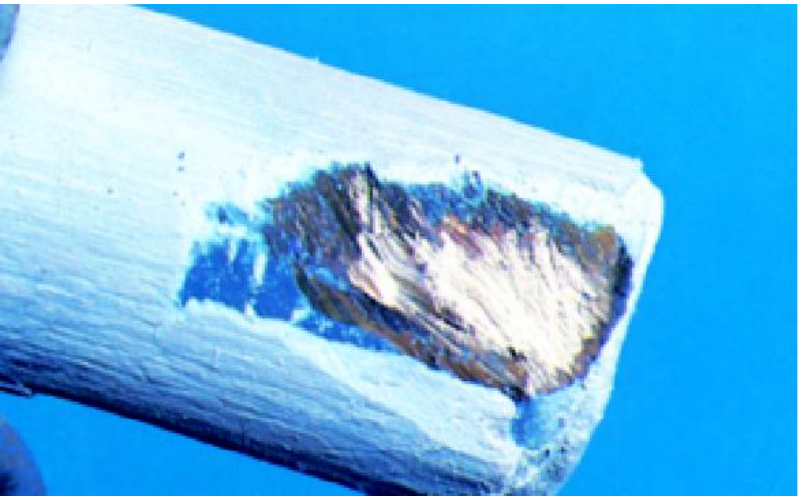
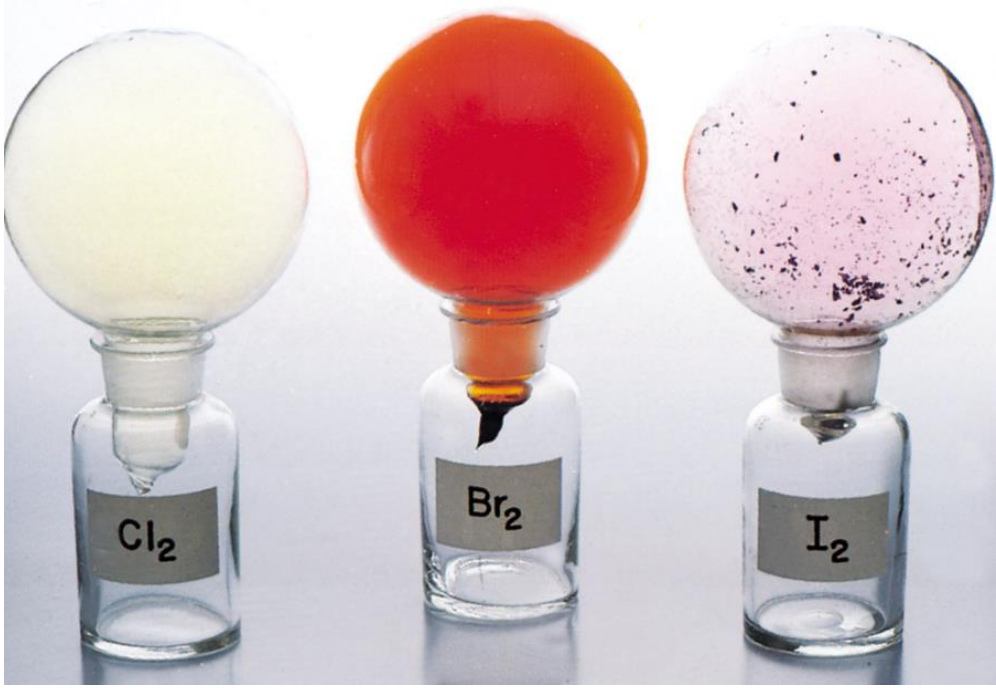
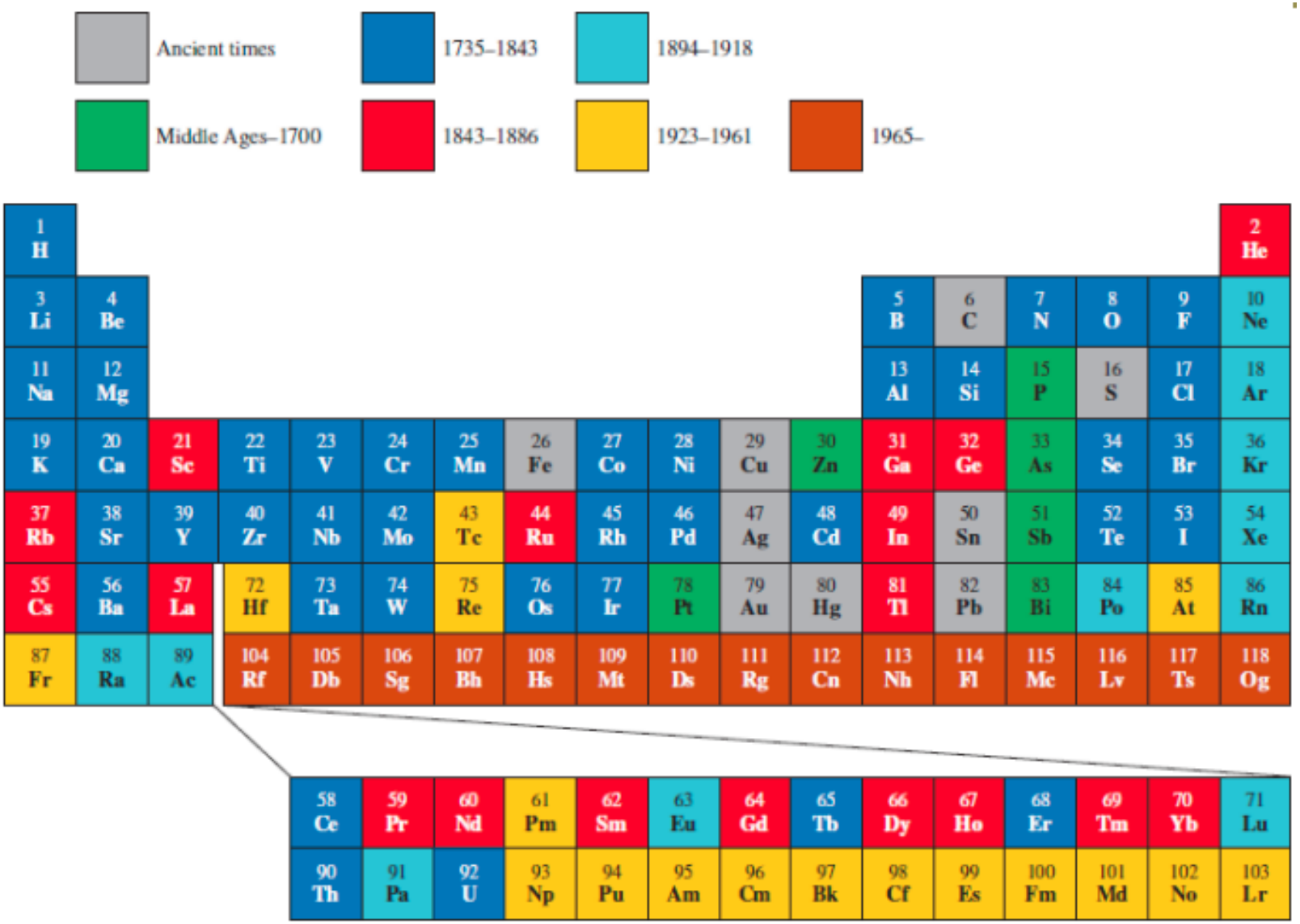




