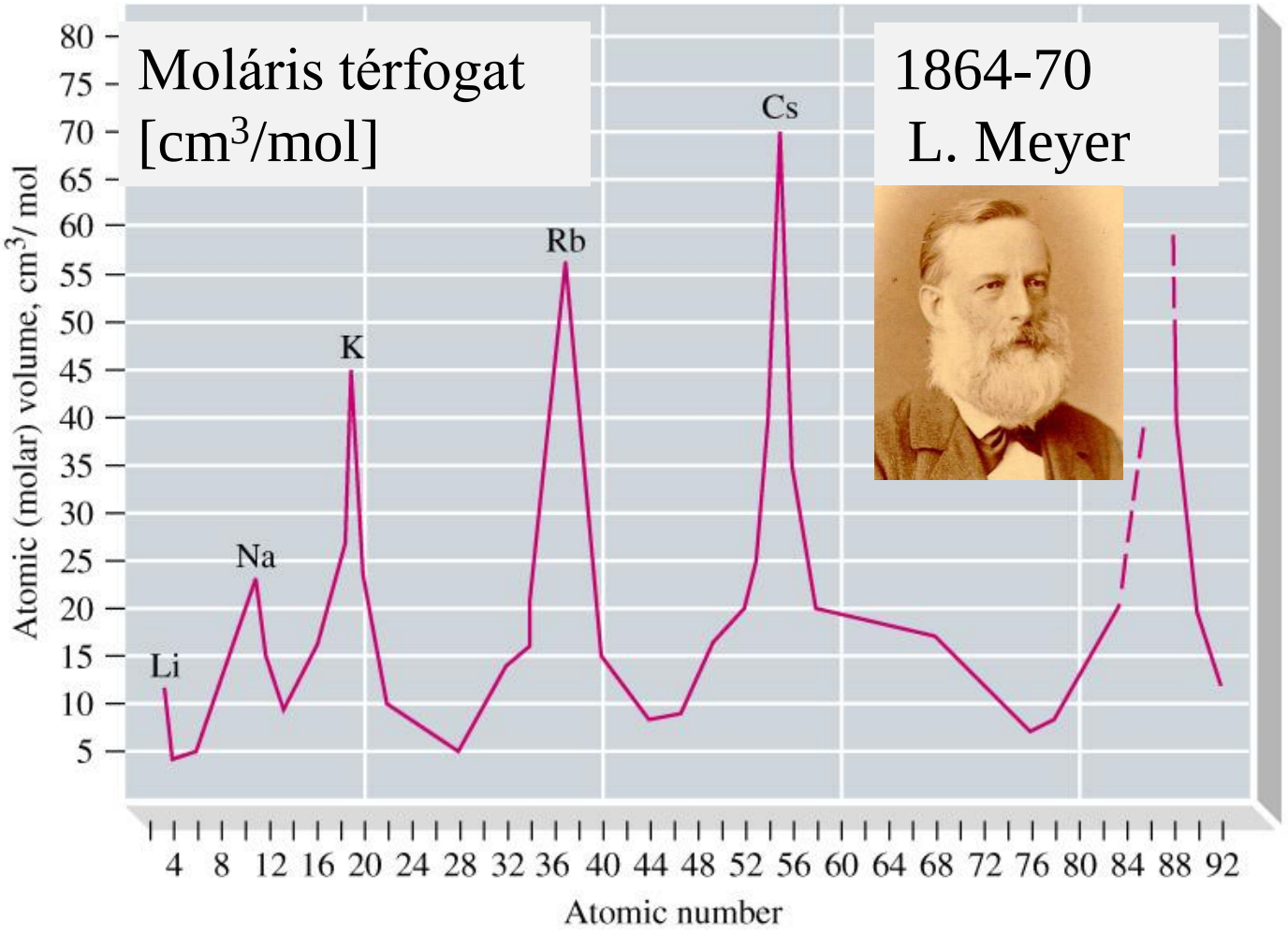
Periódusosság

11-1 Az elemek csoportosítása: a periódusos táblázat



Mengyelejev periódusos táblázata

1870, Meyerrel egy időben, tőle függetlenül. Üres: 44, 68,72,100

Reihen	Gruppe I. — R^2O	Gruppe II. — RO	Gruppe III. — R^2O^3	Gruppe IV. RH^4 RO^2	Gruppe V. RH^3 R^2O^5	Gruppe VI. RH^2 RO^3	Gruppe VII. RH R^2O^7	Gruppe VIII. — RO^4
1	H = 1							
2	Li = 7	Be = 9,4	B = 11	C = 12	N = 14	O = 16	F = 19	
3	Na = 23	Mg = 24	Al = 27,3	Si = 28	P = 31	S = 32	Cl = 35,5	
4	K = 39	Ca = 40	— = 44	Ti = 48	V = 51	Cr = 52	Mn = 55	Fe = 56, Co = 59, Ni = 59, Cu = 63.
5	(Cu = 63)	Zn = 65	— = 68	— = 72	As = 75	Se = 78	Br = 80	
6	Rb = 85	Sr = 87	?Yt = 88	Zr = 90	Nb = 94	Mo = 96	— = 100	Ru = 104, Rh = 104, Pd = 106, Ag = 108
7	(Ag = 108)	Cd = 112	In = 113	Sn = 118	Sb = 122	Te = 125	J = 127	
8	Cs = 133	Ba = 137	?Di = 138	?Ce = 140	–	–	–	– – – –
9	(–)	–	–	–	–	–	–	
10	–	–	?Er = 178	?La = 180	Ta = 182	W = 184	–	Os = 195, Ir = 197, Pt = 198, Au = 199
11	(Au = 199)	Hg = 200	Tl = 204	Pb = 207	Bi = 208			
12	–	–	–	Th = 231	–	U = 240		

