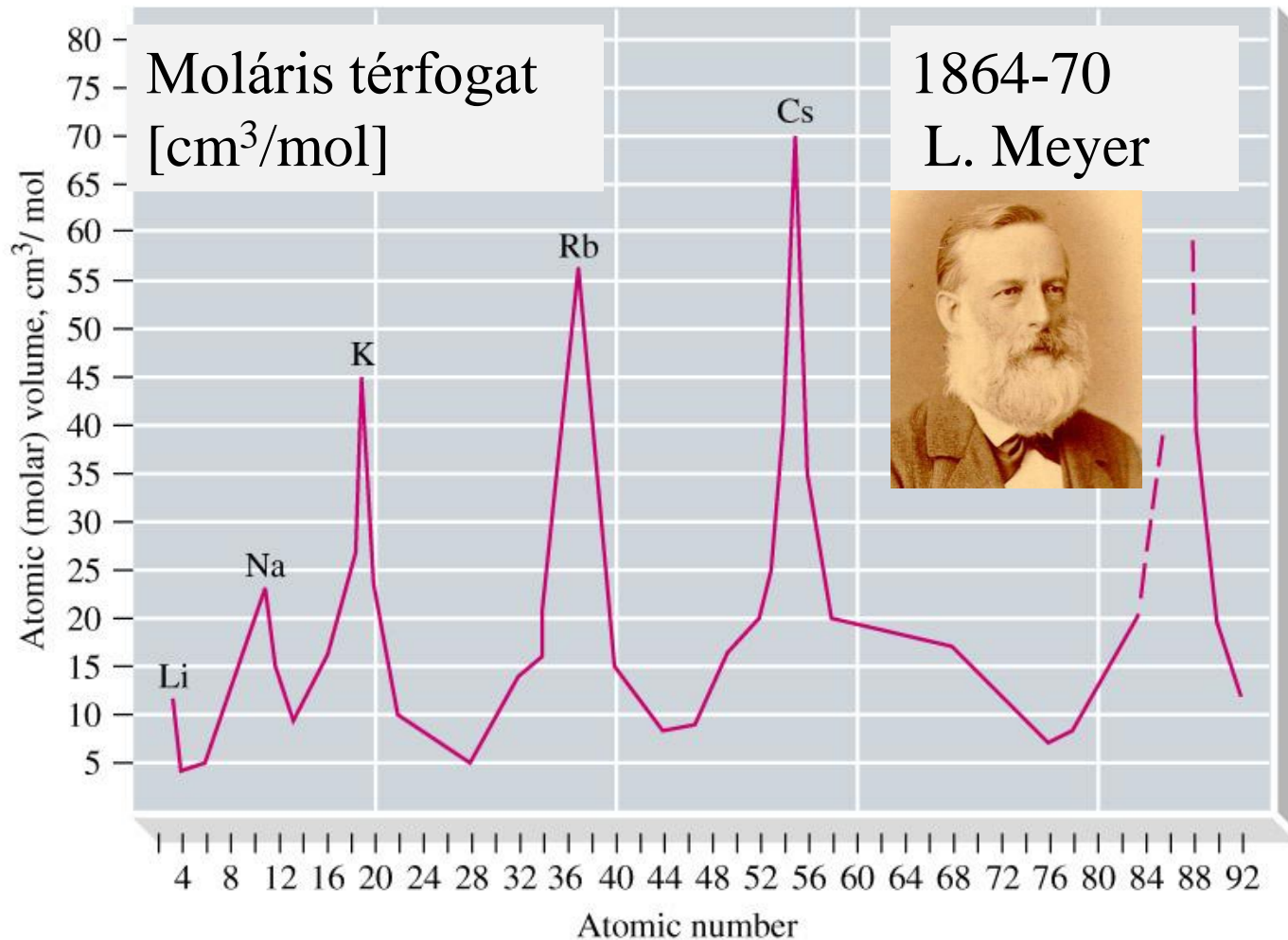


Periódusosság

- 11-1 Az elemek csoportosítása: a periódusos táblázat
- 11-2 Fémek, nemfémek és ionjaik
- 11-3 Az atomok és ionok mérete
- 11-4 Ionizációs energia
- 11-5 Elektron affinitás
- 11-6 Mágneses tulajdonságok
- 11-7 Az elemek periódikus tulajdonságai
 - *Fókusz Higany*

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 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