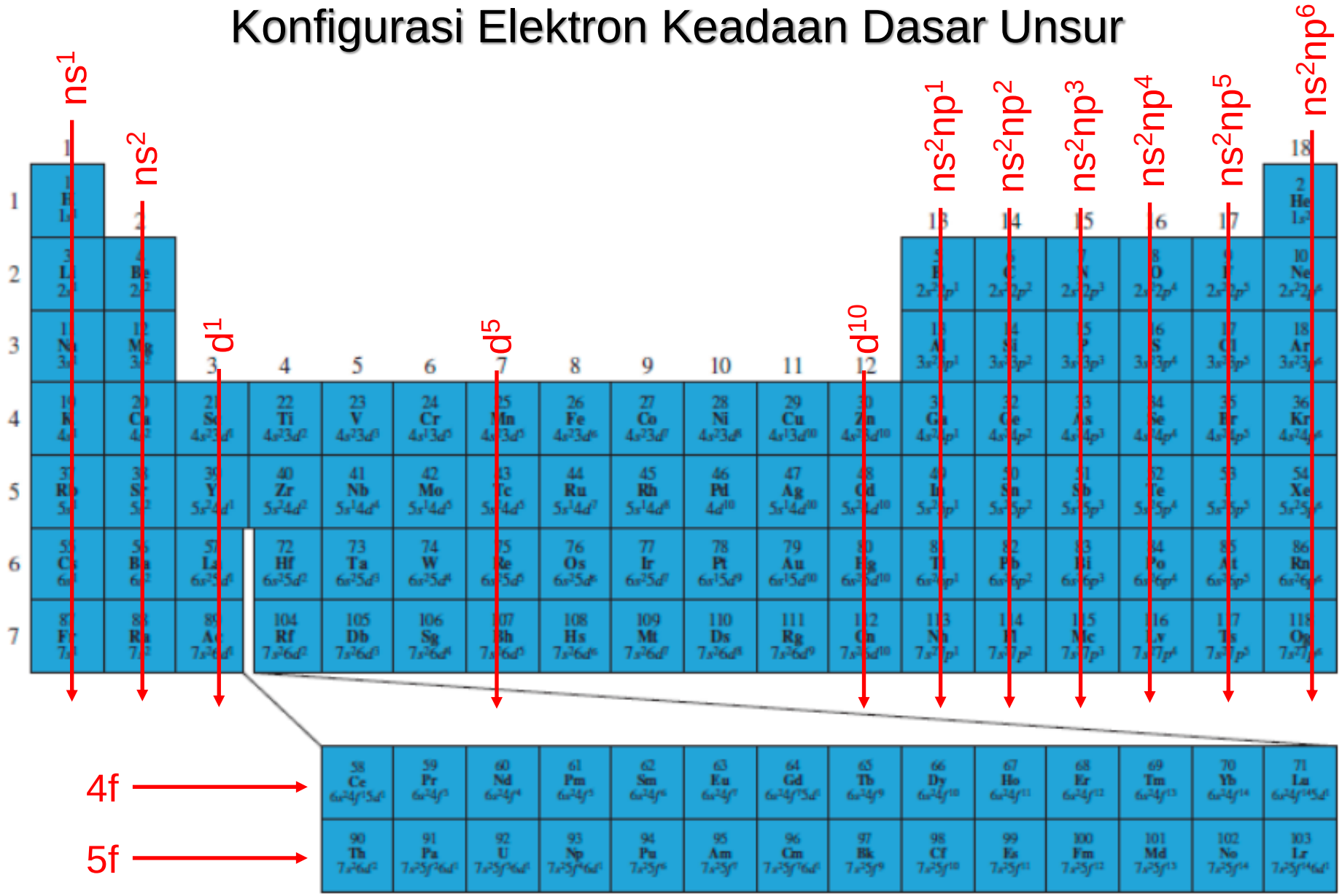
Hubungan Berkala antar Unsur

Bab 8

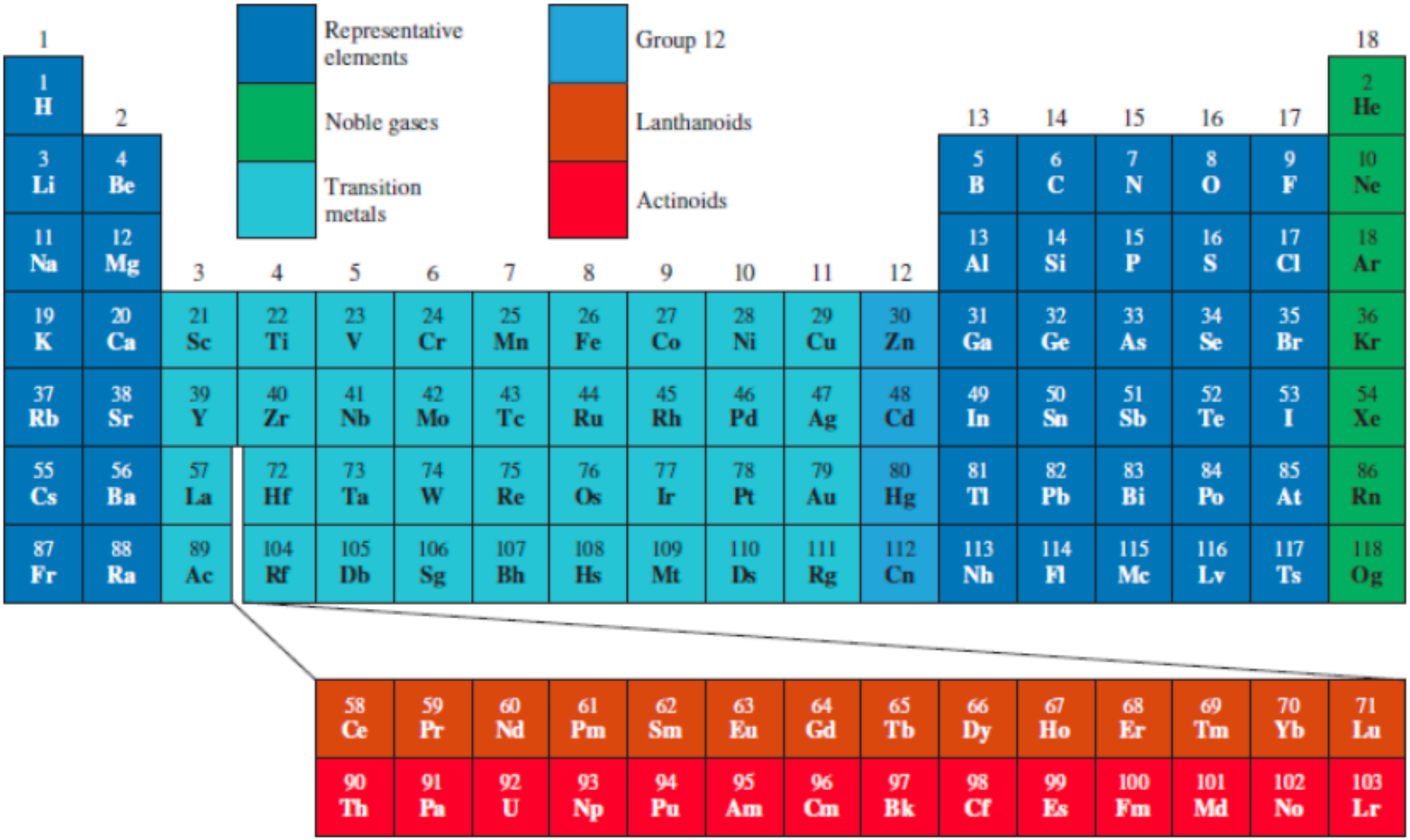
Kapan Unsur-unsur Ditemukan



Konfigurasi Elektron Keadaan Dasar Unsur



Klasifikasi Unsur



Konfigurasi Elektron Kation dan Anion Beberapa Unsur

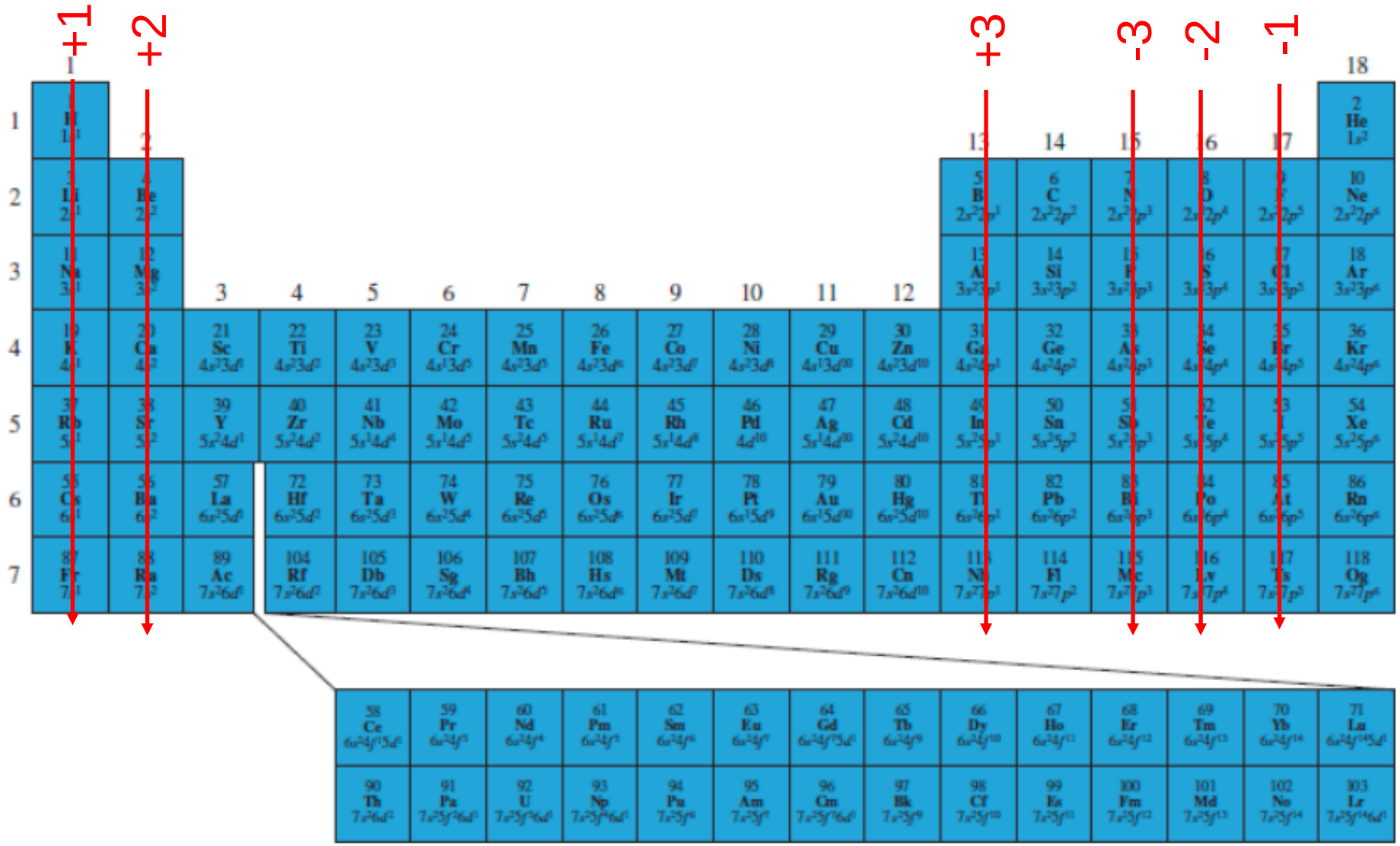
Na	$[Ne]3s^1$	Na^+	[Ne]
Ca	$[Ar]4s^2$	Ca^{2+}	[Ar]
Al	$[Ne]3s^23p^1$	Al^{3+}	[Ne]

Atom kehilangan elektron sehingga kation mempunyai konfigurasi elektron terluar gas mulia.

Atom memperoleh elektron sehingga anion mempunyai konfigurasi elektron terluar gas mulia.

H	$1s^1$	H^-	$1s^2$ or [He]
F	$1s^22s^22p^5$	F^-	$1s^22s^22p^6$ or [Ne]
O	$1s^22s^22p^4$	O^{2-}	$1s^22s^22p^6$ or [Ne]
N	$1s^22s^22p^3$	N^{3-}	$1s^22s^22p^6$ or [Ne]

Kation dan Anion Unsur



Isoelektronik: memiliki jumlah elektron yang sama, dan karenanya memiliki konfigurasi elektron keadaan dasar yang sama

Na^+: [Ne] Al^{3+}: [Ne] F^-: $1s^2 2s^2 2p^6$ or [Ne]

O^{2-}: $1s^2 2s^2 2p^6$ or [Ne] N^{3-}: $1s^2 2s^2 2p^6$ or [Ne]

Na^+, Al^{3+}, F^-, O^{2-}, and N^{3-} semua ***isoelektronik*** dengan Ne

Atom netral manakah yang isoelektronik dengan H^-?

H^-: $1s^2$ konfigurasi elektron yang sama dengan He

Konfigurasi Elektron Kation Logam Transisi

Ketika kation terbentuk dari atom logam transisi, elektron selalu dikeluarkan terlebih dahulu dari orbital ns dan kemudian dari orbital (n – 1)d.

