.9077	60 Nd 144.24	61 Pm (145)(147)	62 Sm 150.4	63 Eu 151.96	64 Gd 157.25	65 Tb 158.9254	66 Dy 162.50	67 Ho 164.9304	68 Er 167.26	69 Tm 168.9342	70 Yb 173.04	71 Lu 174.97

†Actinides

90 Th 232.0381	91 Pa 231.0359	92 U 238.029	93 Np 237.0482	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (254)	100 Fm (257)	101 Md (258)	102 No (255)	103 Lr (260)

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- The International Union for Pure and Applied Chemistry has not adopted official names or symbols for these elements.
- These weights are considered reliable to ±3 in the last place. Other weights are reliable to ±1 in the last place.
- Atomic weights corrected to conform to the 1979 values of the Commission on Atomic Weights.
- Data in this chart have been checked by the National Bureau of Standards' Office of Standard Reference Data.