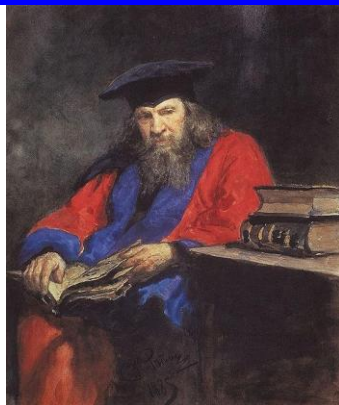
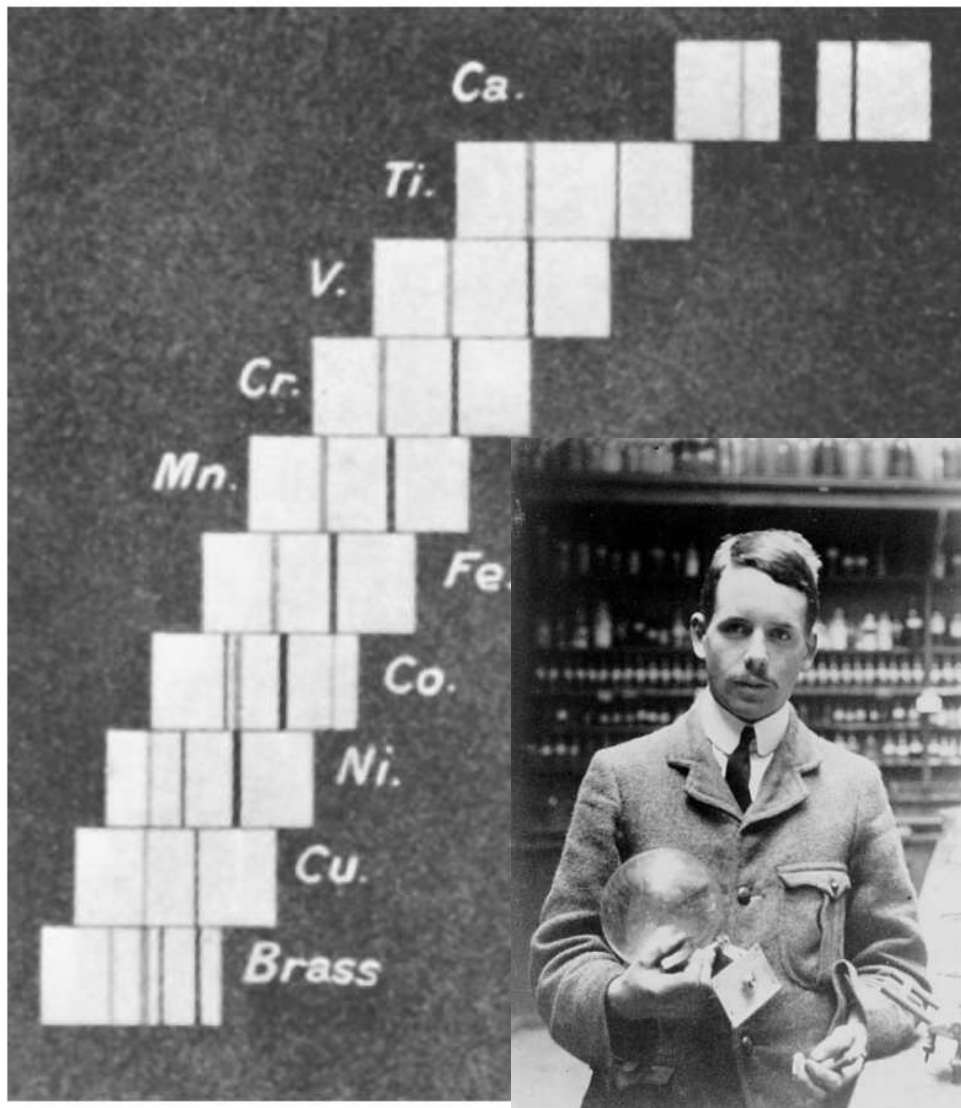


TABLE 10.1 Properties of Germanium: Predicted and Observed

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

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 $Z-1$?

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

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

Alkáli fémek

A periódusos táblázat

Nemesgázok

Alkali földfémek

Halogének

Fő csoport

Átmeneti fémek

1 1A	2 2A	3 3B	4 4B	5 5B	6 6B	7 7B	8 8B	9	10	11 1B	12 2B	13 3A	14 4A	15 5A	16 6A	17 7A	18 8A
1 H 1.00794	2 He 4.00260	3 Li 6.941	4 Be 9.01218	5 B 10.811	6 C 12.011	7 N 14.0067	8 O 15.9994	9 F 18.9984	10 Ne 20.1797	11 Na 22.9898	12 Mg 24.3050	13 Al 26.9815	14 Si 28.0855	15 P 30.9738	16 S 32.06	17 Cl 35.4527	18 Ar 39.948
19 K 39.0983	20 Ca 40.078	21 Sc 44.9559	22 Ti 47.88	23 V 50.9415	24 Cr 51.9961	25 Mn 54.9381	26 Fe 55.847	27 Co 58.9332	28 Ni 58.693	29 Cu 63.546	30 Zn 65.39	31 Ga 69.723	32 Ge 72.61	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 91.224	41 Nb 92.9064	42 Mo 95.94	43 Tc (98)	44 Ru 101.07	45 Rh 102.906	46 Pd 106.42	47 Ag 107.868	48 Cd 112.411	49 In 114.818	50 Sn 118.710	51 Sb 121.757	52 Te 127.60	53 I 126.904	54 Xe 131.29
55 Cs 132.905	56 Ba 137.327	57 *La 138.906	72 Hf 178.49	73 Ta 180.948	74 W 183.84	75 Re 186.207	76 Os 190.23	77 Ir 192.22	78 Pt 195.08	79 Au 196.967	80 Hg 200.59	81 Tl 204.383	82 Pb 207.2	83 Bi 208.980	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra 226.025	89 †Ac 227.028	104 Rf (261)	105 Db (262)	106 Sg (263)	107 Bh (262)	108 Hs (265)	109 Mt (266)	110 (269)	111 (272)	112 (272)	114 (287)	116 (289)	118 (293)	118 (293)	118 (293)	118 (293)
*Lanthanide series			58 Ce 140.115	59 Pr 140.908	60 Nd 144.24	61 Pm (145)	62 Sm 150.36	63 Eu 151.965	64 Gd 157.25	65 Tb 158.925	66 Dy 162.50	67 Ho 164.930	68 Er 167.26	69 Tm 168.934	70 Yb 173.04	71 Lu 174.967	
†Actinide series			90 Th 232.038	91 Pa 231.036	92 U 238.029	93 Np 237.048	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (260)	