Fe: $[Ar]4s^2 3d^6$

Fe^{2+}: $[Ar]4s^0 3d^6$ or $[Ar]3d^6$

Fe^{3+}: $[Ar]4s^0 3d^5$ or $[Ar]3d^5$

Mn: $[Ar]4s^2 3d^5$

Mn^{2+}: $[Ar]4s^0 3d^5$ or $[Ar]3d^5$

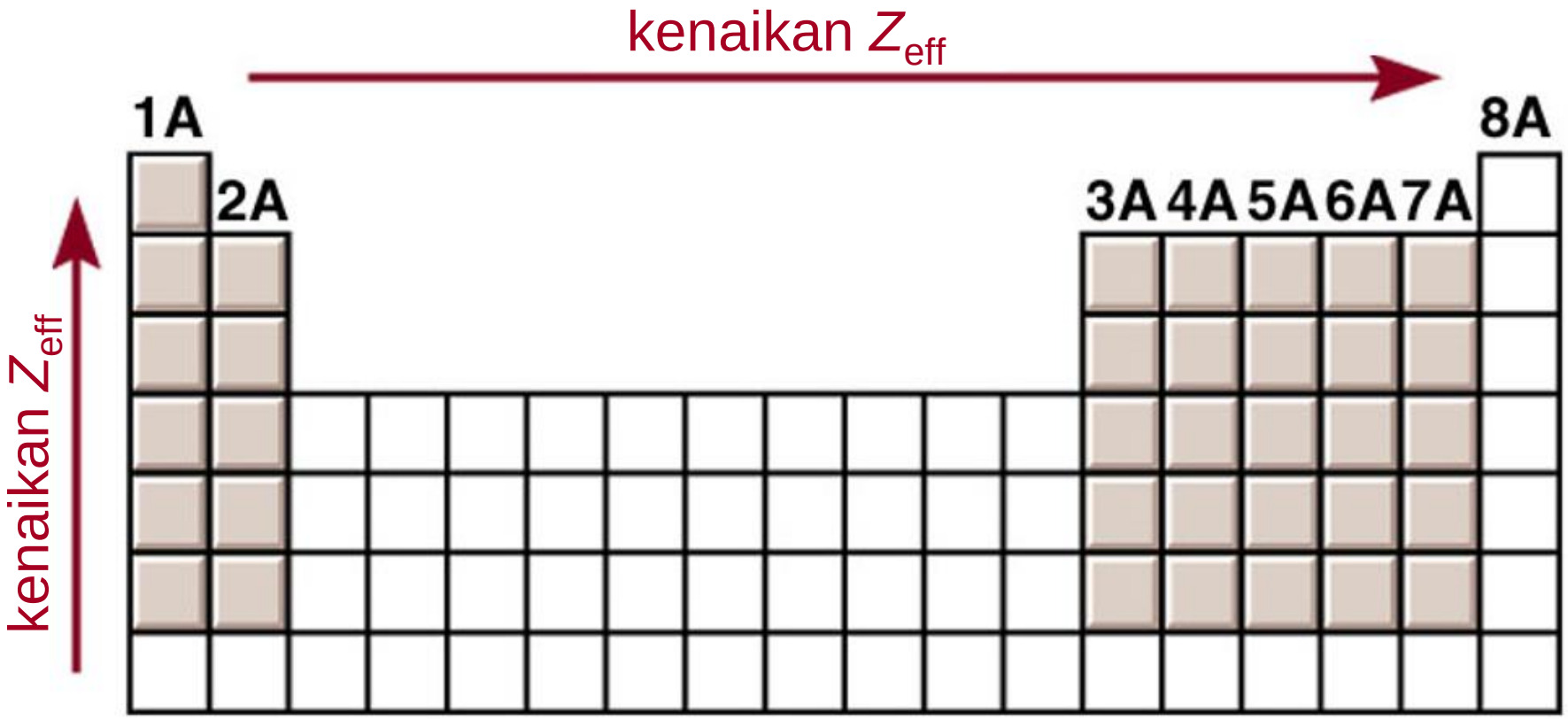
Muatan inti efektif (Z_{eff}) adalah “muatan positif” yang dirasakan oleh sebuah elektron.

$Z_{eff} = Z - \sigma$ $\quad 0 < \sigma < Z$ (σ = konstanta perisai)

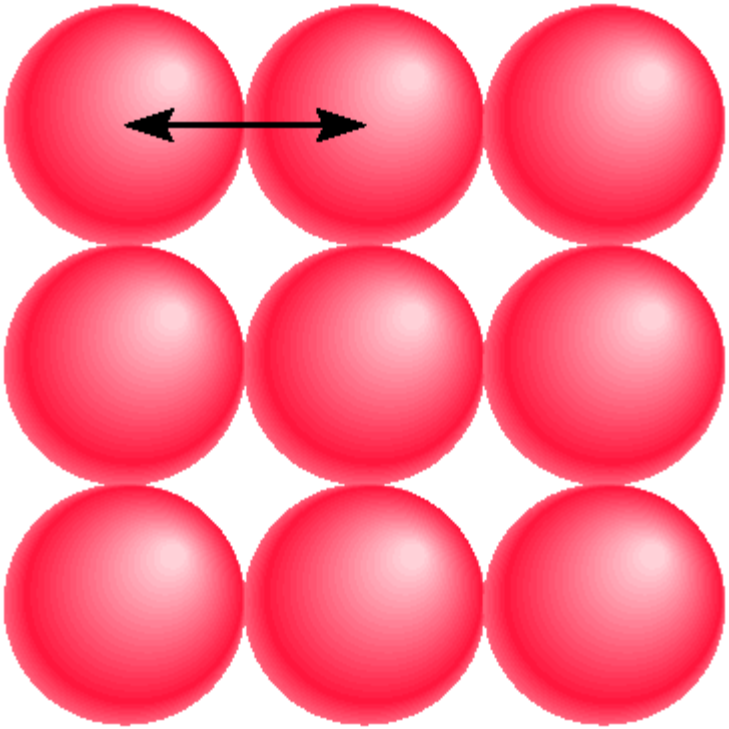
$Z_{eff} \approx Z$ – jumlah elektron dalam atau inti

	Z	inti	Z_{eff}	Radius (pm)
Na	11	10	1	186
Mg	12	10	2	160
Al	13	10	3	143
Si	14	10	4	132

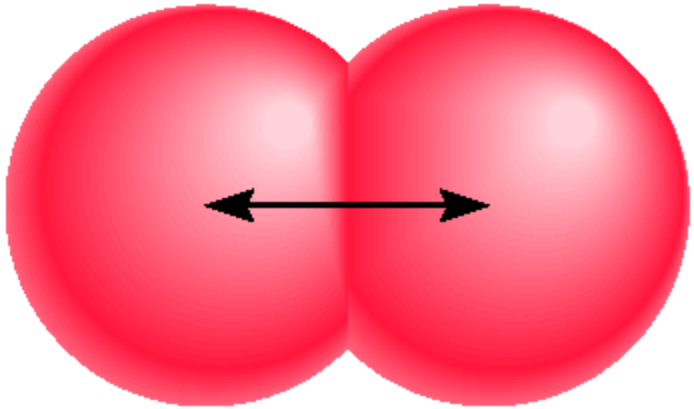
Muatan Inti Efektif (Z_{eff})



