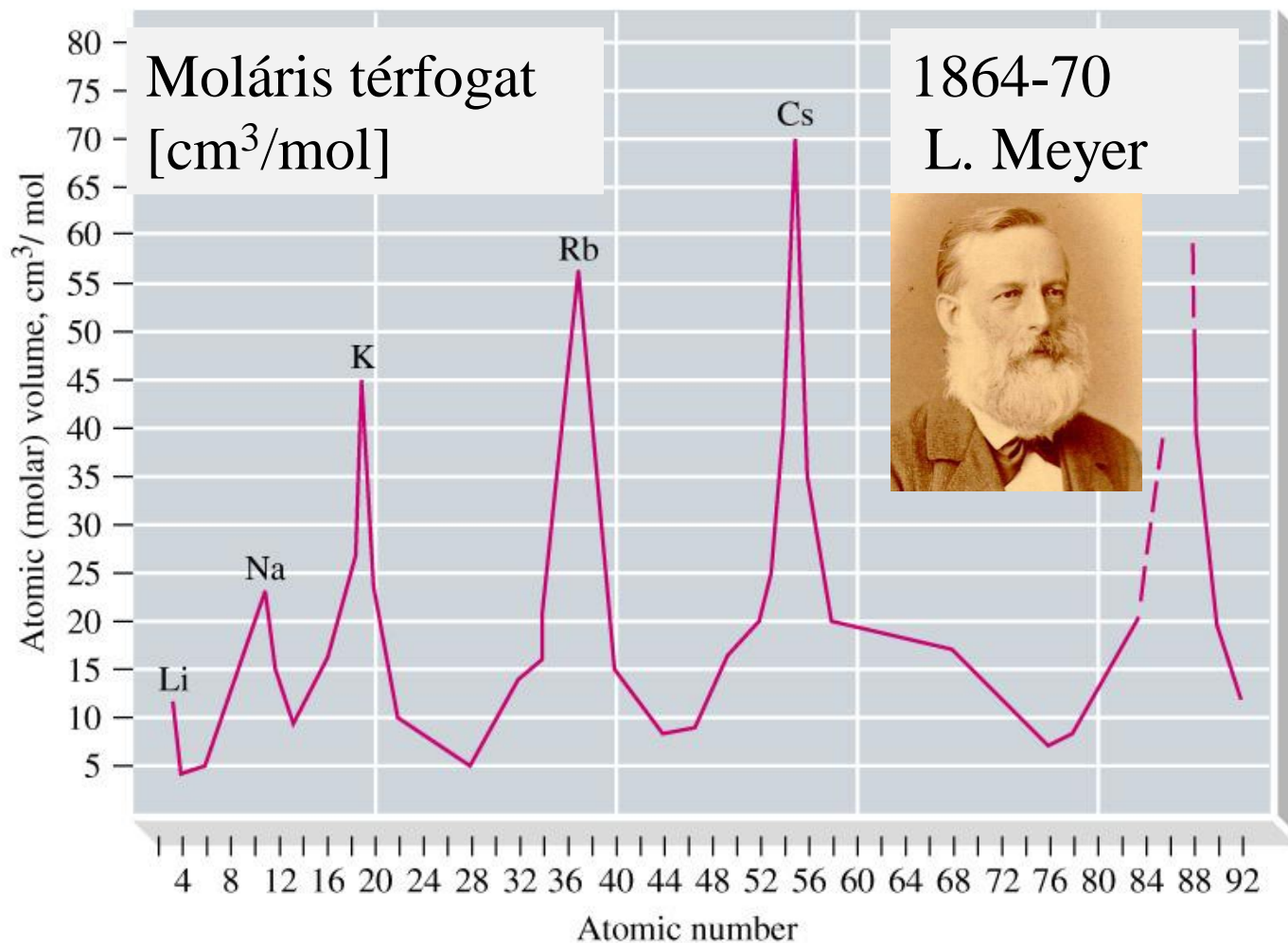


Periódusosság

- 3-1 Az elemek csoportosítása: a periódusos táblázat
- 3-2 Fémek, nemfémek és ionjaik
- 3-3 Az atomok és ionok mérete
- 3-4 Ionizációs energia
- 3-5 Elektron affinitás
- 3-6 Mágneses tulajdonságok
- 3-7 Az elemek periodikus tulajdonságai
 - *Fókusz Higany*

3-1 Az elemek csoportosítása: a periódusos táblázat



Mengyelejev periódusos táblázata

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

| Reihen | Gruppe I. — R ² O | Gruppe II. — RO | Gruppe III. — R ² O ³ | Gruppe IV. RH ⁴ RO ² | Gruppe V. RH ³ R ² O ⁵ | Gruppe VI. RH ² RO ³ | Gruppe VII. RH R ² O 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