Megjósolt elemek

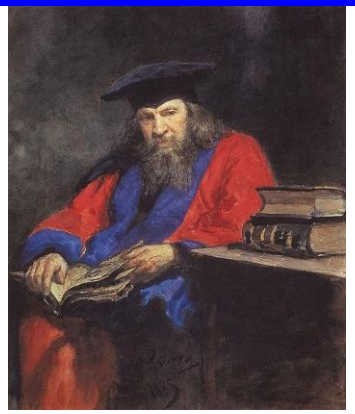
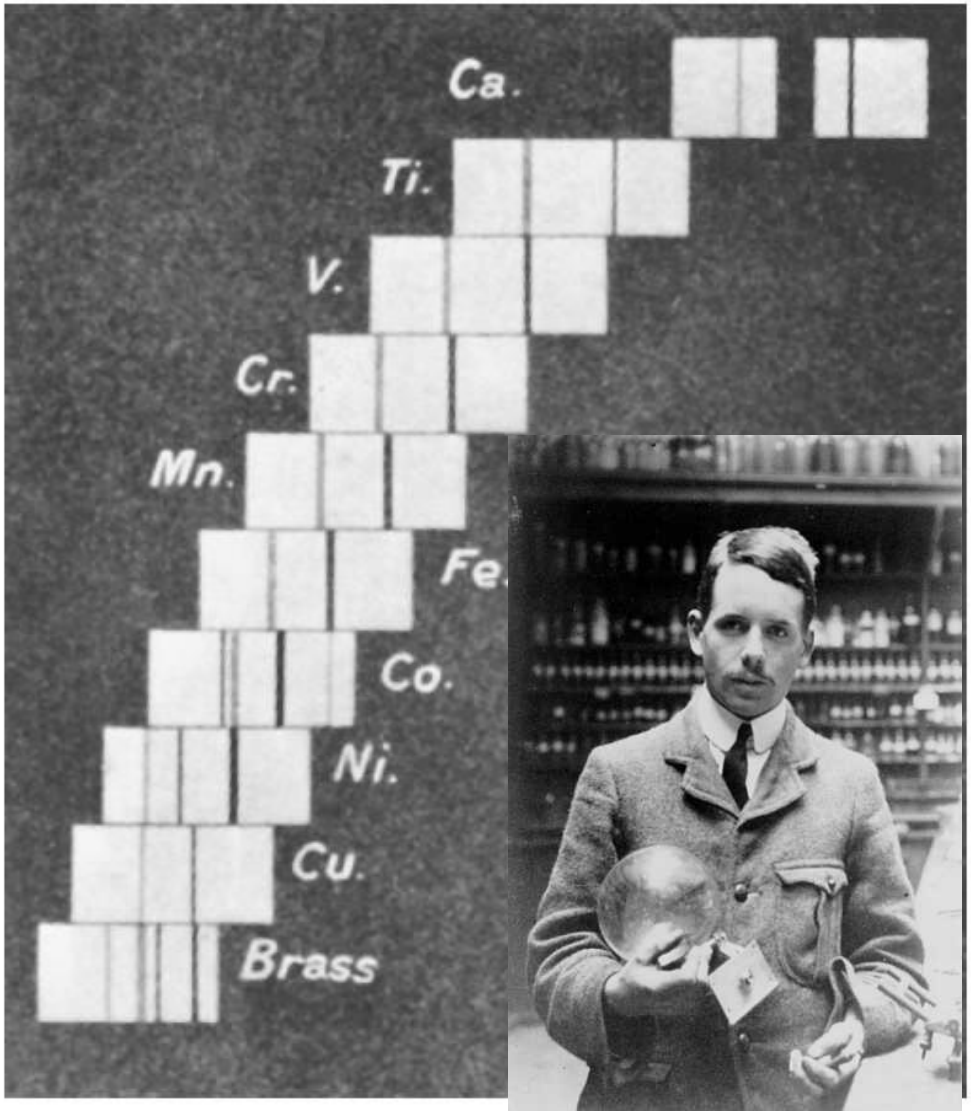


TABLE 10.1 Properties of Germanium: Predicted and Observed

Property	Predicted Eka-silicon (1871)	Observed Germanium (1886)
Atomic mass	72	72.6
Density, g/cm^3	5.5	5.47
Color	dirty gray	grayish white
Density of oxide, g/cm^3	EsO_2: 4.7	GeO_2: 4.703
Boiling point of chloride	$EsCl_4$: below 100 °C	$GeCl_4$: 86 °C
Density of chloride, g/cm^3	$EsCl_4$: 1.9	$GeCl_4$: 1.887

Röntgen spektrum: Z kvantitatív meghat.



- Henry Moseley 1913
  - A Röntgen sugárzás K_α (1s héj) vonalai korreláltathatóak az atommag töltésével.
- $\nu(K_\alpha) = A\,(Z - b)^2$
  - Új, megjósolt elemek
    43 Tc (1937),
    61 Pm (1945),
    75 Re (1925).
  - Rutherfordra hat

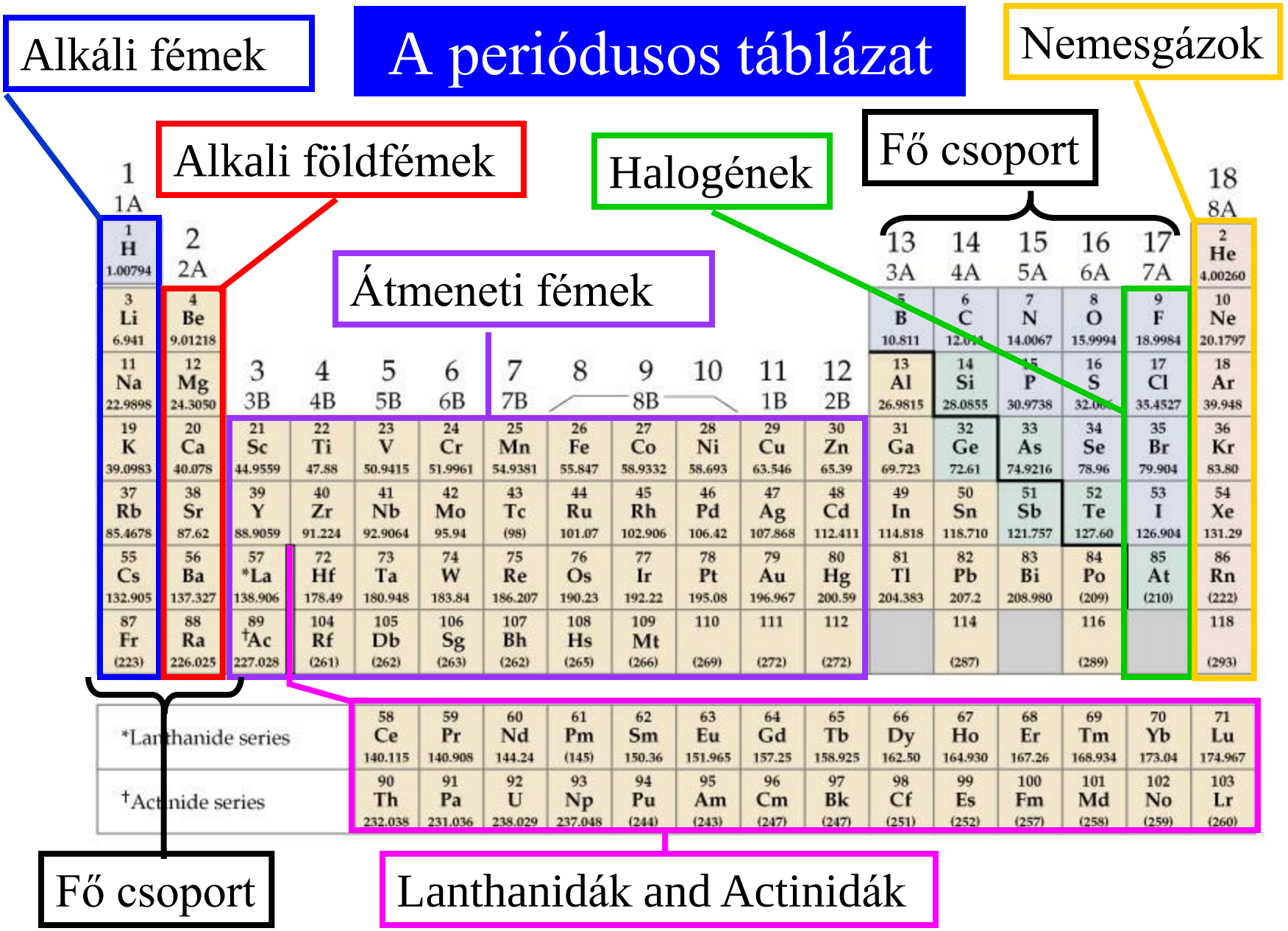
Kapcsolat a Bohr féle atommodellel

- Bohr: $E = h \cdot \nu = E_i - E_f = R_H \cdot (Z-1)^2 \left(\frac{1}{1^2} - \frac{1}{2^2} \right)$
- 1913: n = 2 $\longrightarrow$ 1, Miért *Z*-1?