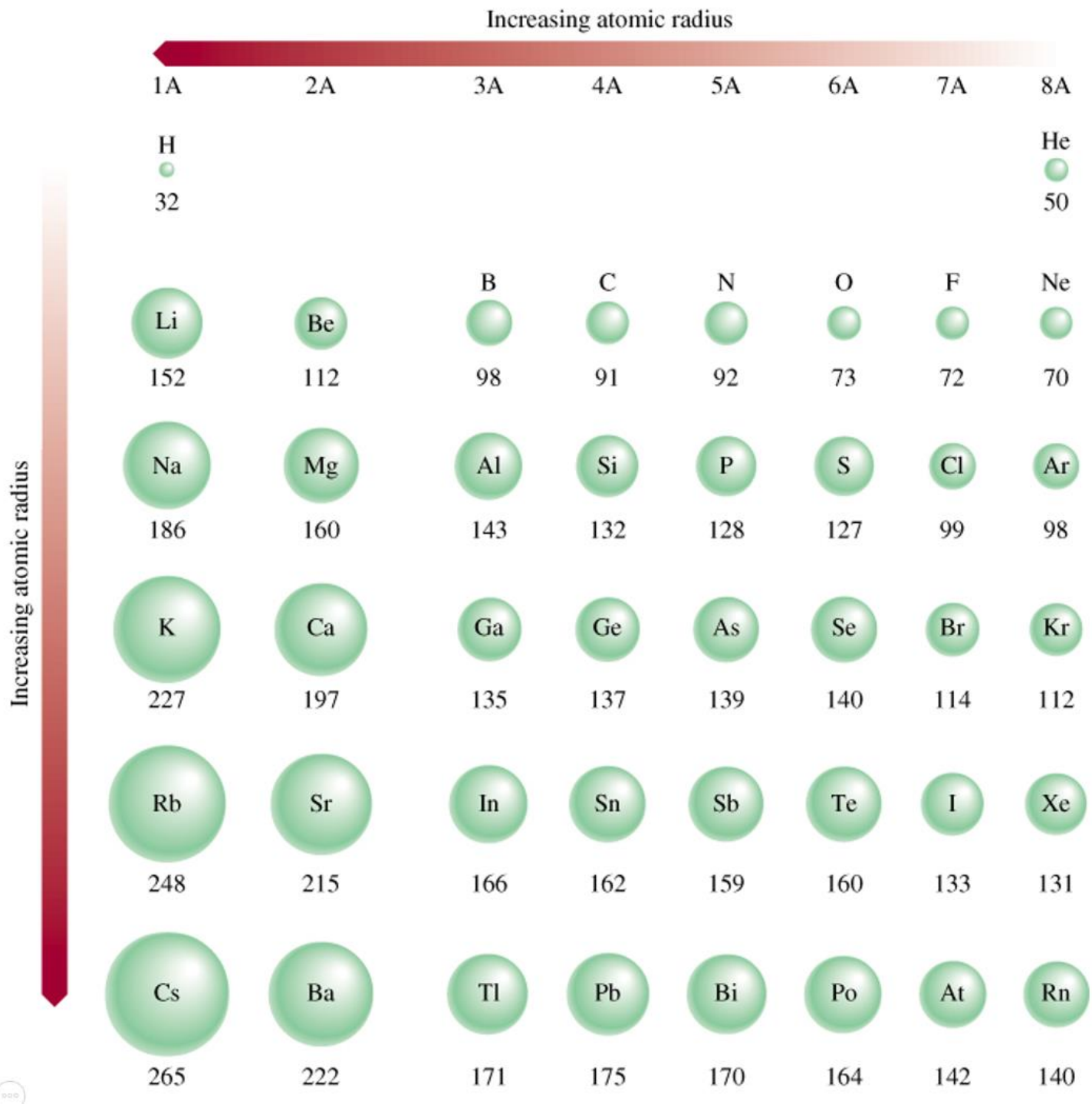
Jari-jari Atom



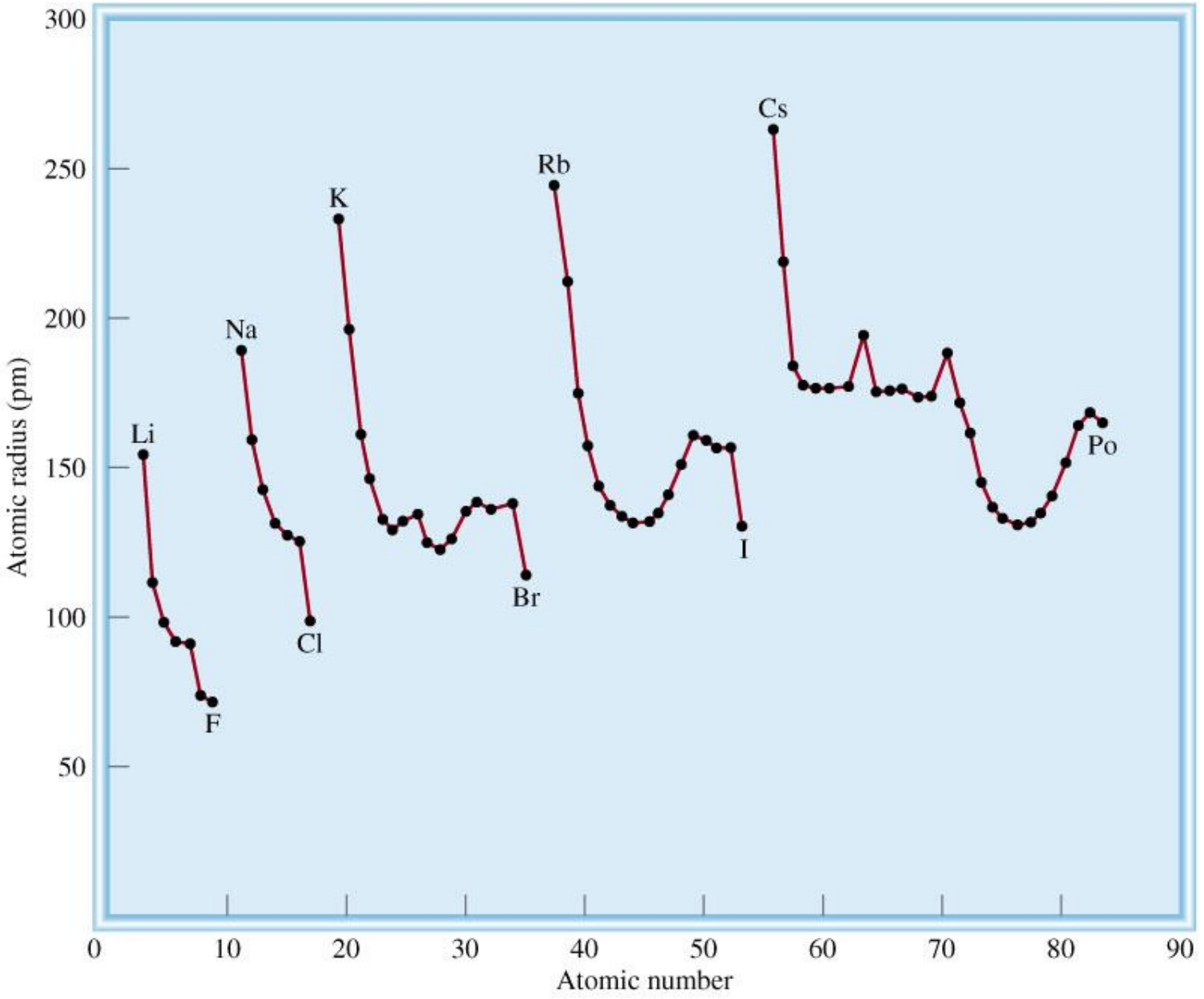
Jari-jari metalik



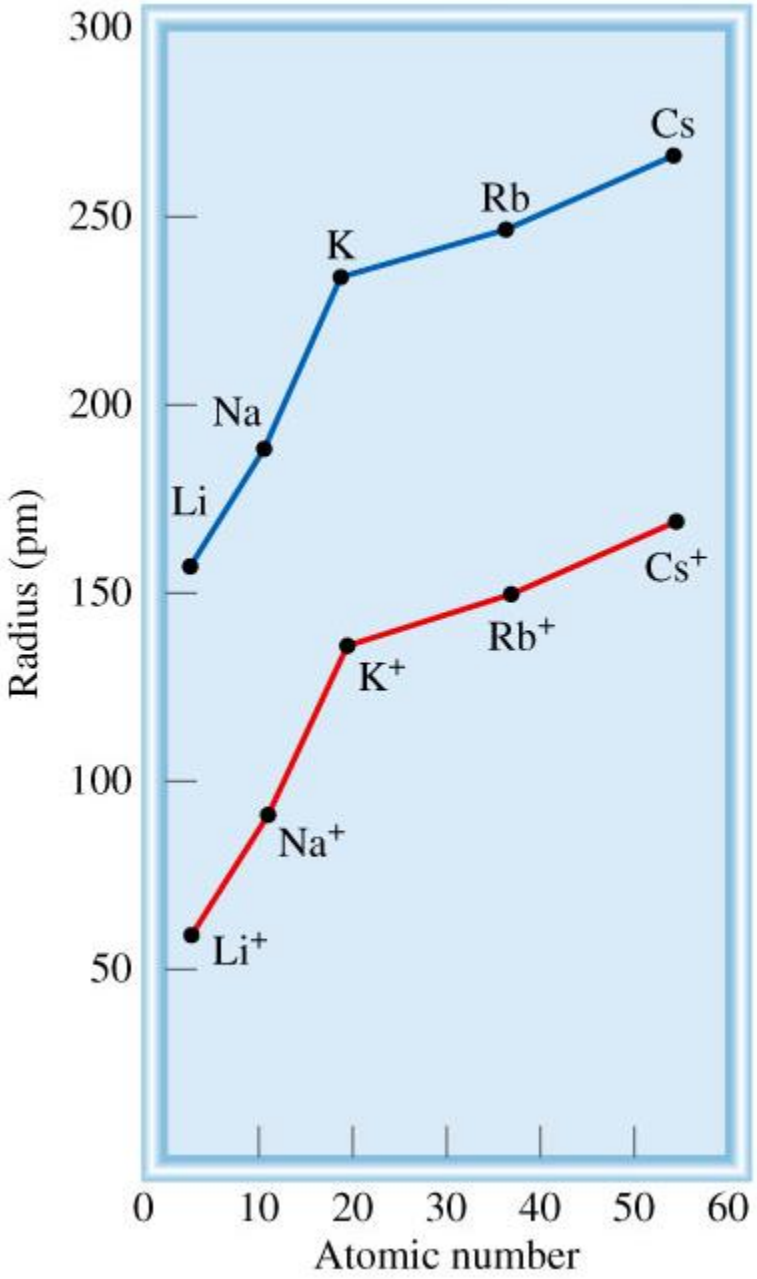
Jari-jari kovalen

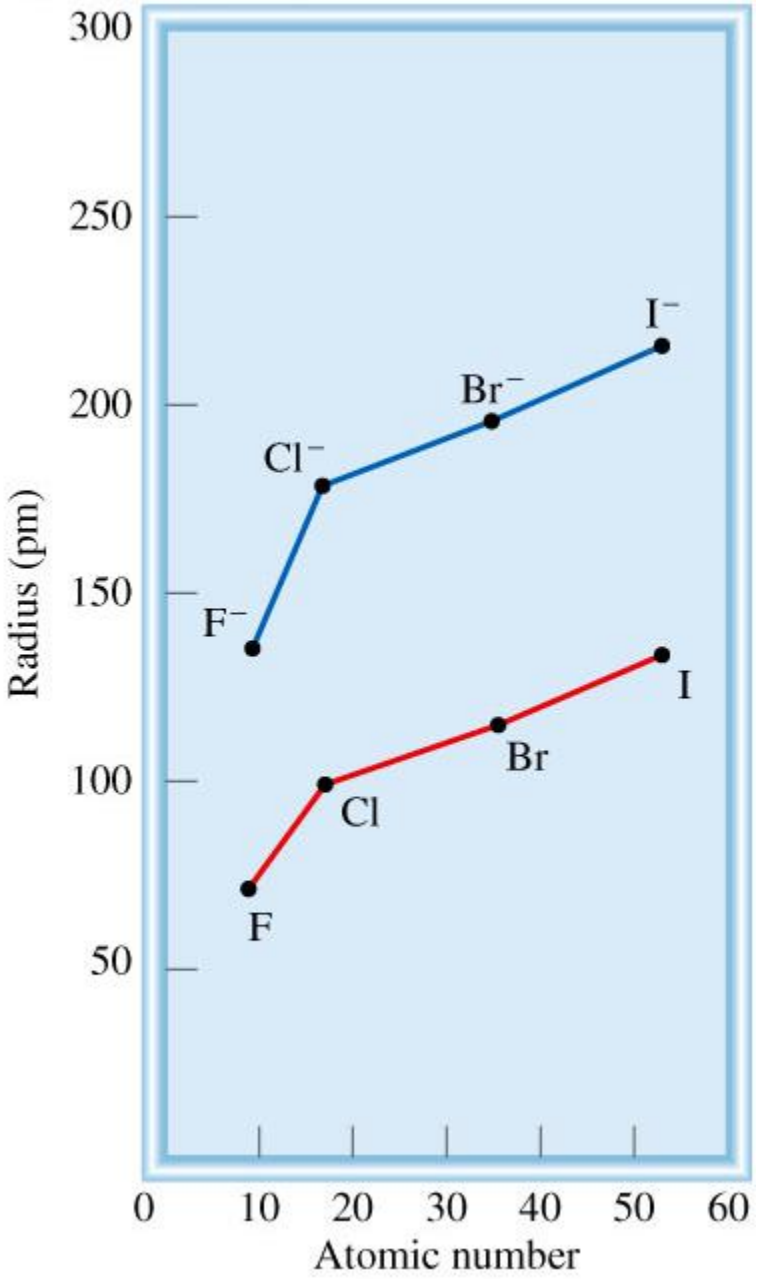

Increasing atomic radius
Increasing atomic radius
1A
2A
3A
4A
5A
6A
7A
8A
H
32
He
50
B
C
N
O
F
Ne
Li
Be
152
112
98
91
92
73
72
70
Na
Mg
Al
Si
P
S
Cl
Ar
186
160
143
132
128
127
99
98
K
Ca
Ga
Ge
As
Se
Br
Kr
227
197
135
137
139
140
114
112
Rb
Sr
In
Sn
Sb
Te
I
Xe
248
215
166
162
159
160
133
131
Cs
Ba
Tl
Pb
Bi
Po
At
Rn
265
222
171
175
170
164
142
140