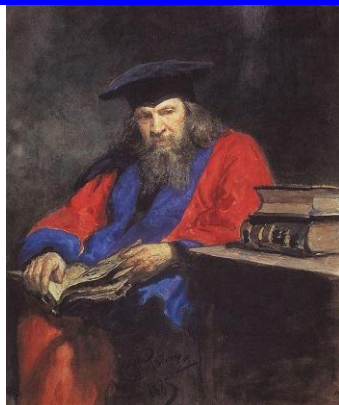


TABLE 10.1 Properties of Germanium: Predicted and Observed

| 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 |

Szilícium, germánium és szén



5mm
1/4"



3-2 Fémek, nemfémek és ionjaik

- Fémek
 - Jó hő és elektromos vezetők.
 - Alakíthatók.
 - Mérsékelt – magas op.
 - Fémes kristály, az elektronok szabadon mozognak
- Nemfémek
 - Nem vezetik a hőt és az elektromosságot.
 - Törékenyek.
 - Néhányuk gáz.

A fémek elektron leadásra hajlamosak

| | 1 | 2 | 13 | 14 | 15 | 16 | 17 | 18 |
|----------------|----|----|----|----|----|----|----|----|
| H ⁺ | H | | | | | | | He |
| He | Li | Be | B | C | N | O | F | Ne |
| Ne | Na | Mg | Al | Si | P | S | Cl | Ar |
| Ar | K | Ca | Ga | Ge | As | Se | Br | Kr |
| Kr | Rb | Sr | In | Sn | Sb | Te | I | Xe |

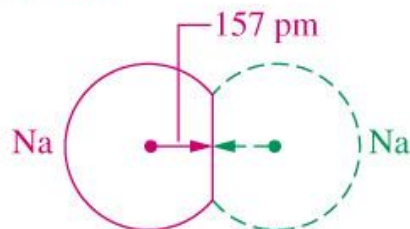
A nemfémek az elektron felvételre hajlamosak

| 1 | 2 | 13 | 14 | 15 | 16 | 17 | 18 |
|----|----|----|----|----|----|----|----|
| H | | | | | | | He |
| Li | Be | B | C | N | O | F | Ne |
| Na | Mg | Al | Si | P | S | Cl | Ar |
| K | Ca | Ga | Ge | As | Se | Br | Kr |
| Rb | Sr | In | Sn | Sb | Te | I | Xe |

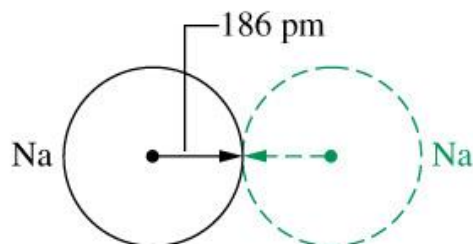
The diagram shows a portion of the periodic table with columns labeled 1, 2, 13, 14, 15, 16, 17, and 18. Elements are placed in colored boxes: H (light blue), He (light pink), Li, Be, Na, Mg, K, Ca, Rb, Sr (yellow), B, C, N, O, F, Ne, Al, Si, P, S, Cl, Ar, Ga, Ge, As, Se, Br, Kr, In, Sn, Sb, Te, I, Xe (light blue). A thick black line outlines the nonmetal region, starting from Al and moving down to Sb. Red arrows point from N to Ne, Si to Ar, As to Kr, and Te to Xe, indicating the direction of increasing electronegativity.

3-3 Az atomok és ionok mérete

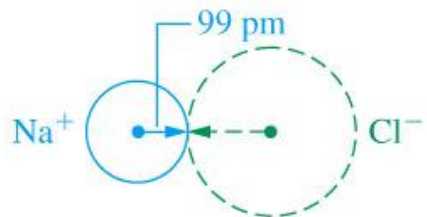
Covalent radius:



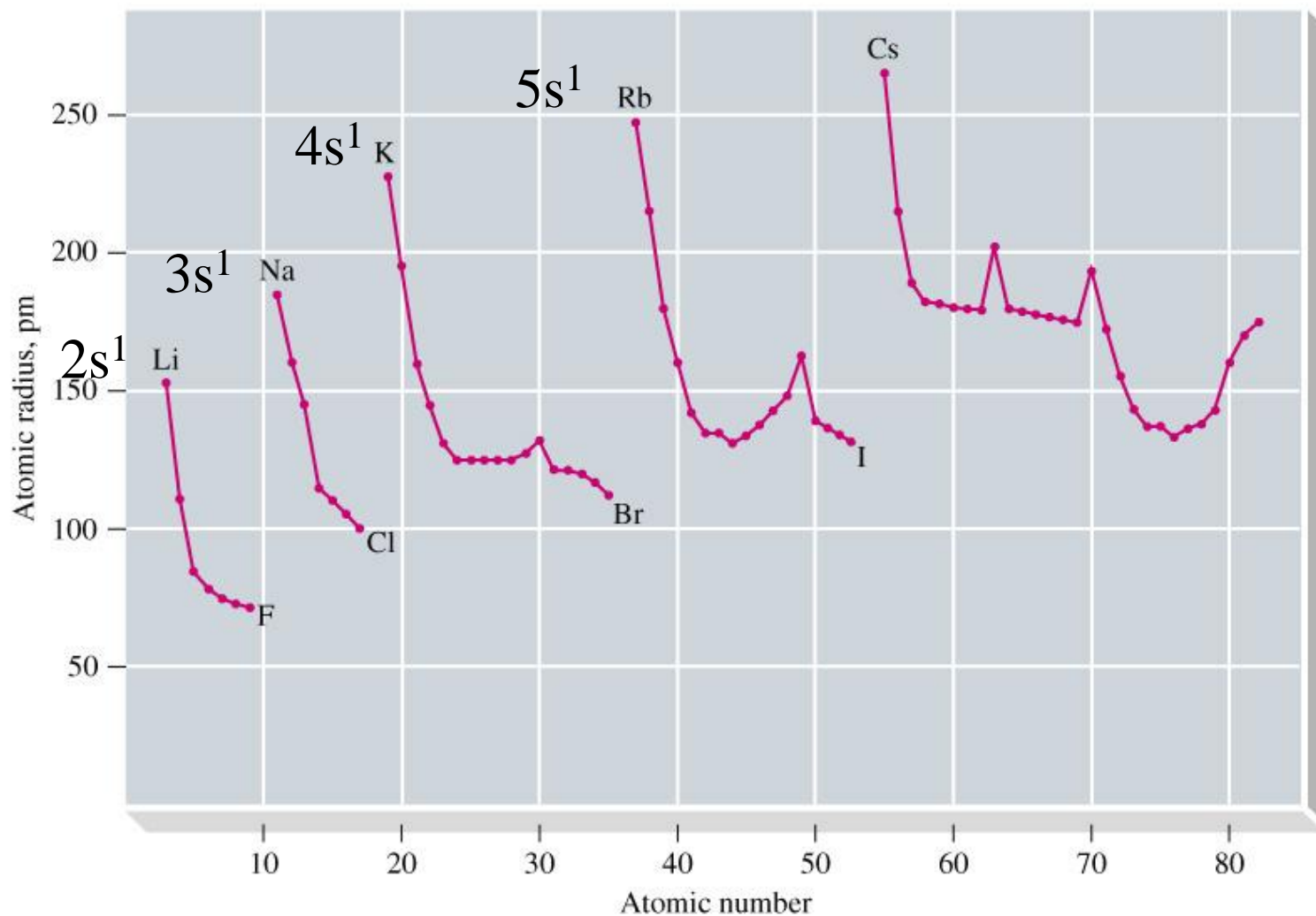
Metallic radius:



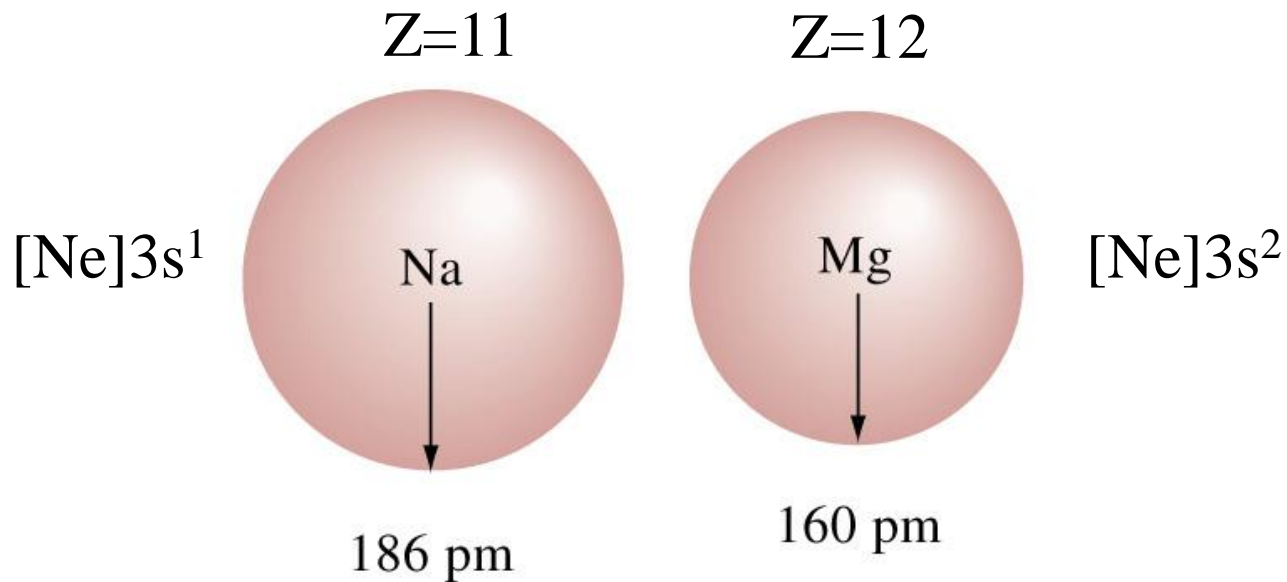
Ionic radius:



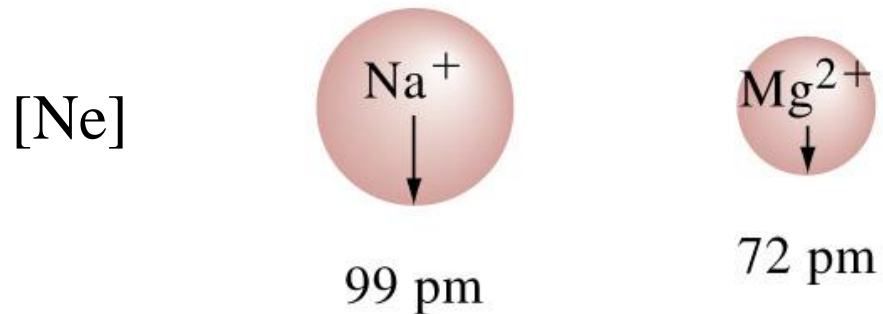
Az atomsugár



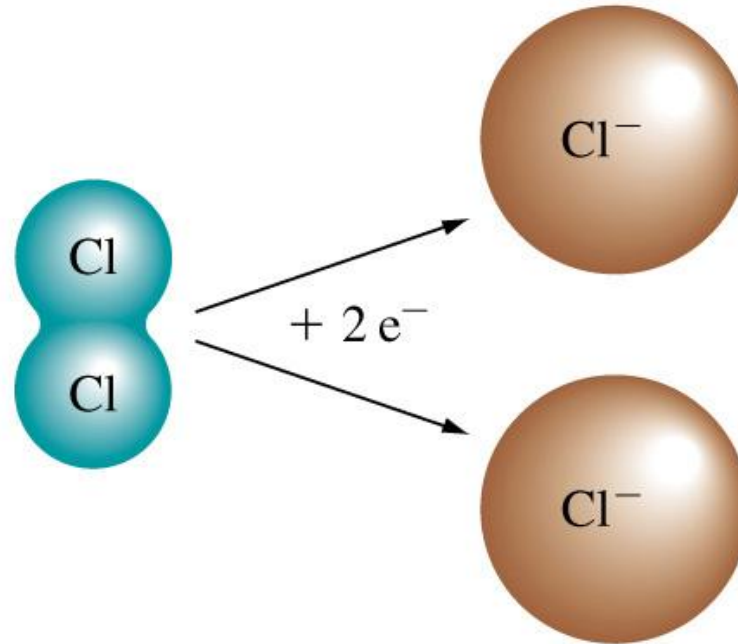
Kation sugár



Ne → 131 pm



Anion sugár



Covalent
radius
99 pm

Ionic
radius
181 pm

Atom és Ion Sugarak

| | | | | | | | | | | | | | | | | | | |
|--|---|--|--|---|--|--|--|--|--|---|--|--|--|--|---|--|---|--|
| Li 152 Li⁺ 59 | Be 111 Be²⁺ 27 | | | | | | | | | | | B 88 | C 77 | N 75 N³⁻ 171 | O 73 O²⁻ 140 | F 71 F⁻ 133 | | |
| Na 186 Na⁺ 99 | Mg 160 Mg²⁺ 72 | | | | | | | | | | | Al 143 Al³⁺ 53 | Si 117 | P 110 P³⁻ 212 | S 104 S²⁻ 184 | Cl 99 Cl⁻ 181 | | |
| K 227 K⁺ 138 | Ca 197 Ca²⁺ 100 | Sc 161 Sc³⁺ 75 | Ti 145 Ti²⁺ 86 | V 132 V²⁺ 79 V³⁺ 64 | Cr 125 Cr²⁺ 82 Cr³⁺ 62 | Mn 124 Mn²⁺ 83 | Fe 124 Fe²⁺ 77 Fe³⁺ 65 | Co 125 Co²⁺ 