$$\nu = \frac{R_H}{h} (Z-1)^2 \frac{3}{4} = 2.48 \cdot 10^{15} (Z-1)^2 [Hz]$$

- Moseley empirikus képlete:
- 1910-14 $\nu(K_\alpha) = 2.47 \cdot 10^{15} (Z-1)^2 [Hz]$

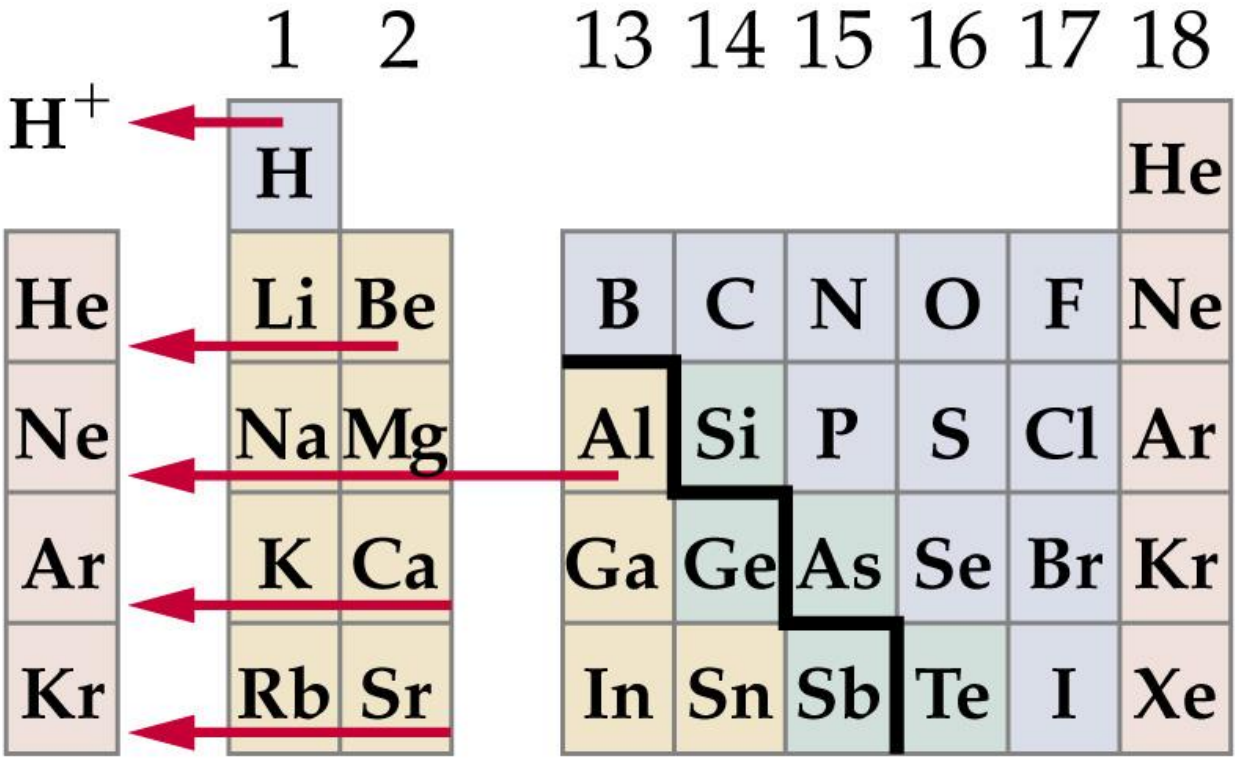
A periódusos táblázat



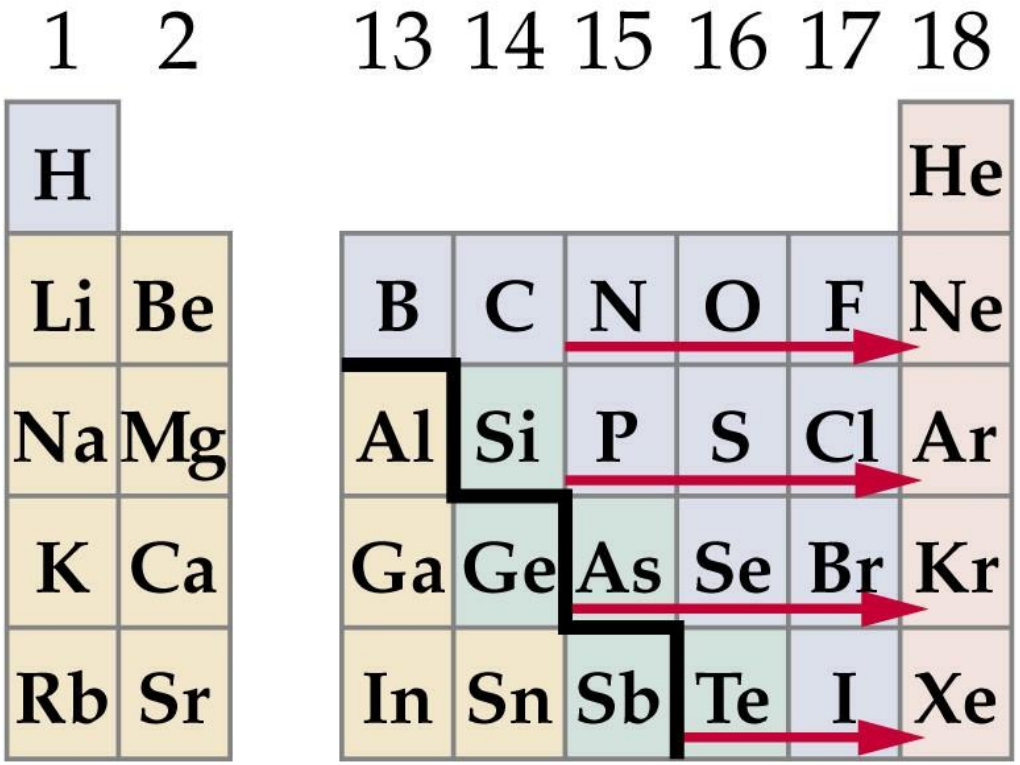
11-2 Fémek, nemfémek és ionjaik

- Fémek
  - Jó hő és elektromos vezetők.
  - Alakíthatók.
  - Mérsékelt – magas op.
- Nemfémek
  - Nem vezetik a hőt és az elektromosságot.
  - Törékenyek.
  - Néhányuk gáz.