Fő csoport

Lanthanidák and Actinidák

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

	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

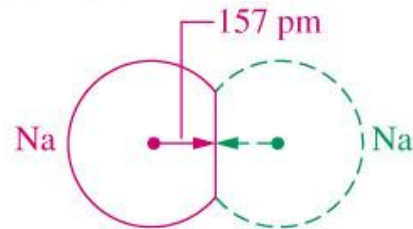
A nemfémek az elektron felvételre hajlamosak

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

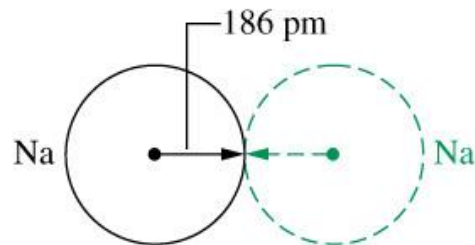
The diagram shows a portion of the periodic table with columns labeled 1, 2, 13, 14, 15, 16, 17, and 18. Elements are placed in colored boxes: H (light blue), He (light red), Li, Be, Na, Mg, K, Ca, Rb, Sr (yellow), B, C, N, O, F, Ne, Al, Si, P, S, Cl, Ar, Ga, Ge, As, Se, Br, Kr, In, Sn, Sb, Te, I, Xe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

11-3 Az atomok és ionok mérete

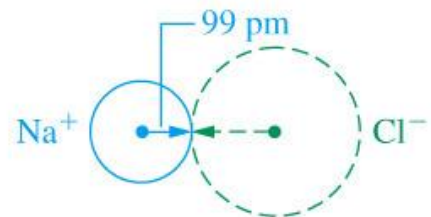
Covalent radius:



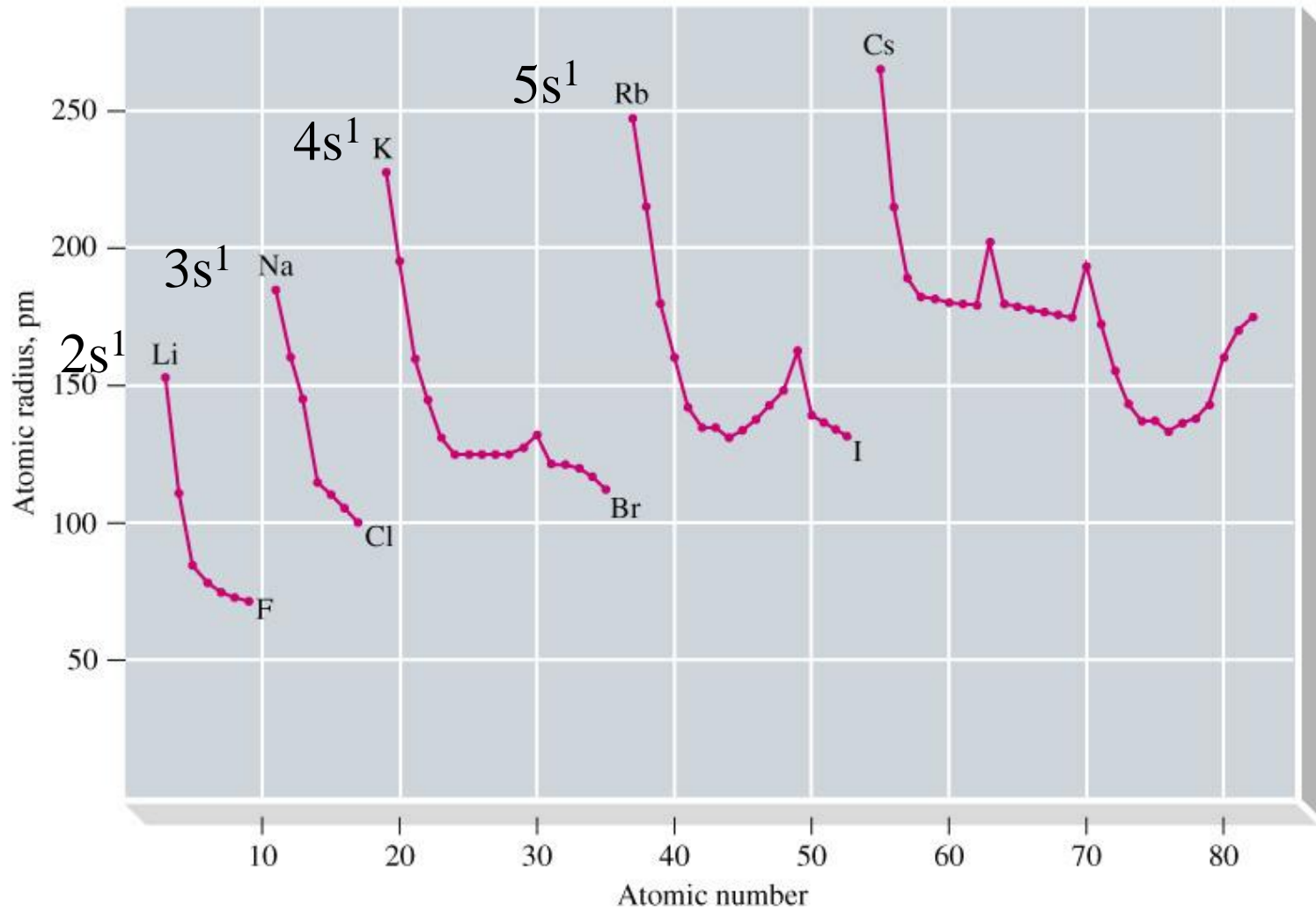
Metallic radius:



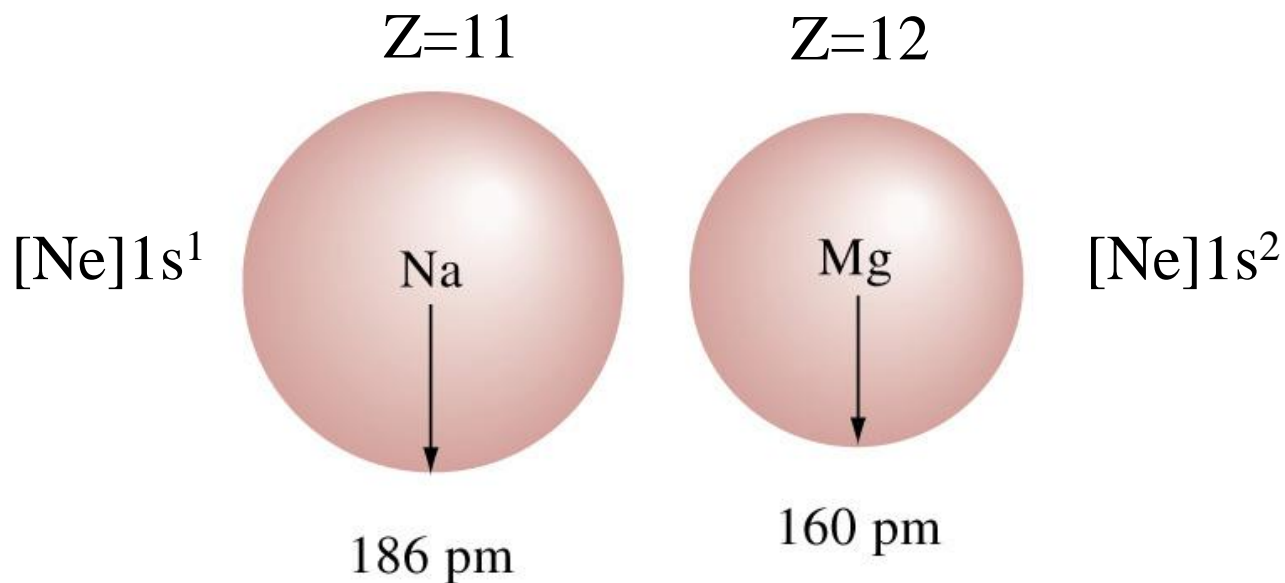
Ionic radius:



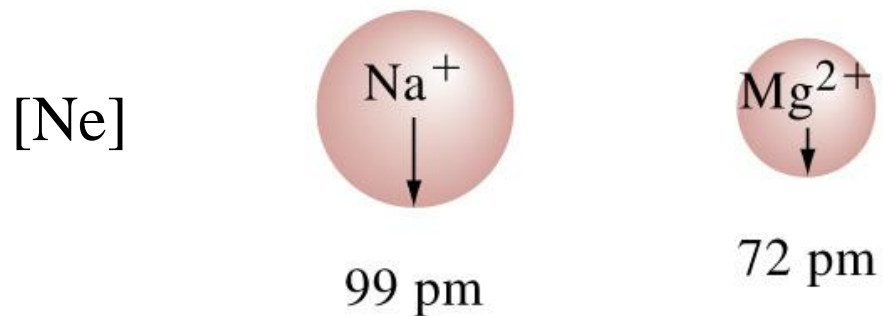
Az atomsugár



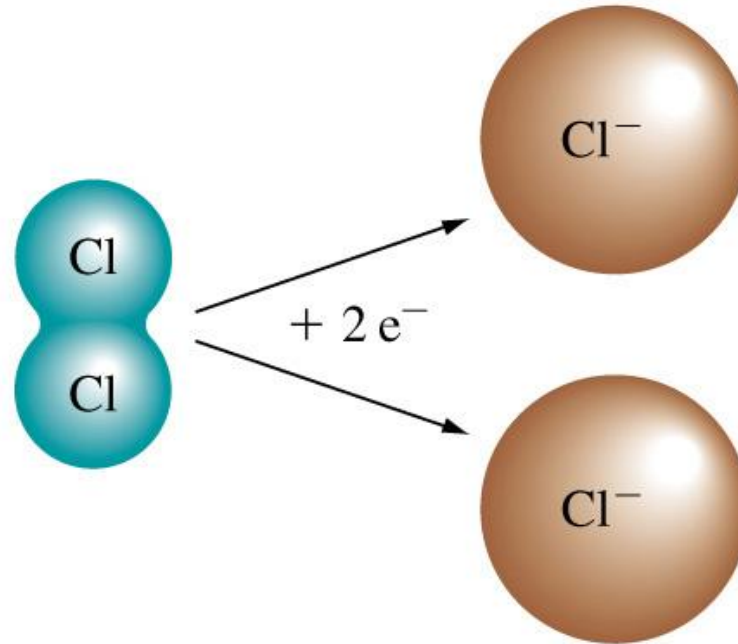
Kation sugár



Ne \rightarrow 131 pm



Anion sugár



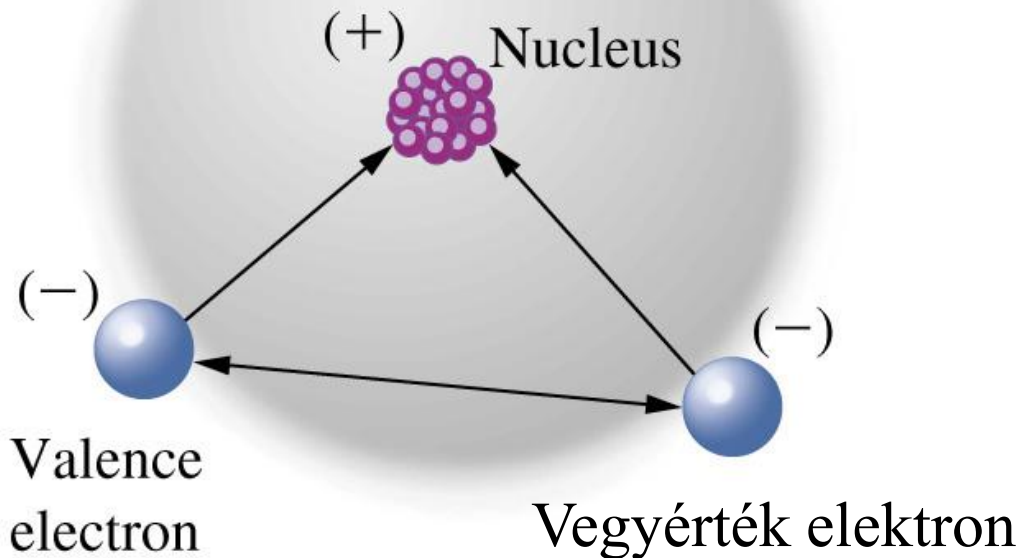
Covalent
radius
99 pm

Ionic
radius
181 pm

Árnyékolás

Screen of electron charge
from core electrons

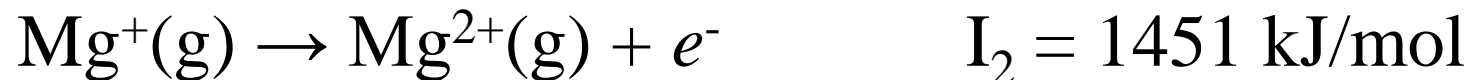
Törzs elektronok árnyékoló hatása



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

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

11-4 Ionizációs energia



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

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