75 Co³⁺ 61 | Ni 125 Ni²⁺ 70 | Cu 128 Cu⁺ 96 Cu²⁺ 73 | Zn 133 Zn²⁺ 75 | Ga 122 Ga³⁺ 62 | Ge 122 | As 121 | Se 117 Se²⁻ 198 | Br 114 Br⁻ 196 | | |
| Rb 248 Rb⁺ 149 | Sr 215 Sr²⁺ 113 | | | | | | | | | | | Ag 144 Ag⁺ 115 | Cd 149 Cd²⁺ 95 | In 163 In³⁺ 79 | Sn 141 Sn²⁺ 93 | Sb 140 Sb³⁺ 76 | Te 137 Te²⁻ 221 | I 133 I⁻ 220 |

3-4 Ionizációs energia



Az előző órán láttuk:

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

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

$$Z_{\text{eff}1} = 2.85$$

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

$$Z_{\text{eff}2} = 3.2$$

Első Ionizációs energia

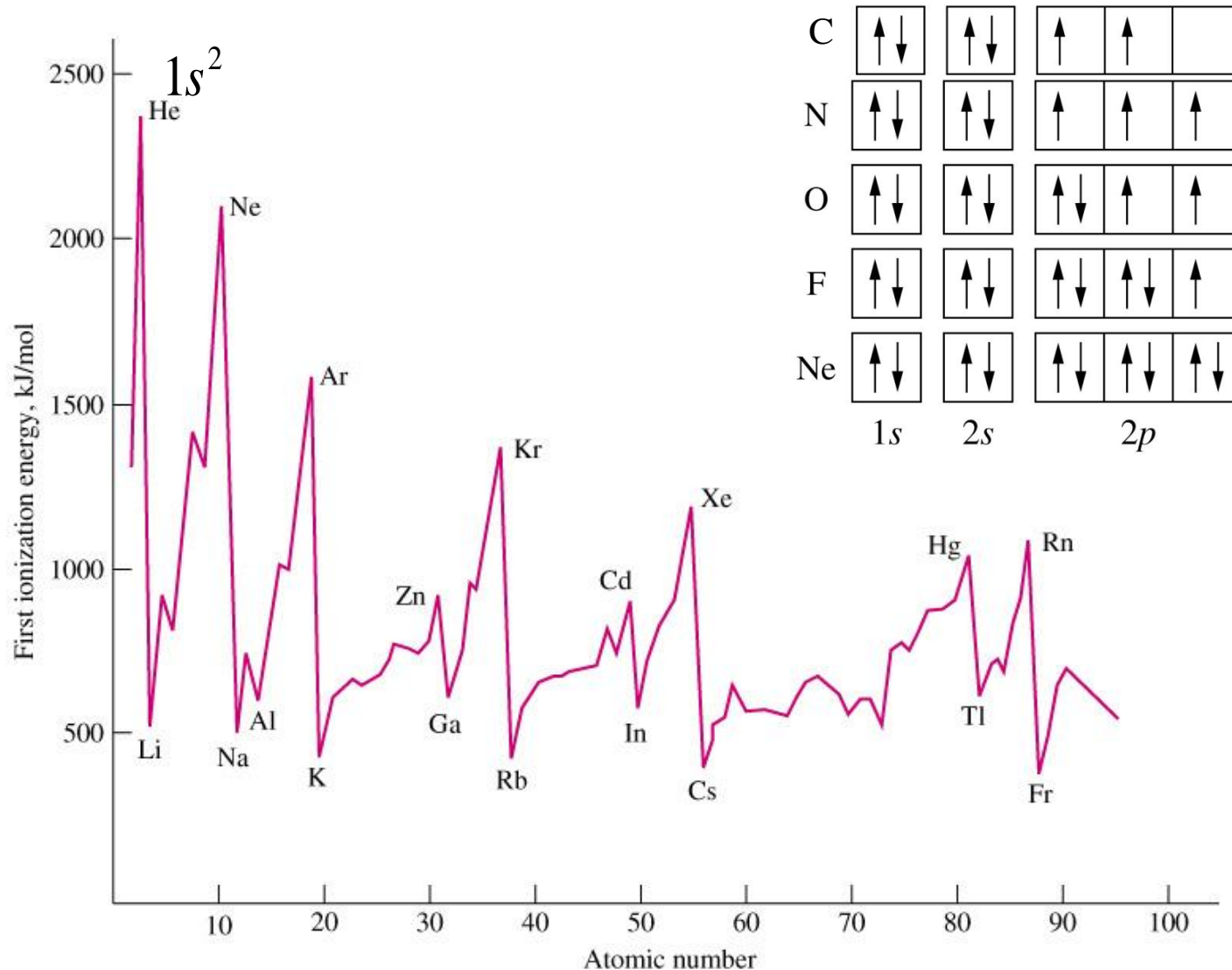


TABLE 10.4 Ionization Energies of the Third-Period Elements (in kJ/mol)