A fémek elektron leadásra hajlamosak

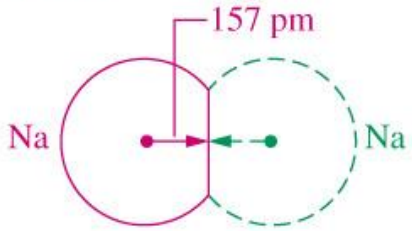


A nemfémek az elektron felvételre hajlamosak

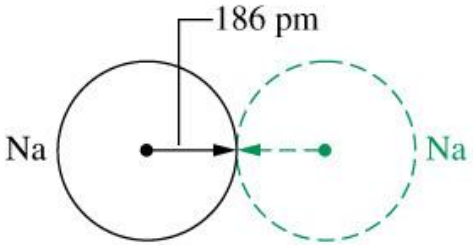


11-3 Az atomok és ionok mérete

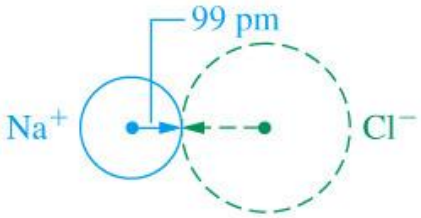
Covalent radius:



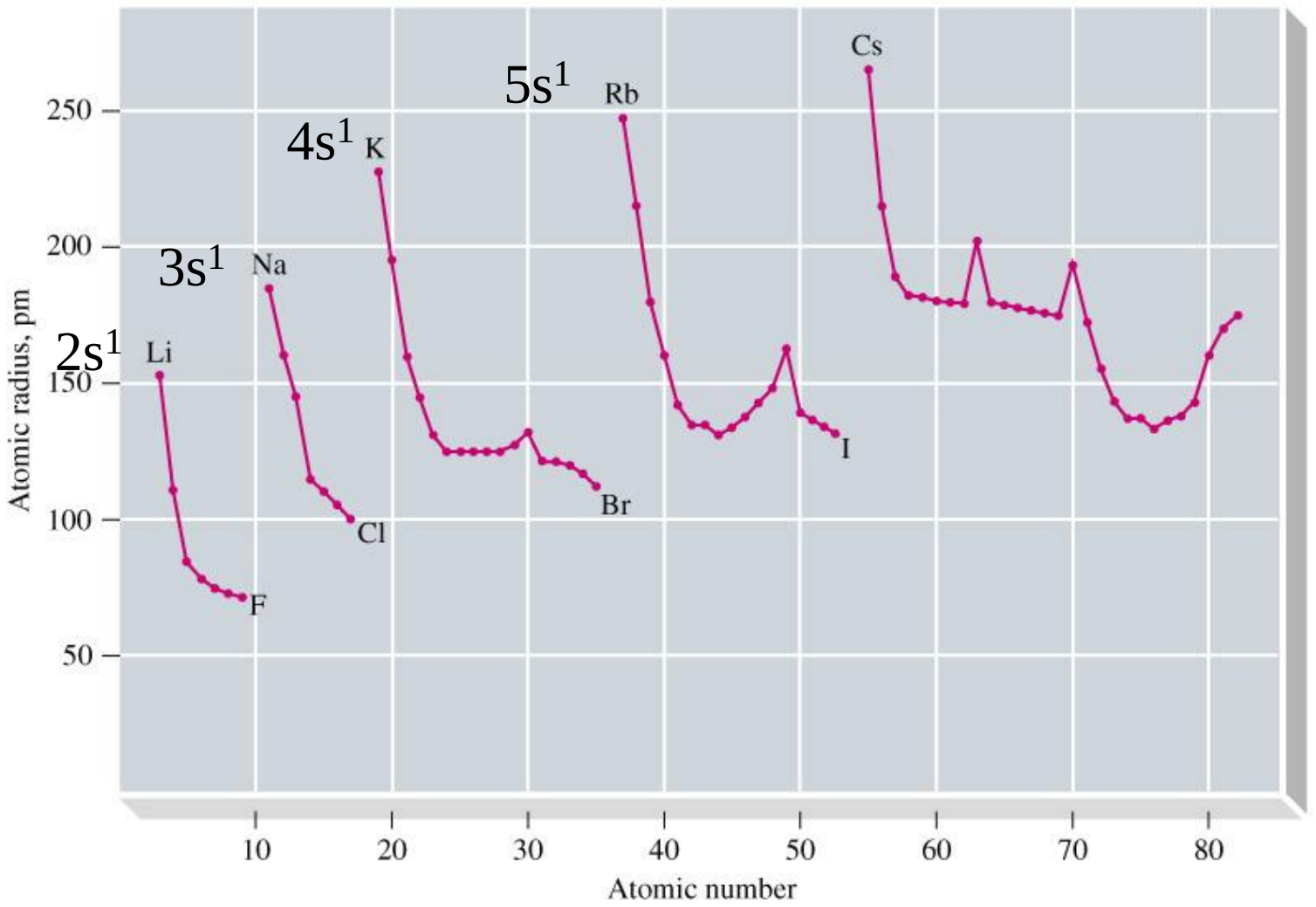
Metallic radius:



Ionic radius:



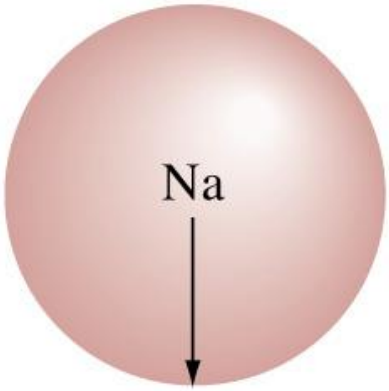
Az atomsugár



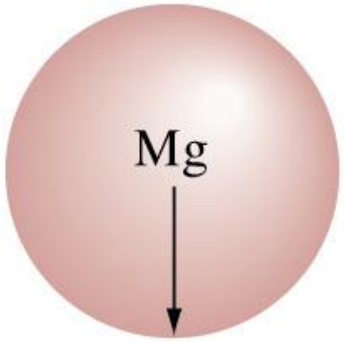
Kation sugár

Z=11 Z=12

[Ne]1s^1



186 pm

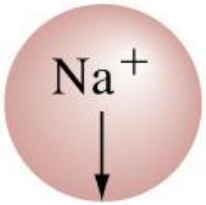


160 pm

[Ne]1s^2

Ne $\rightarrow$ 131 pm

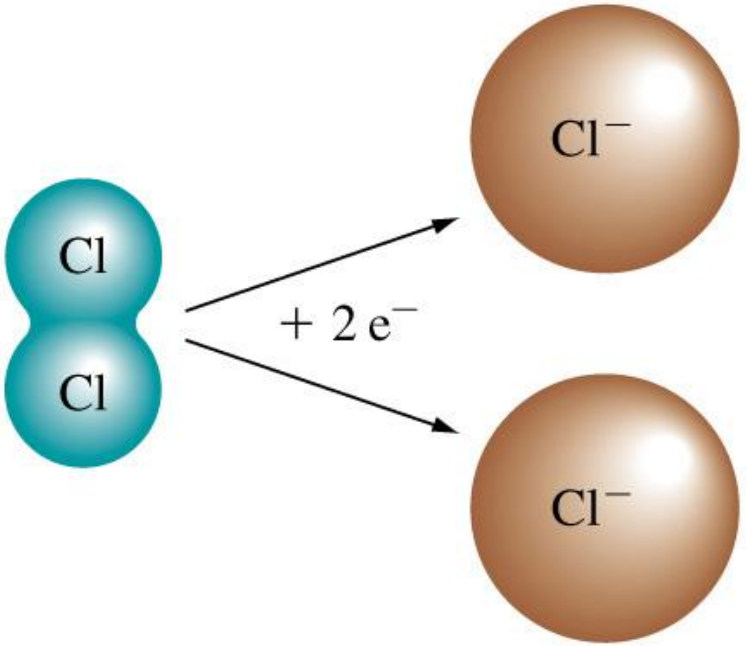
[Ne]