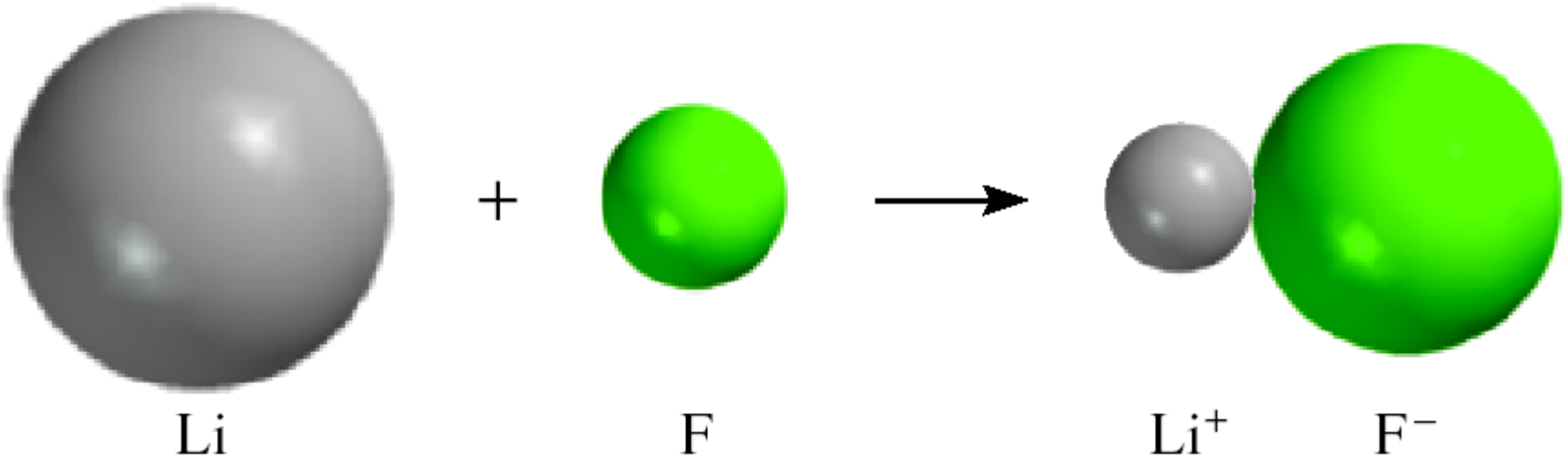
Tren Jari-jari Atom



Perbandingan Jari-jari Atom dengan Jari-jari Ionik

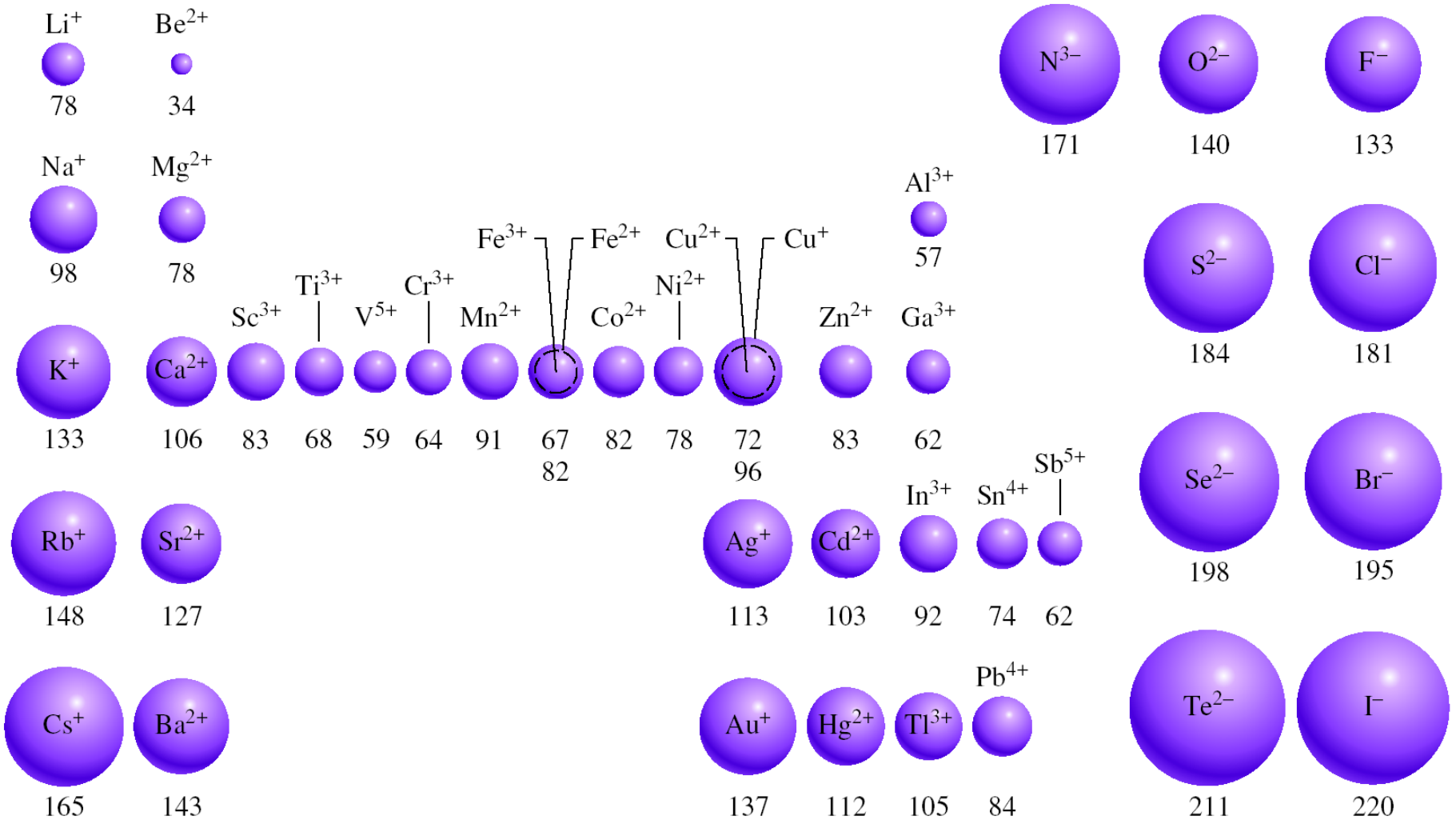






Kation selalu lebih kecil dari atom pembentuknya.
Anion selalu lebih besar dari atom pembentuknya.

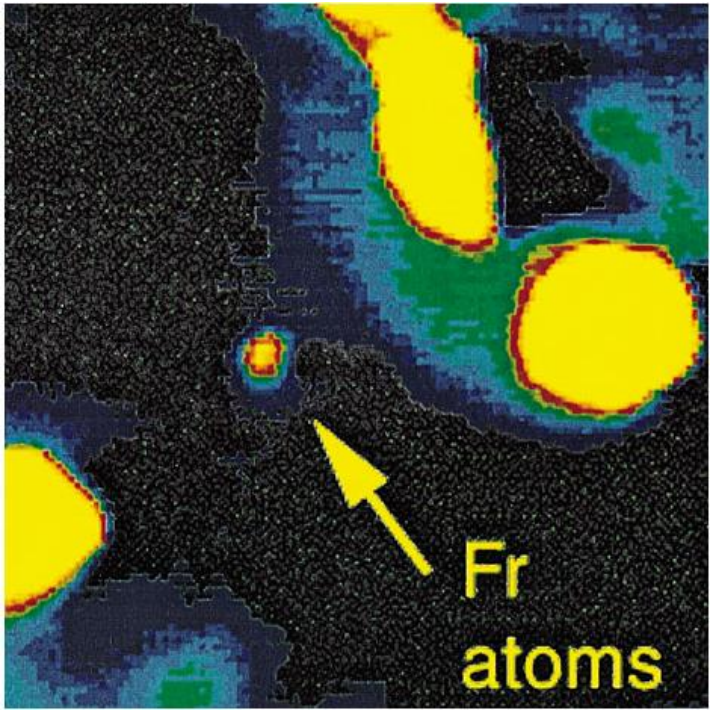
Jari-jari (dalam pm) Ion-Ion Unsur yang Dikenal

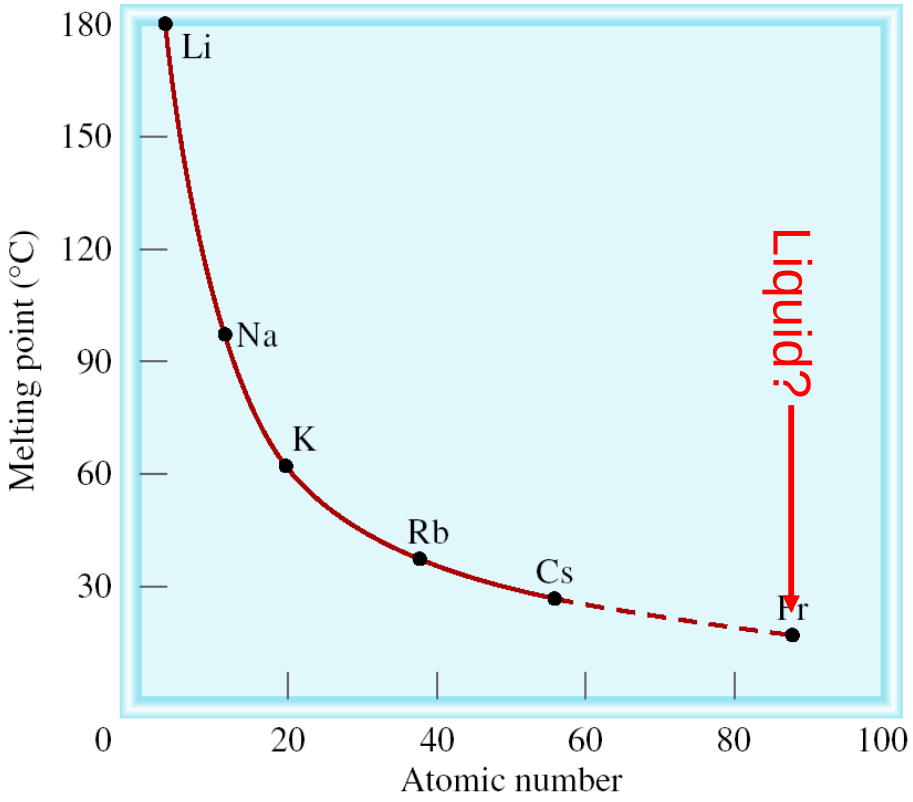


Kimia "*in Action*": Unsur Cair ke-3?

118 unsur, 2 cairan pada 25^0C – Br_2 and Hg

^{223}Fr, $t_{1/2}$ = 21 menit





Energi ionisasi adalah energi minimum (kJ/mol) yang diperlukan untuk melepaskan elektron dari atom gas dalam keadaan dasarnya.