| | 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 |

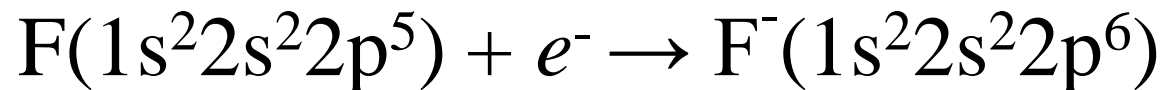
Ionizációs energiák

I_2 (Mg) vs. I_3 (Mg)

I_1 (Mg) vs. I_1 (Al)

I_1 (P) vs. I_1 (S)

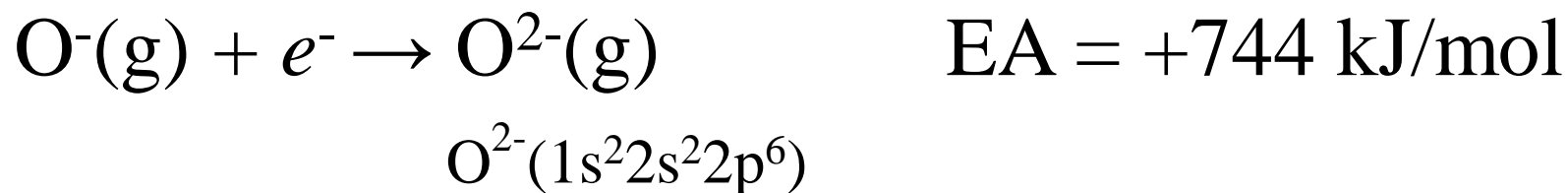
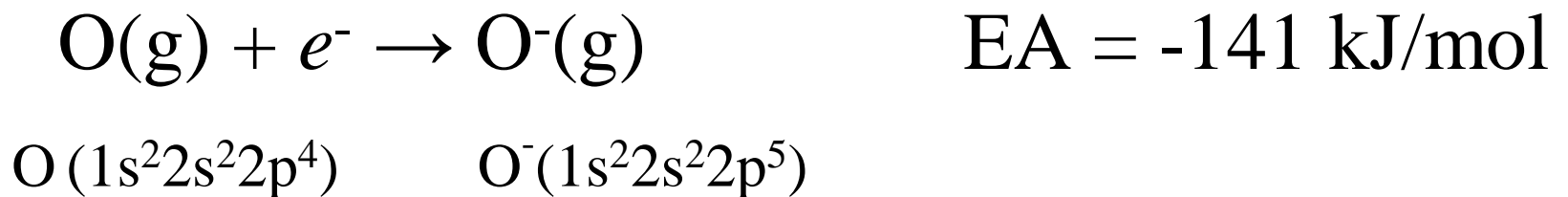
3-5 Elektron affinitás



Az első elektronaffinitás [kJ/mol]

| 1 | | 2 | 13 | 14 | 15 | 16 | 17 | 18 |
|--------------------|-----------------|--------------------|---------------------|---------------------|---------------------|---------------------|----|-----------------|
| H -72.8 | | | | | | | | 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 -- |

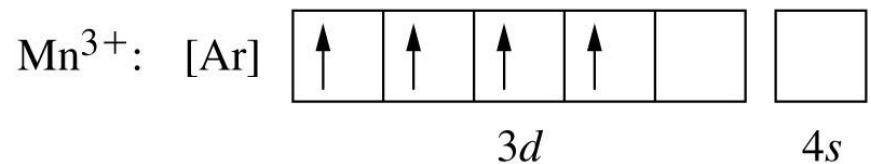
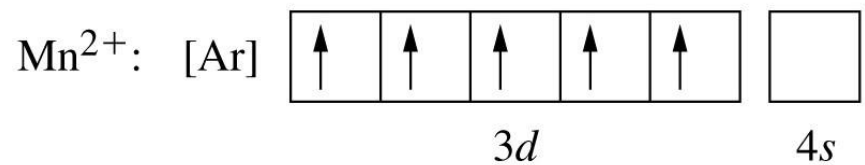
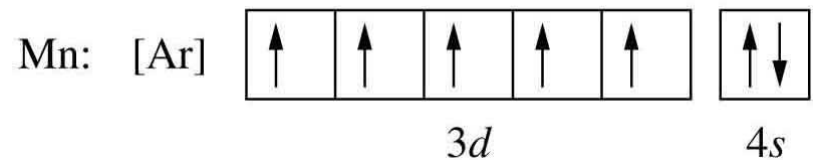
A második Elektronaffinitás