99 pm

72 pm

Anion sugár



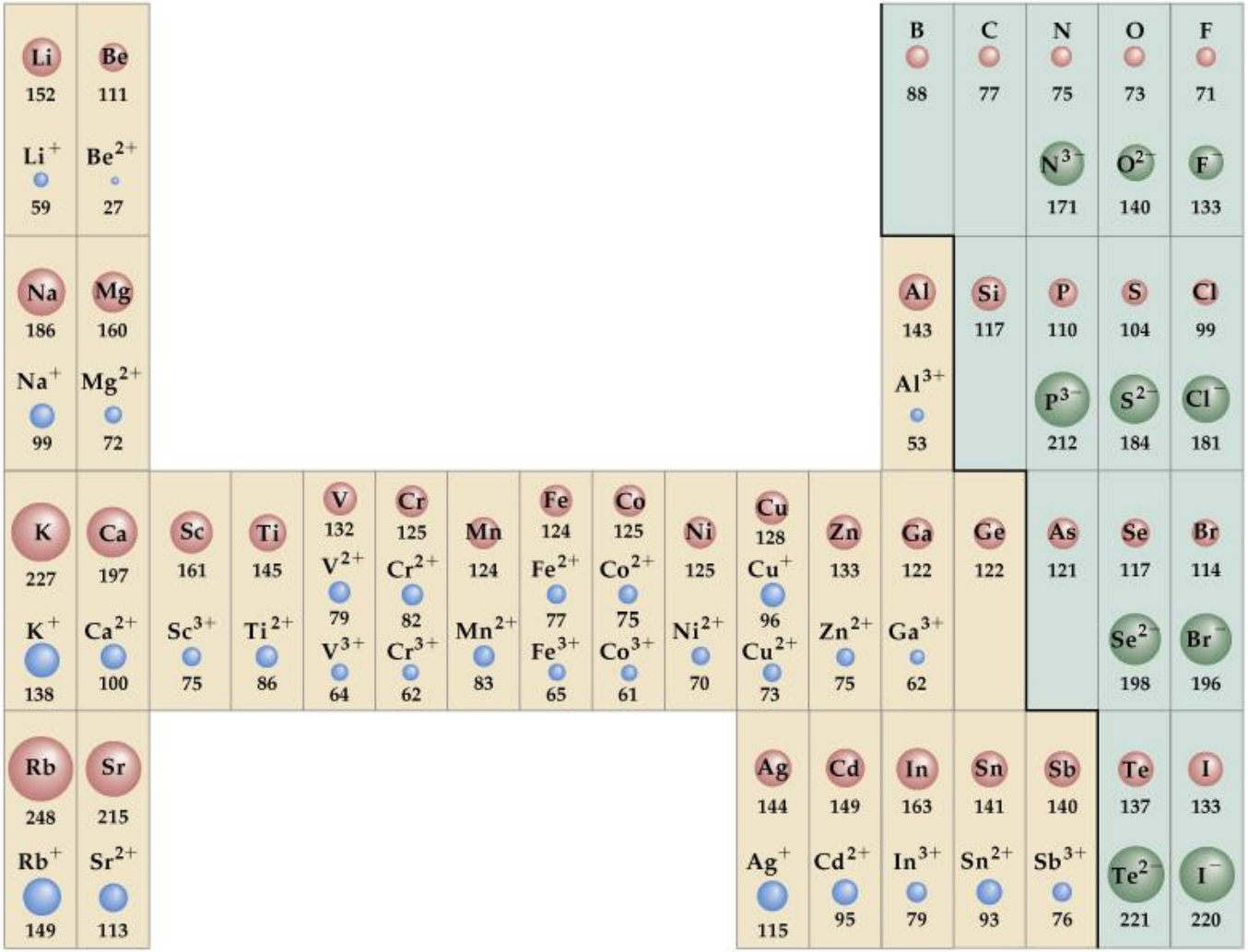
Covalent radius

99 pm

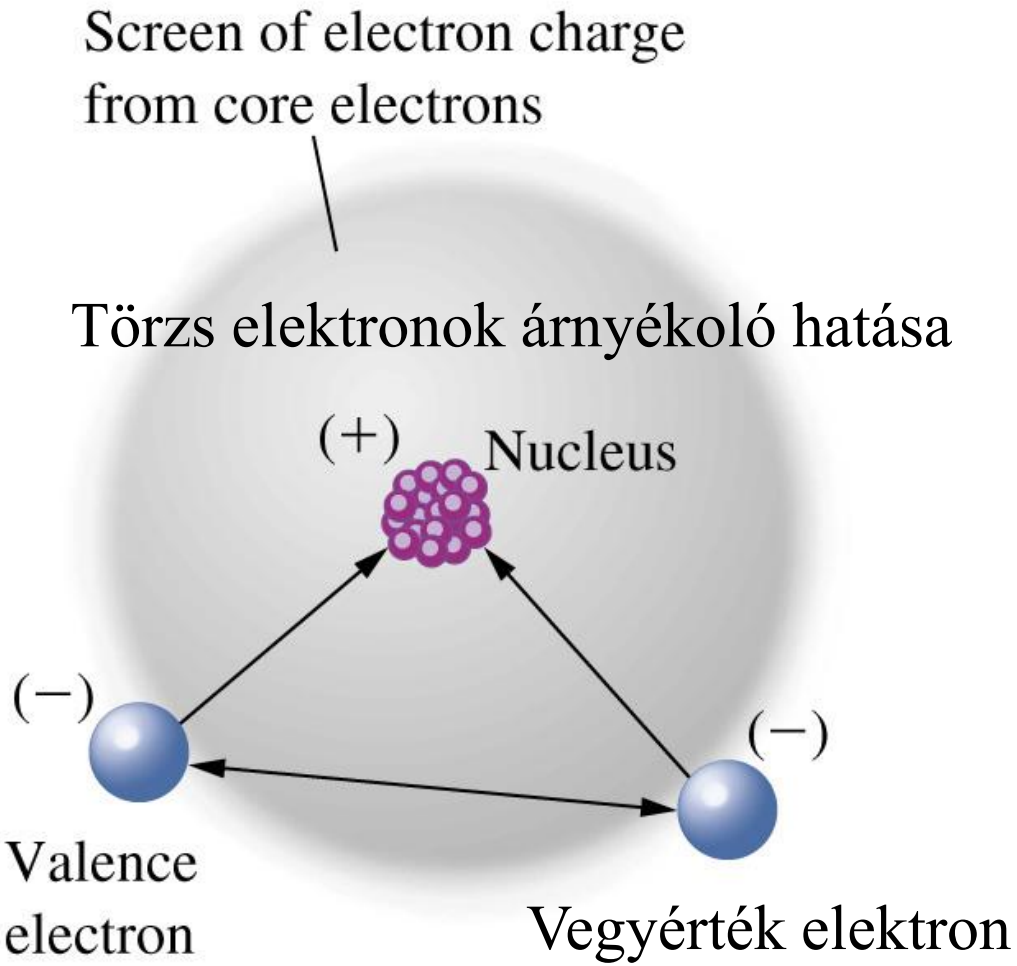
Ionic radius

181 pm

Atom és Ion Sugarak



Árnyékolás



$$Z_{eff} = Z - S$$

$$E_n = - R_H \frac{Z_{eff}^2}{n^2}$$

11-4 Ionizációs energia

$Mg(g) \rightarrow Mg^{+}(g) + e^{-}$ $\quad I_1 = 738$ kJ/mol

$Mg^{+}(g) \rightarrow Mg^{2+}(g) + e^{-}$ $\quad I_2 = 1451$ kJ/mol

$$I = R_H \frac{Z_{eff}^2}{n^2}$$

$S_1 = 2 + 8 \cdot 0.85 + 0.35 = 9.15$

$Z_{eff1} = 2.85$

$S_2 = 2 + 8 \cdot 0.85 = 8.80$

$Z_{eff2} = 3.2$

Első Ionizációs energia

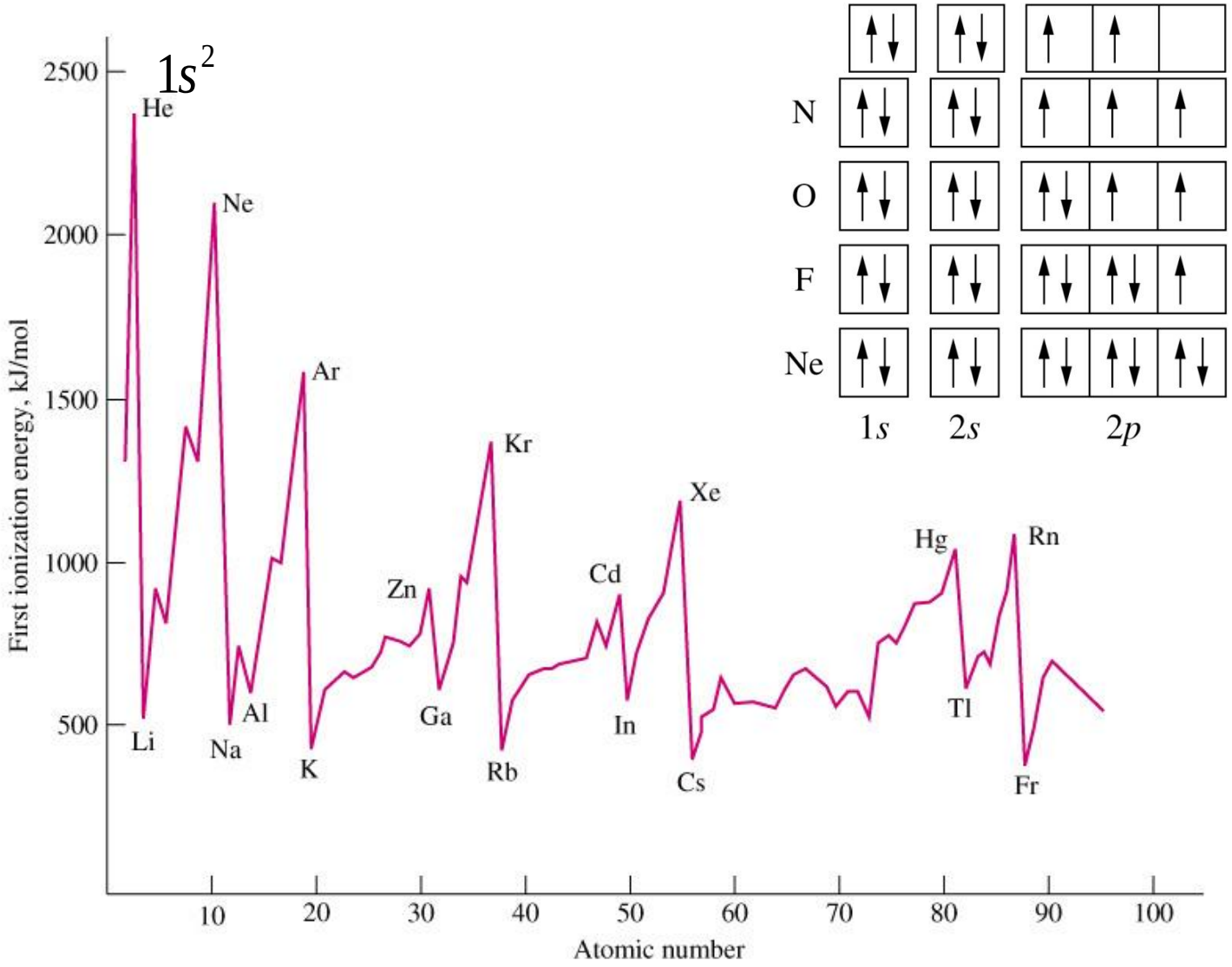


TABLE 10.4 Ionization Energies of the Third-Period Elements (in kJ/mol)

	Na	Mg	Al	Si	P	S	Cl	Ar
I_1	495.8	**737.7**	**577.6**	786.5	**1012**	**999.6**	1251.1	1520.5
I_2	4562	**1451**	1817	1577	1903	2251	2297	2666
I_3		**7733**	2745	3232	2912	3361	3822	3931
I_4			11580	4356	4957	4564	5158	5771
I_5				16090	6274	7013	6542	7238
I_6					21270	8496	9362	8781
I_7						27110	11020	12000