$I_1 + X_{(g)} \longrightarrow X^+_{(g)} + e^-$ I_1 energi ionisasi pertama

$I_2 + X^+_{(g)} \longrightarrow X^{2+}_{(g)} + e^-$ I_2 energi ionisasi kedua

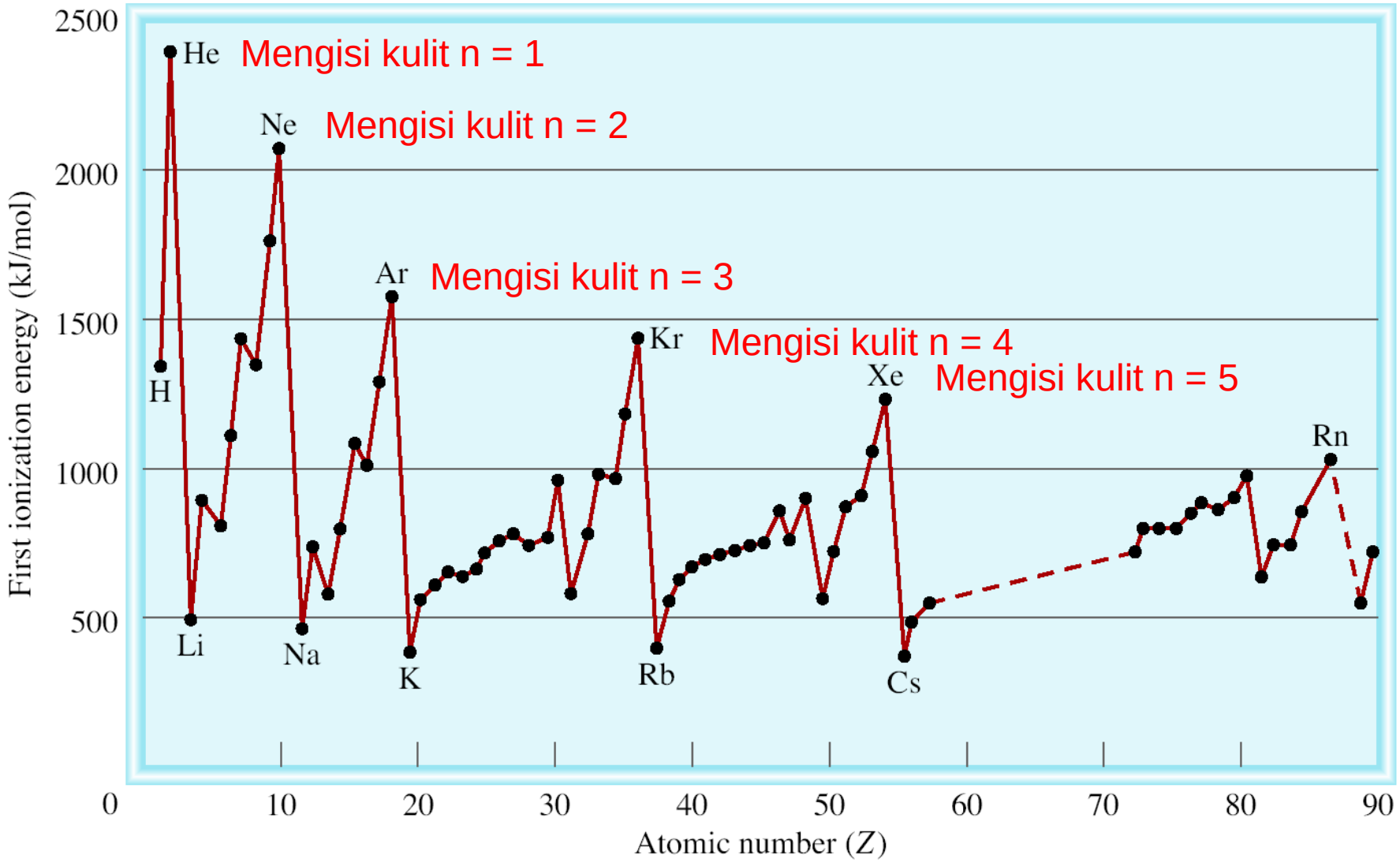
$I_3 + X^{2+}_{(g)} \longrightarrow X^{3+}_{(g)} + e^-$ I_3 energi ionisasi ketiga

$$I_1 < I_2 < I_3$$

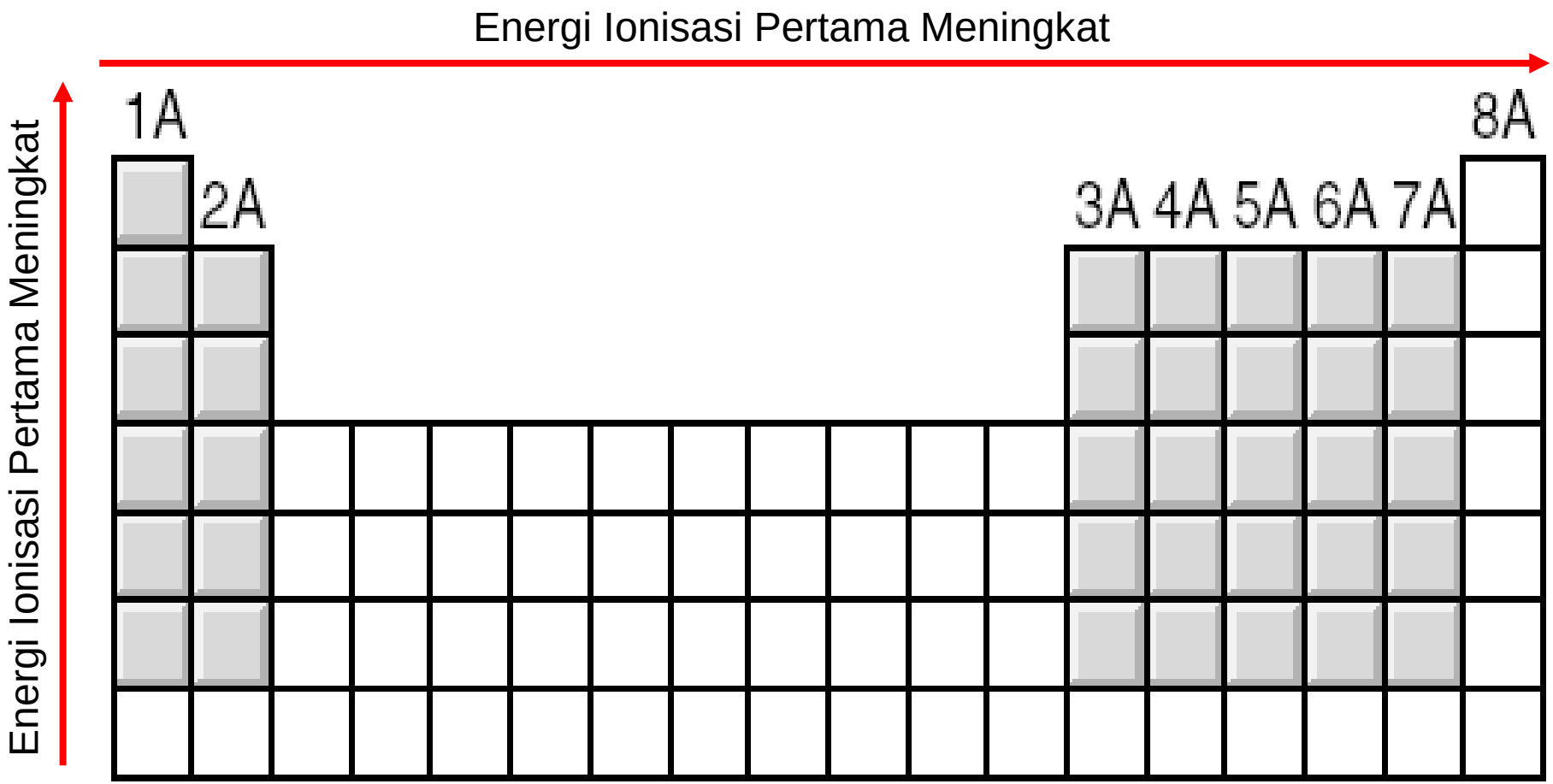
TABLE 8.2 The Ionization Energies (kJ/mol) of the First 20 Elements

Z	Element	First	Second	Third	Fourth	Fifth	Sixth
1	H	1,312					
2	He	2,373	5,251				
3	Li	520	7,300	11,815			
4	Be	899	1,757	14,850	21,005		
5	B	801	2,430	3,660	25,000	32,820	
6	C	1,086	2,350	4,620	6,220	38,000	47,261
7	N	1,400	2,860	4,580	7,500	9,400	53,000
8	O	1,314	3,390	5,300	7,470	11,000	13,000
9	F	1,680	3,370	6,050	8,400	11,000	15,200
10	Ne	2,080	3,950	6,120	9,370	12,200	15,000
11	Na	495.9	4,560	6,900	9,540	13,400	16,600
12	Mg	738.1	1,450	7,730	10,500	13,600	18,000
13	Al	577.9	1,820	2,750	11,600	14,800	18,400
14	Si	786.3	1,580	3,230	4,360	16,000	20,000
15	P	1,012	1,904	2,910	4,960	6,240	21,000
16	S	999.5	2,250	3,360	4,660	6,990	8,500
17	Cl	1,251	2,297	3,820	5,160	6,540	9,300
18	Ar	1,521	2,666	3,900	5,770	7,240	8,800
19	K	418.7	3,052	4,410	5,900	8,000	9,600
20	Ca	589.5	1,145	4,900	6,500	8,100	11,000

Variasi Energi Ionisasi Pertama dengan Nomor Atom



Tren Umum Energi Ionisasi Pertama



Afinitas elektron adalah perubahan energi negatif yang terjadi ketika elektron diterima oleh atom dalam wujud gas untuk membentuk anion.

$$X_{(g)} + e^- \longrightarrow X^-_{(g)}$$

$F_{(g)} + e^- \longrightarrow X^-_{(g)}$ $\Delta H = -328$ kJ/mol EA = +328 kJ/mol