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

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

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

Első Ionizációs energia

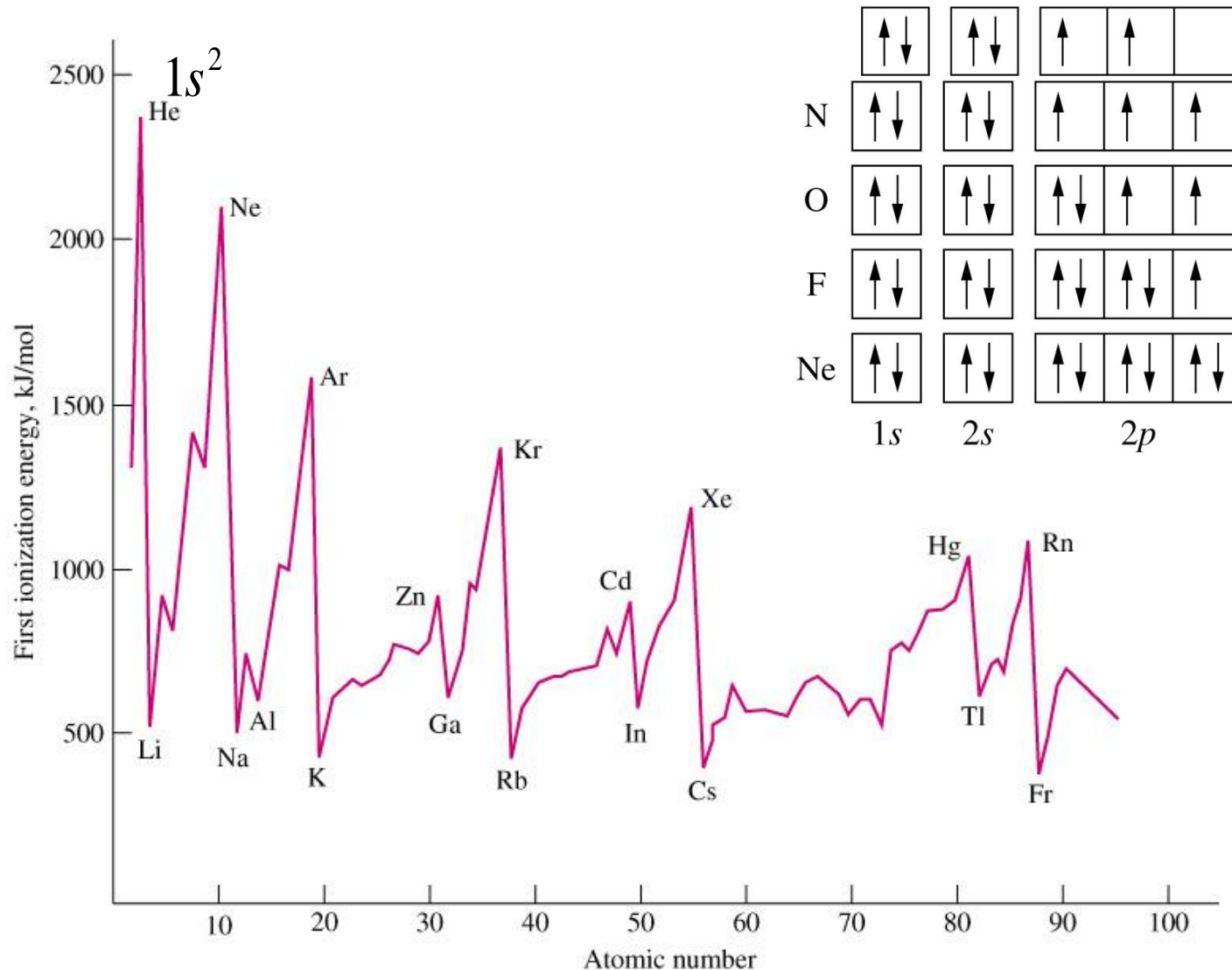


TABLE 10.4 Ionization Energies of the Third-Period Elements (in kJ/mol)

	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

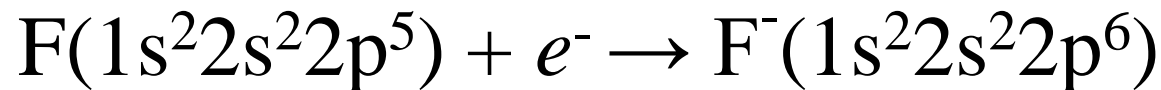
Ionizációs energiák

I_2 (Mg) vs. I_3 (Mg)

I_1 (Mg) vs. I_1 (Al)

I_1 (P) vs. I_1 (S)

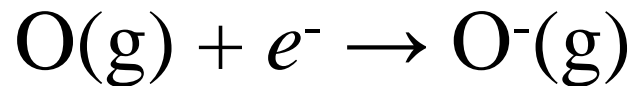
11-5 Elektron affinitás



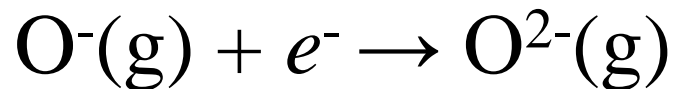
Az első elektronaffinitás [kJ/mol]