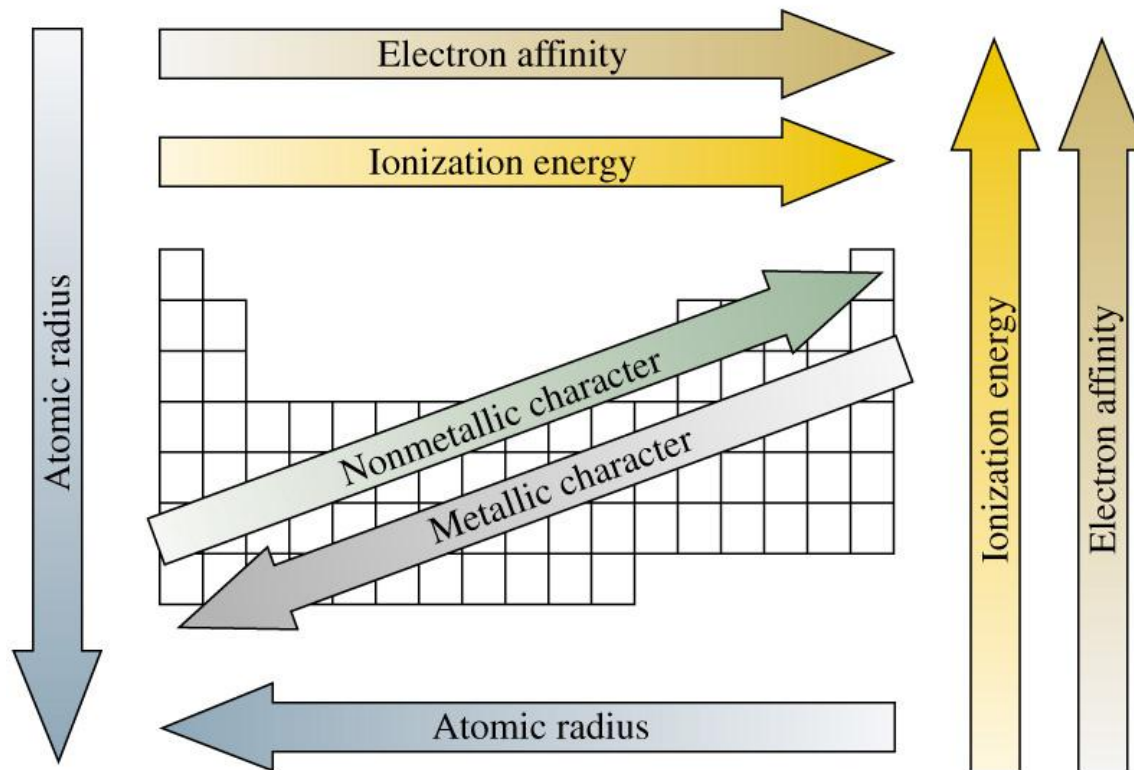
3-6 Mágneses tulajdonságok

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

Paramágnesesség



3-7 Az elemek periódikus tulajdonságai



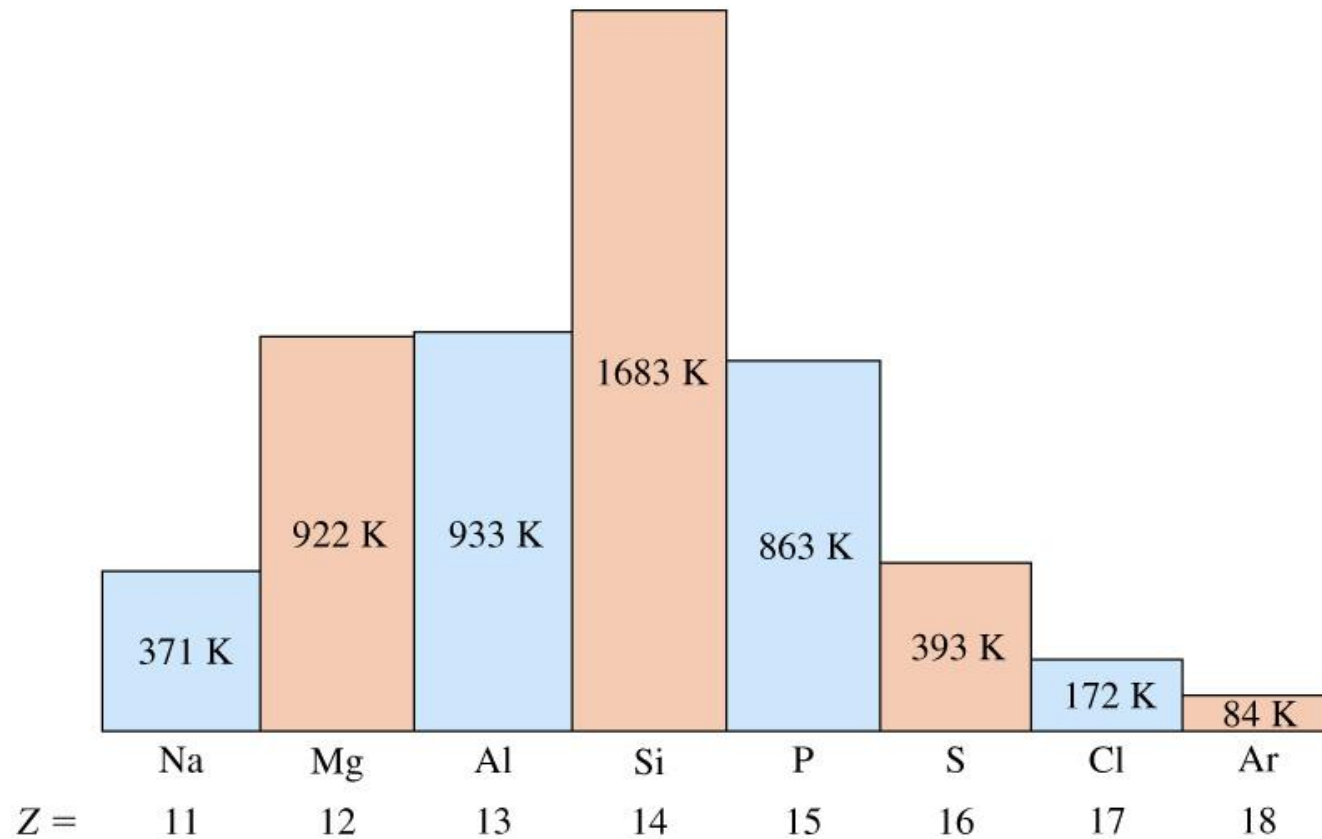
Olvadáspont, forráspont



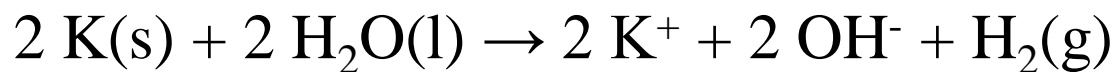
TABLE 10.5 Some Properties of Three Halogen (Group 17) Elements

| | 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