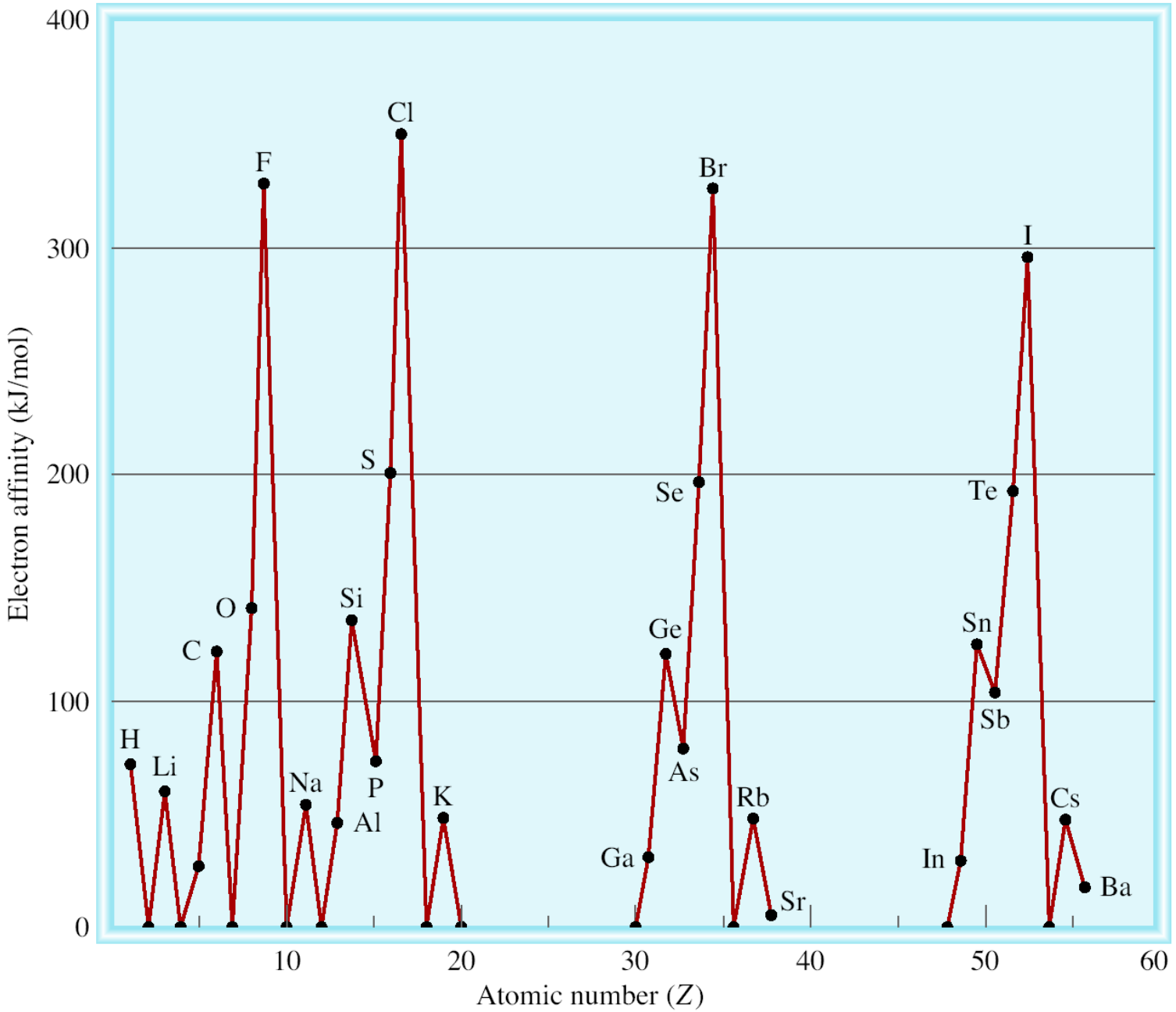
$O_{(g)} + e^- \longrightarrow O^-_{(g)}$ $\Delta H = -141$ kJ/mol EA = +141 kJ/mol

TABLE 8.3 Electron Affinities (kJ/mol) of Some Representative Elements and the Noble Gases*

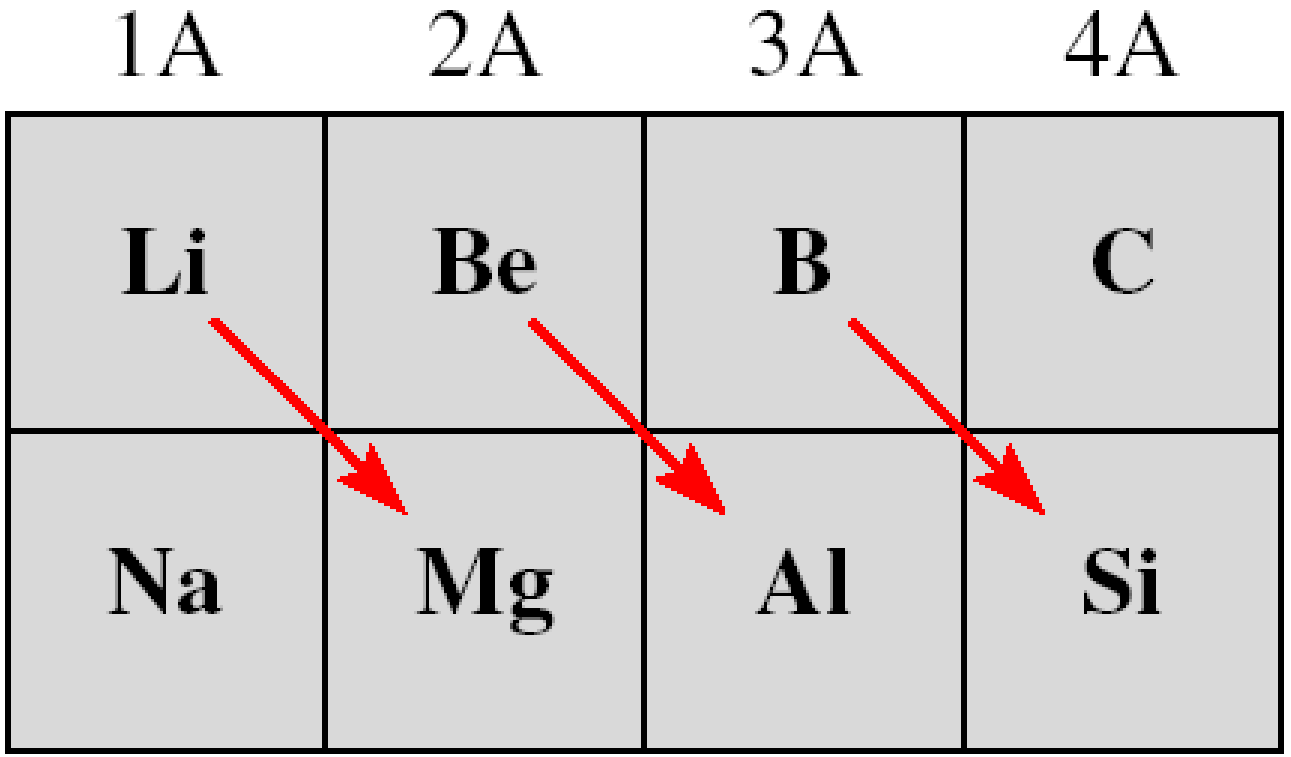
1A	2A	3A	4A	5A	6A	7A	8A
H							He
73							< 0
Li	Be	B	C	N	O	F	Ne
60	≤ 0	27	122	0	141	328	< 0
Na	Mg	Al	Si	P	S	Cl	Ar
53	≤ 0	44	134	72	200	349	< 0
K	Ca	Ga	Ge	As	Se	Br	Kr
48	2.4	29	118	77	195	325	< 0
Rb	Sr	In	Sn	Sb	Te	I	Xe
47	4.7	29	121	101	190	295	< 0
Cs	Ba	Tl	Pb	Bi	Po	At	Rn
45	14	30	110	110	?	?	< 0

*The electron affinities of the noble gases, Be, and Mg have not been determined experimentally, but are believed to be close to zero or negative.

Variasi Afinitas Elektron dengan Nomor Atom (H – Ba)



Hubungan Diagonal pada Tabel Periodik

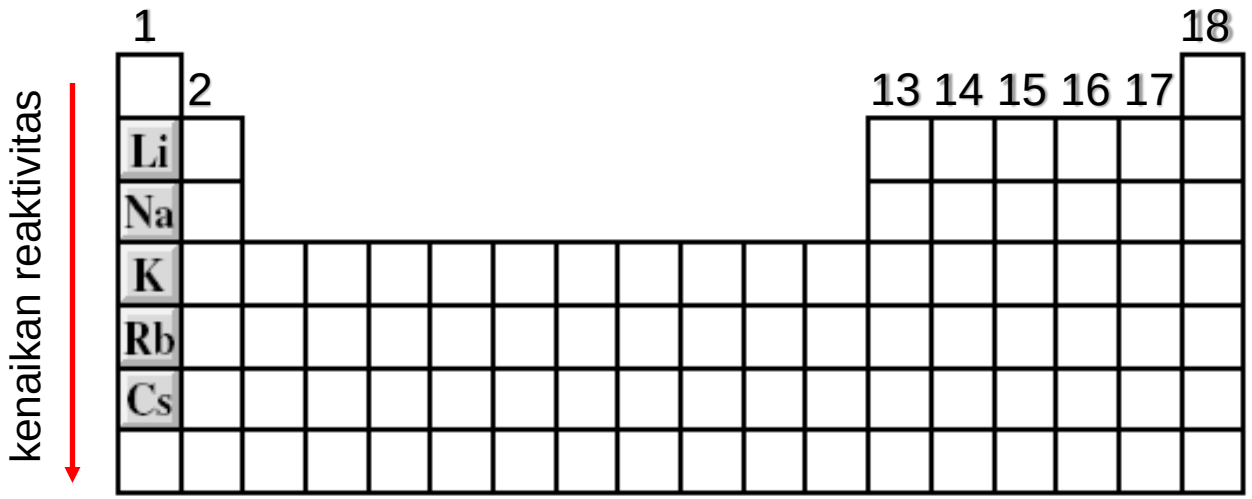


Unsur Golongan 1(ns^1, $n \geq 2$)

$$M \longrightarrow M^{+1} + 1e^-$$

$$2M_{(s)} + 2H_2O_{(l)} \longrightarrow 2MOH_{(aq)} + H_{2(g)}$$

$$4M_{(s)} + O_{2(g)} \longrightarrow 2M_2O_{(s)}$$

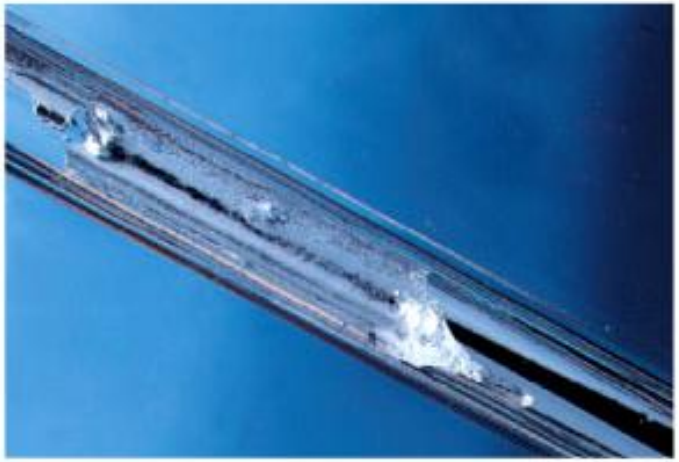


Unsur Golongan 1 (ns^1, $n \geq 2$)

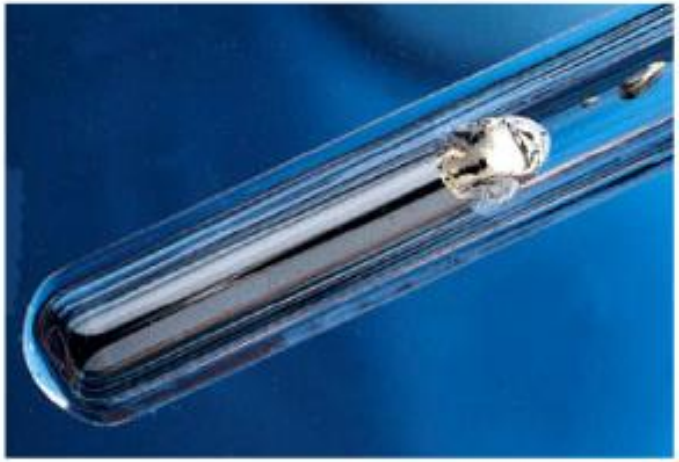
Lithium (Li)

