

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

كلما زادت شحنة النواة يزيد عدد إلكترونات حب الـ إلكترونات وتقل طاقة المدارات الخارجة

Review slide 7

* Z_{eff} : effective nuclear charge
 أقل قوة التواضع لسبب حب الإلكترونات الأخرى

- Electrons in the same energy level shield each other
- 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

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

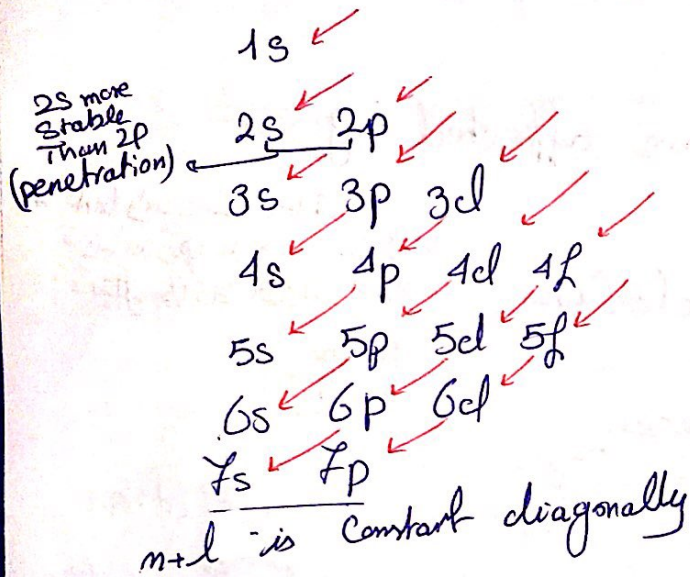
* an orbital can hold a maximum of two electrons

- * aufbau principle → 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

- A partial orbital diagram :- shows only the highest energy sublevels being filled

* Electron Configurations and Group :-

Same Group \rightarrow Same outer electron configuration
 \rightarrow Same chemical behavior



* 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

\hookrightarrow outer electrons

+ e^- at any $(n-1)d$

so $ns + (n-1)d$ electrons

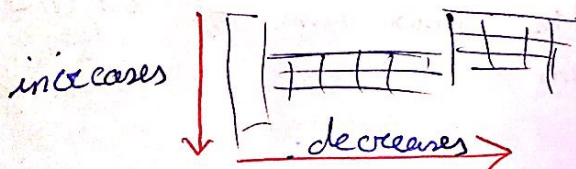
• transition elements

\hookrightarrow outer electrons

* Trends in Atomic size :

1 Atomic size \uparrow $\leftarrow n \uparrow$

2 Z_{eff} \uparrow — Atomic size \downarrow

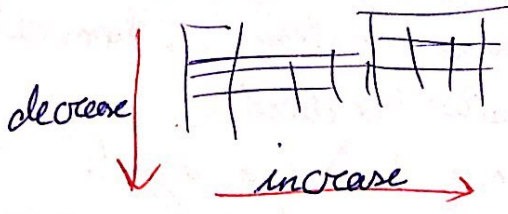


Anions has lower Z_{eff} than cations and lower higher Atomic size

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



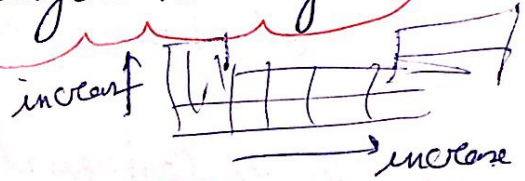
* Trends in Electron Affinity

EA₁ is negative
 EA₂ 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

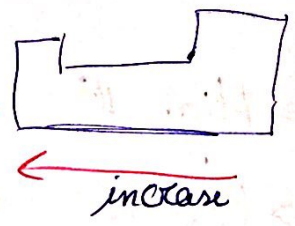
← Groups 6A, 7A
Reactive nonmetals
 • high IE
 • highly negative EAs
 • form negative ions

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

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

Metallc Behavior

- shiny solids
- moderate → high melting points
- good conductors → heat, electricity
- can easily be shaped
- loses electrons → form cations
- * easily oxidized
- * 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

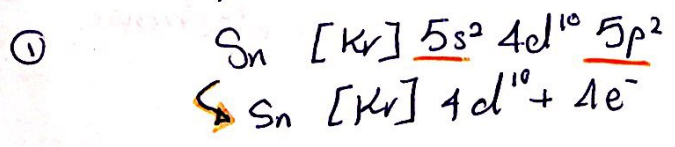
Electron Configurations of Main Group ions :-

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

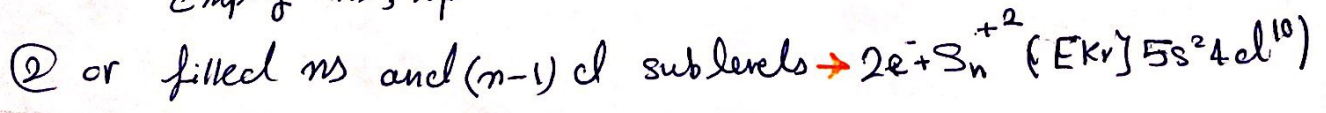
Ex: $Na^+ [He] 2s^2 2p^2 = [Ne]$ isoelectronic with Ne