Ionizációs energiák

I_2 (Mg) vs. I_3 (Mg) I_1 (Mg) vs. I_1 (Al) I_1 (P) vs. I_1 (S)

11-5 Elektron affinitás

$F(g) + e^- \rightarrow F^-(g)$ EA = -328 kJ/mol

$F(1s^2 2s^2 2p^5) + e^- \rightarrow F^-(1s^2 2s^2 2p^6)$

$Li(g) + e^- \rightarrow Li^-(g)$ EA = -59.6 kJ/mol

Az első elektronaffinitás [kJ/mol]

1							18
H −72.8	2	13	14	15	16	17	He --
Li −59.6	Be --	B −26.7	C −153.9	N −7	O −141.0	F −328.0	Ne --
Na −52.9	Mg --	Al −42.5	Si −133.6	P −72	S −200.4	Cl −349.0	Ar --
K −48.4	Ca --	Ga −28.9	Ge −119.0	As −78	Se −195.0	Br −324.6	Kr --
Rb −46.9	Sr --	In −28.9	Sn −107.3	Sb −103.2	Te −190.2	I −295.2	Xe --
Cs −45.5	Ba --	Tl −19.2	Pb −35.1	Bi −91.2	Po −186	At −270	Rn --

A második Elektronaffinitás

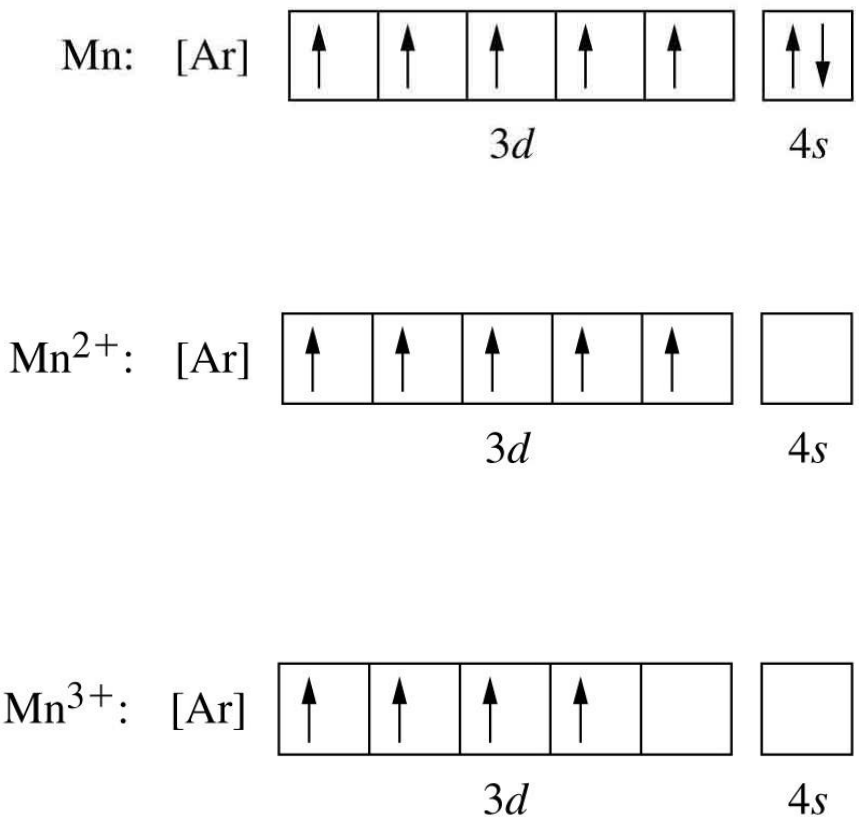
$O(g) + e^- \rightarrow O^-(g)$ EA = -141 kJ/mol

$O^-(g) + e^- \rightarrow O^{2-}(g)$ EA = +744 kJ/mol

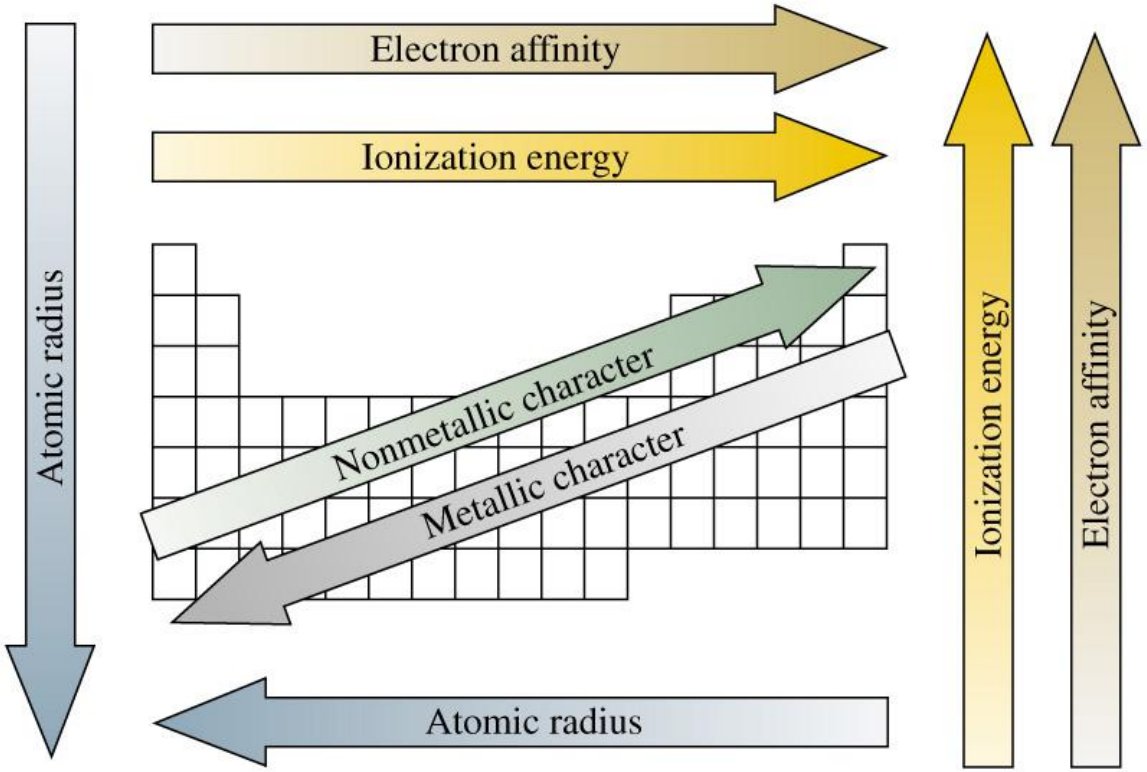
11-6 Mágneses tulajdonságok

- Diamágneses atomok vagy ionok:
  - Minden e^- párosítva.
  - A mágneses tér gyengén taszítja.
- Paramágneses atomok vagy ionok:
  - *Párosítatlan* e^-.
  - A külső mágneses tér vonzza.