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



$$\text{EA} = -141 \text{ kJ/mol}$$

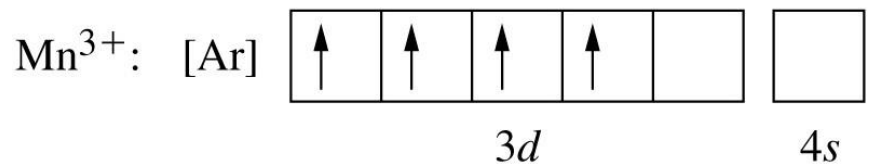
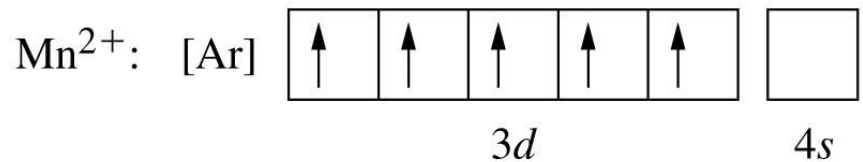
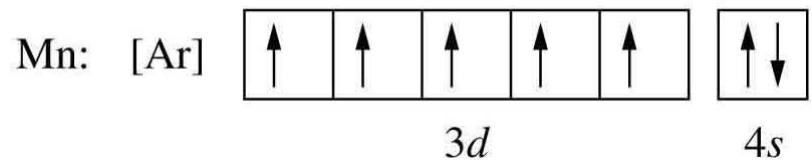