Pseudo-noble gas Configuration :-

عن بعد الخصر الكرونية من السارات الذرية لبقية



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

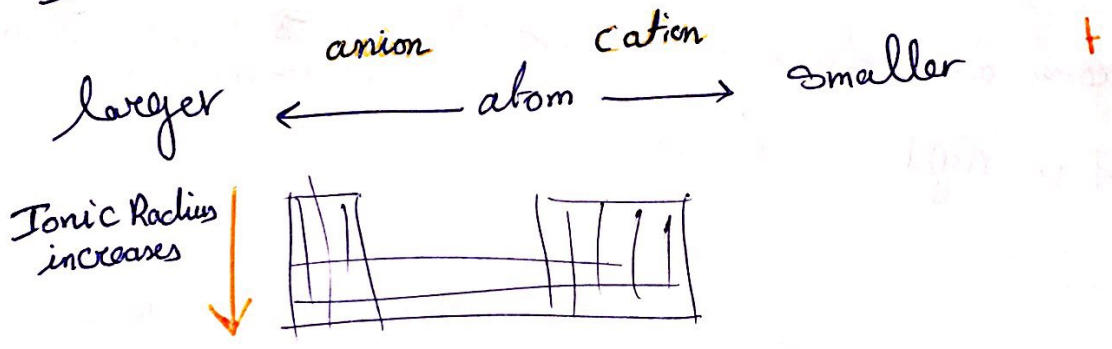


Sn^{4+} or Sn^{2+} اذنه عكسي لى سونه زوكاه صوالقات

* Magnetic Properties of Transition Metal Ions

- If the atom has an unpaired electron it is attracted by a magnetic field (paramagnetism)
- By contrast, an atom with no paired electrons is not attracted by a magnetic field (diamagnetism)

Ionic Size vs Atomic Size



* 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 = $2n^2$

* lanthanides → 4f orbitals are filled } inner transition
 Period 6
 * actinides → 5f ~ ~ ~ }
 Period 7

* Atomic size for Transition elements:

• Period 5 > Period 4 Period 5 ≈ Period 6

• Increases a bit down a Column
 • left to right : decrease

ملاحظة: المجموعة 10 لا تحتوي على العناصر الخارجية

حالات خاصة في الطاقة الأولية:
 في المجموعتين 2 و 8 طاقة B, D أقل

- * Elements on the left of periodic table forms cations
- * ~ ~ ~ right ~ ~ ~ anions
- * ~ ~ ~ Top ~ ~ ~ anions
- * ~ ~ ~ bottom ~ ~ ~ cations

راجع توزيع ال Cu و Cr و Pt
 + Q 63

- Atomic Size
- Ionization Energy
- Metallic Behavior

Periodic Chart of the Elements



P-Block
lose up electrons before ns electrons

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

more acidic
(المزيد الحمضية) decreases
Increases

1 H 1.0079	2 He 4.00260																	10 Ne 20.179	18 Ar 39.948	36 Kr 83.80	54 Xe 131.30	86 Rn (222)																												
3 Li 6.941	4 Be 9.01218																	9 F 18.998403	17 Cl 35.453	35 Br 79.904	53 I 126.9045	85 At (210)																												
11 Na 22.98977	12 Mg 24.305																	8 O 15.9994	16 S 32.06	34 Se 78.96	52 Te 127.60	84 Po (209)																												
19 K 39.0983	20 Ca 40.08																	7 N 14.0067	15 P 30.97376	33 As 74.9216	51 Sb 121.75	83 Bi 208.9804																												
37 Rb 85.4678	38 Sr 87.62																	6 C 12.011	14 Si 28.0855	32 Ge 72.59	50 Sn 118.69	82 Pb 207.2																												
55 Cs 132.9054	56 Ba 137.33																	5 B 10.81	13 Al 26.98154	31 Ga 69.72	49 In 114.82	81 Tl 204.37																												
87 Fr (223)	88 Ra 226.0254																	4 Be	10 Ne	18 Ar	36 Kr	54 Xe	86 Rn																											
21 Sc 44.9559	22 Ti 47.88	23 V 50.9414	24 Cr 51.996	25 Mn 54.938	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	58 Ce 140.12	59 Pr 140.9077	60 Nd 144.24	61 Pm (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
89 Ac (227)	90 Th 232.0377	91 Pa 231.0369	92 U 238.0289	93 Np 237.0481	94 Pu 244.0642	95 Am 243.0613	96 Cm 247.0771	97 Bk 247.0771	98 Cf 251.0825	99 Es 252.0833	100 Fm 257.1037	101 Md 258.1037	102 No 259.1037	103 Lr 260.1037	104 Rf 261.1037	105 Db 262.1037	106 Sg 263.1037	107 Bh 264.1037	108 Hs 265.1037	109 Mt 266.1037	110 Ds 267.1037	111 Rg 268.1037	112 Cn 269.1037	113 Nh 270.1037	114 Fl 271.1037	115 Mc 272.1037	116 Lv 273.1037	117 Ts 274.1037	118 Og 275.1037	119 Nh 276.1037	120 Fl 277.1037	121 Mc 278.1037	122 Lv 279.1037	123 Ts 280.1037	124 Og 281.1037	125 Nh 282.1037	126 Fl 283.1037	127 Mc 284.1037	128 Lv 285.1037	129 Ts 286.1037	130 Og 287.1037									

حالة

Increases

Atomic size Remains almost unchanged

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

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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 computed relative to 12 in the last place. Other weights are relative to 1 in the last place.
Atomic weights connected to columns are the 1988 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.
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