Paramágnesesség



11-7 Az elemek periódikus tulajdonságai

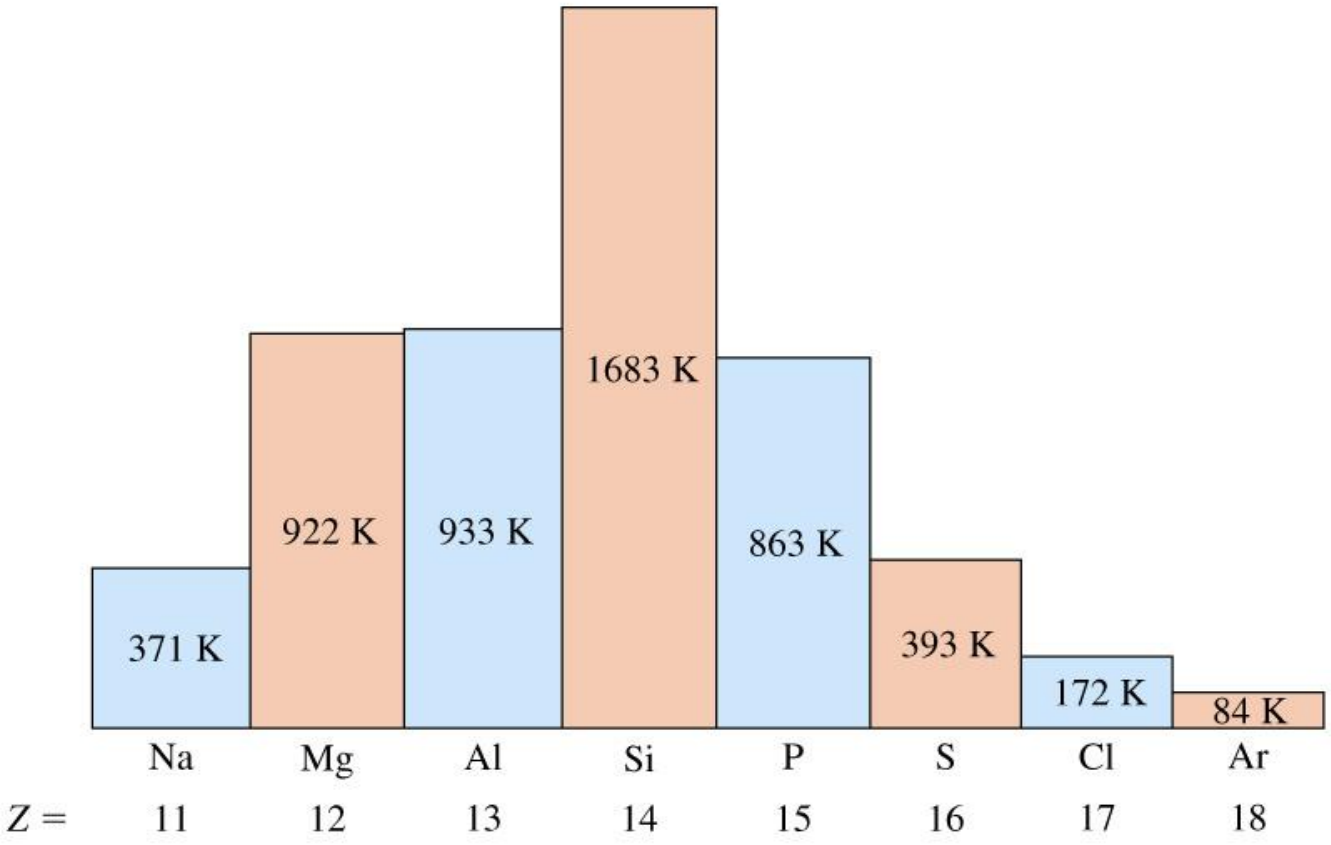


Olvadáspont, forráspont

TABLE 10.5 Some Properties of Three Halogen (Group 17) Elements

	Atomic Number	Atomic Mass, u	Molecular Form	Melting Point, K	Boiling Point, K
Cl	17	35.45	Cl_2	172	239
Br	35	79.90	Br_2	?	?
I	53	126.90	I_2	387	458

Elemek olvadáspontja

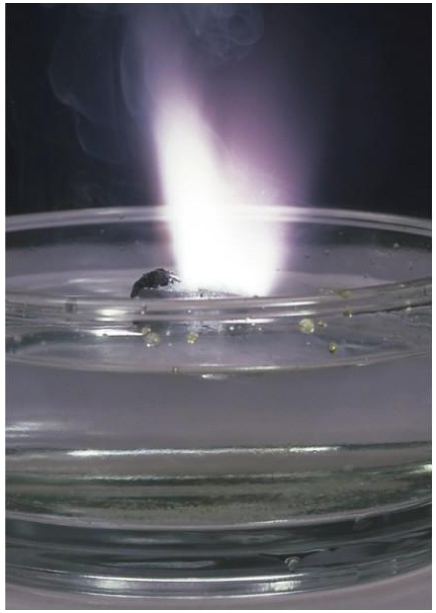


Két sorozat olvadáspontjai

TABLE 10.6 Melting Points of Two Series of Compounds

	Molecular Mass, u	Melting Point, °C
CF_4	88.0	−183.7
CCl_4	153.8	−22.9
CBr_4	331.6	90.1
CI_4	519.6	171
HF	20.0	−83.6
HCl	36.5	−114.2
HBr	80.9	−86.8
HI	127.9	−50.8

A 1. és 2. csoportba tartozó fémek redukciós képessége



$$2\ K(s) + 2\ H_2O(l) \rightarrow 2\ K^+ + 2\ OH^- + H_2(g)$$

$I_1 = 419$ kJ

$I_1 = 590$ kJ

$I_2 = 1145$ kJ

$$Ca(s) + 2\ H_2O(l) \rightarrow Ca^{2+} + 2\ OH^- + H_2(g)$$

Halogének oxidálóképessége

$$2\ Na + Cl_2 \rightarrow 2\ NaCl$$

(a) (b)

$$Cl_2 + 2\ I^- \rightarrow 2\ Cl^- + I_2$$

Elemi oxidok sav-bázis tulajdonságai

- Bázikus oxidok van anhidridek:

  $Li_2O(s) + H_2O(l) \rightarrow 2\ Li^+(aq) + 2\ OH^-(aq)$

- Savas oxidok vagy anhidridek:

  $SO_2\ (g) + H_2O(l) \rightarrow\ H_2SO_3(aq)$

- Na_2O, MgO bázisos oldat
- Cl_2O, SO_2 , P_4O_{10} savas oldat
- SiO_2 erős bázisban oldódik, savas oxid.

Fókusz Hg és a periodikusság

- Szilárdnak kellene lennie.
- Az s-pályák relativisztikus összehúzódása a Hg esetében különösen nagy.
- Az Au színe a relativisztikus hatás miatt vöröses.