A 1. és 2. csoportba tartozó fémek redukációs képessége



$$I_1 = 419 \text{ kJ}$$

$$I_1 = 590 \text{ kJ}$$

$$I_2 = 1145 \text{ kJ}$$

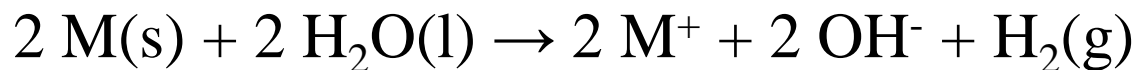
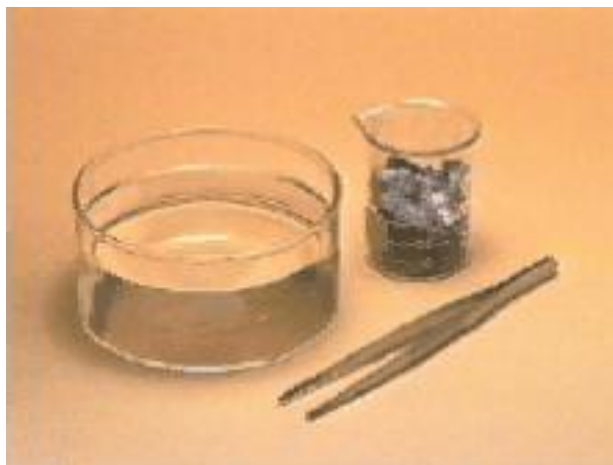


Az 1. csoportba tartozó fémek redukációs képessége közötti különbségek

• Li + víz

Na + víz

K + víz



■ *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.