$$\text{EA} = +744 \text{ kJ/mol}$$

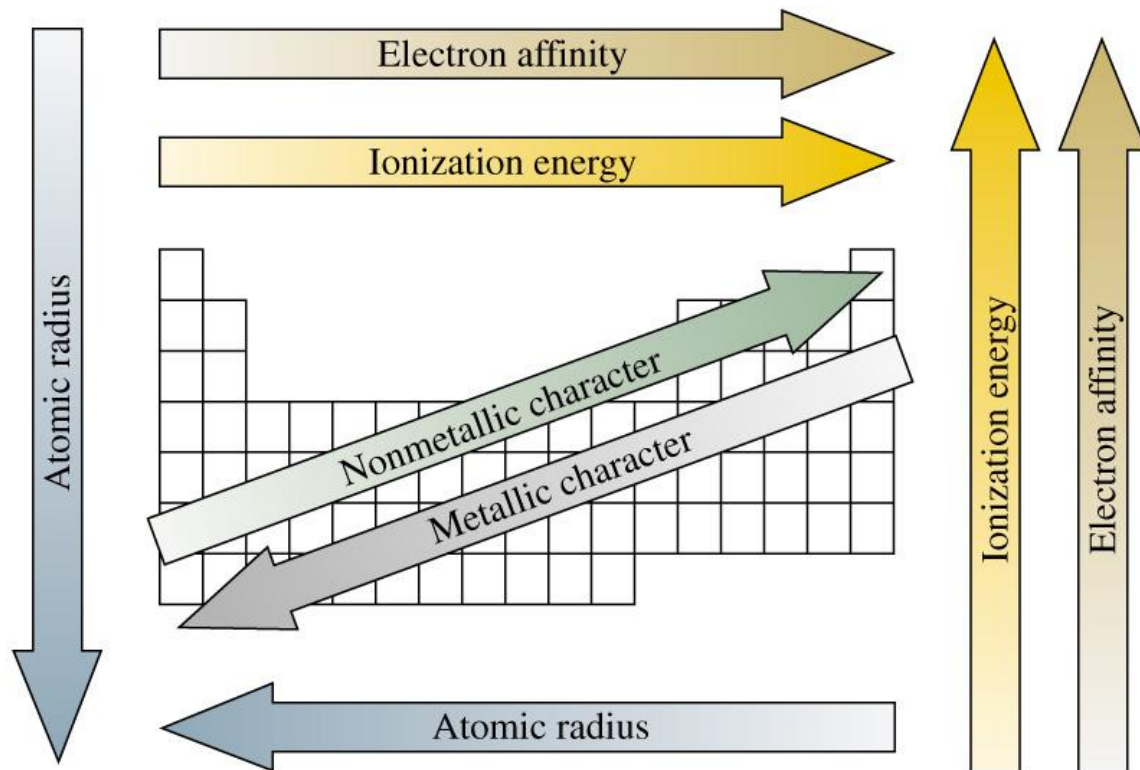
11-6 Mágneses tulajdonságok

- 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



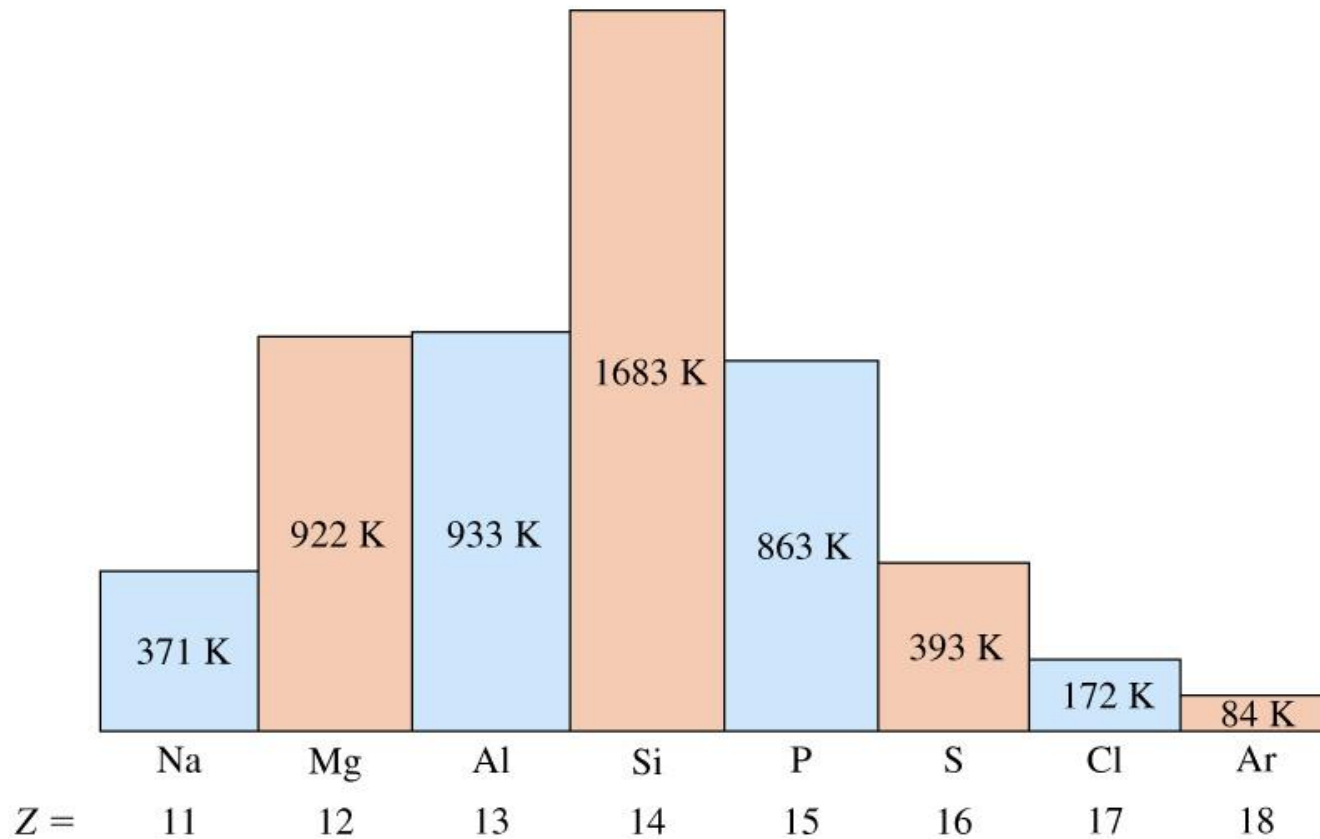
Olvadáspont, forráspont



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

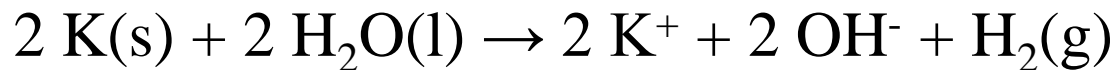
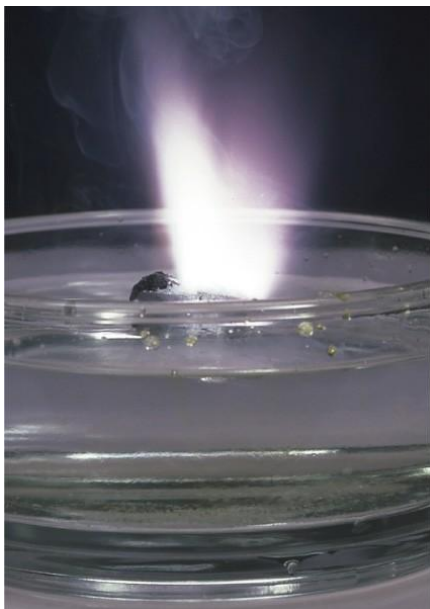


Két sorozat olvadáspontjai

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
Cl 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



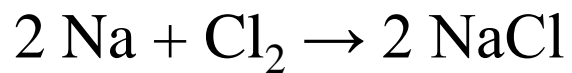
$$I_1 = 419 \text{ kJ}$$

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

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



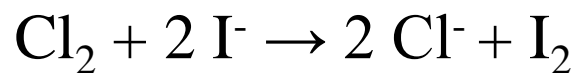
Halogének oxidálóképessége



(a)

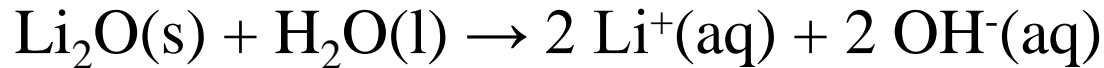


(b)

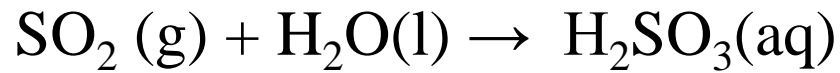


Elemi oxidok sav-bázis tulajdonságai

- Bázikus oxidok van anhidridek:



- Savas oxidok vagy anhidridek:



- 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.