Sodium (Na)

Potassium (K)



Rubidium (Rb)



Cesium (Cs)

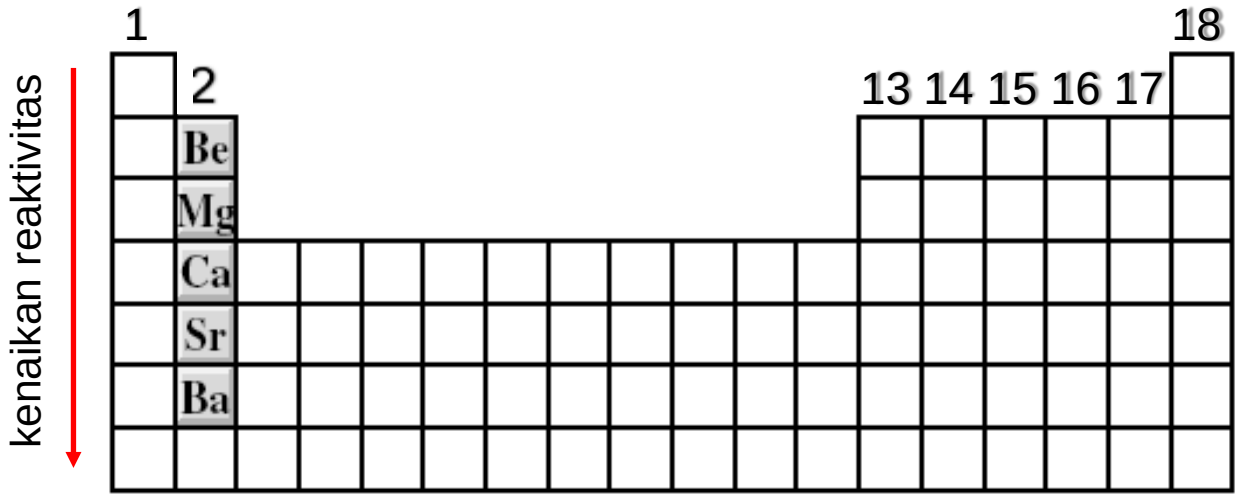
Unsur Golongan 2 (ns^2, $n \geq 2$)

$M \longrightarrow M^{+2} + 2e^-$

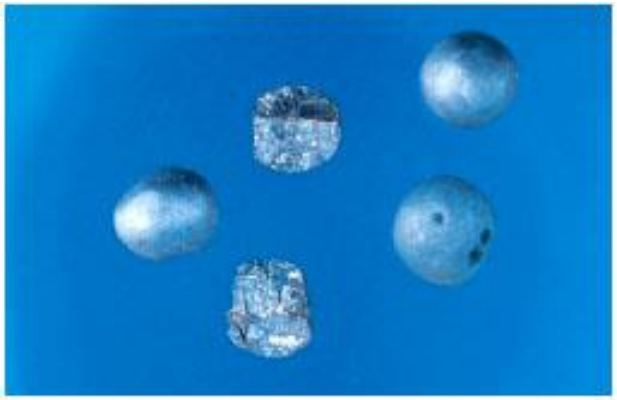
$Be_{(s)} + 2H_2O_{(l)} \longrightarrow$ Tidak terjadi reaksi

$Mg_{(s)} + 2H_2O_{(g)} \longrightarrow Mg(OH)_{2(aq)} + H_{2(g)}$

$M_{(s)} + 2H_2O_{(l)} \longrightarrow M(OH)_{2(aq)} + H_{2(g)}$ M = Ca, Sr, or Ba

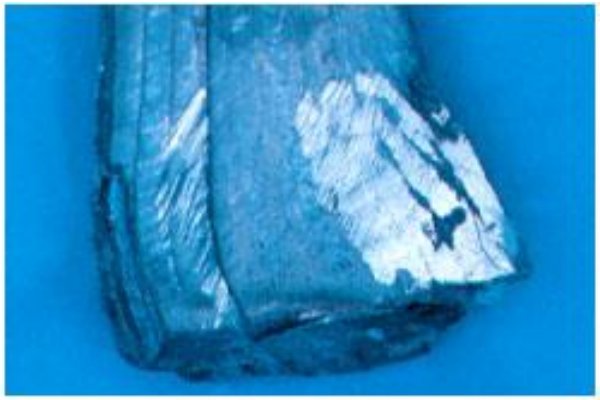


Unsur Golongan 2 (ns^2, $n \geq 2$)

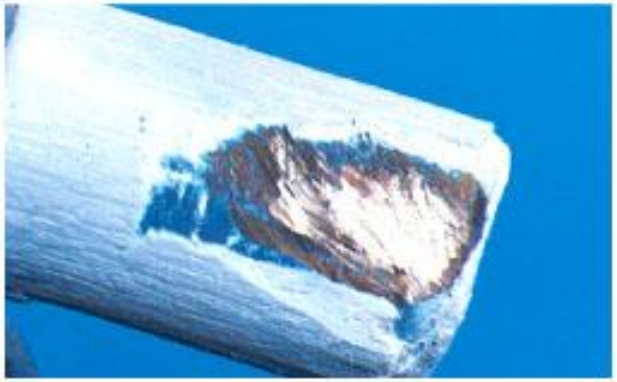


Beryllium (Be)

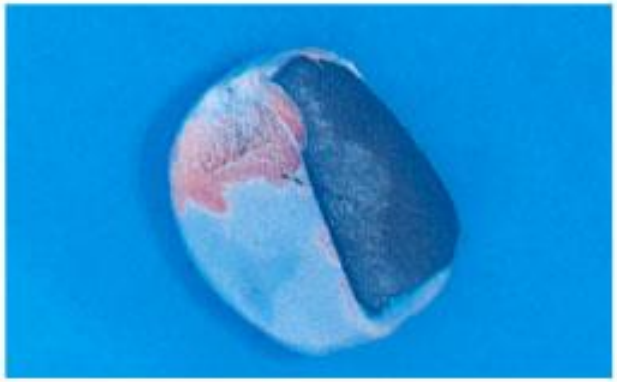
Magnesium (Mg)



Calcium (Ca)



Strontium (Sr)



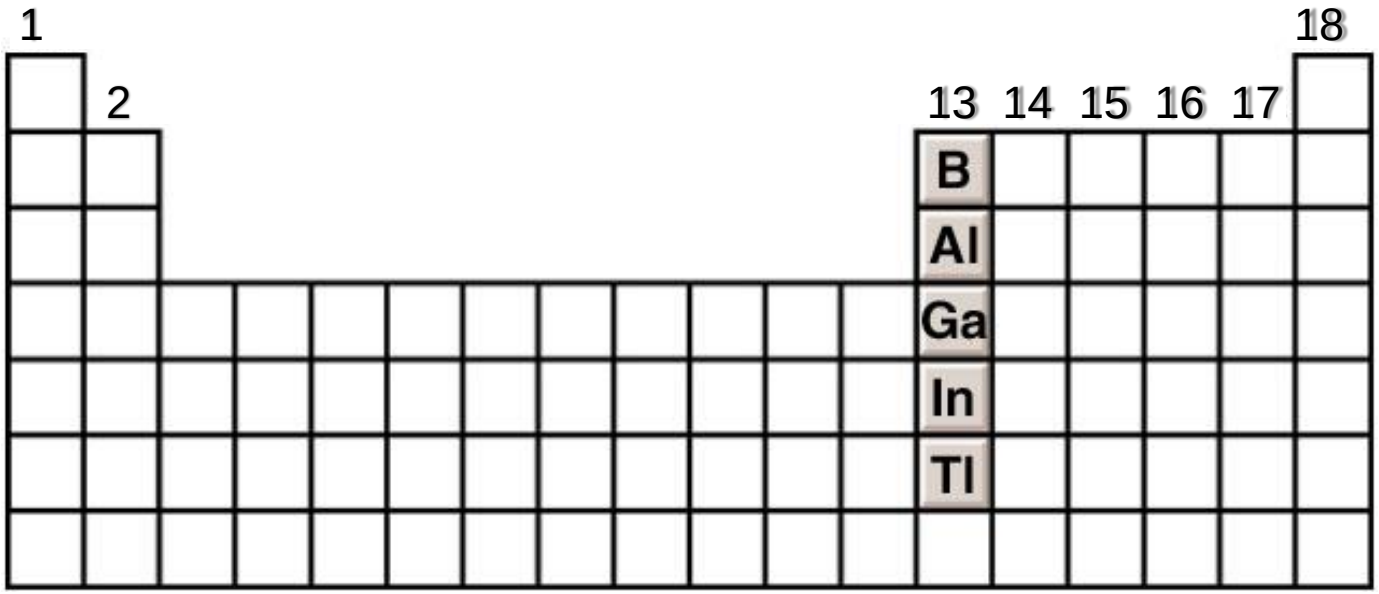
Barium (Ba)

Radium (Ra)

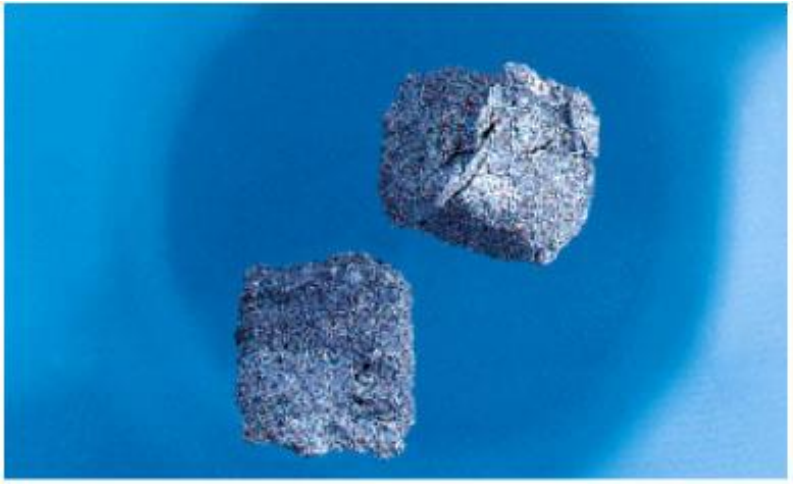
Unsur Golongan 13 (ns^2np^1, $n \geq 2$)

$$4Al_{(s)} + 3O_{2(g)} \longrightarrow 2Al_2O_{3(s)}$$

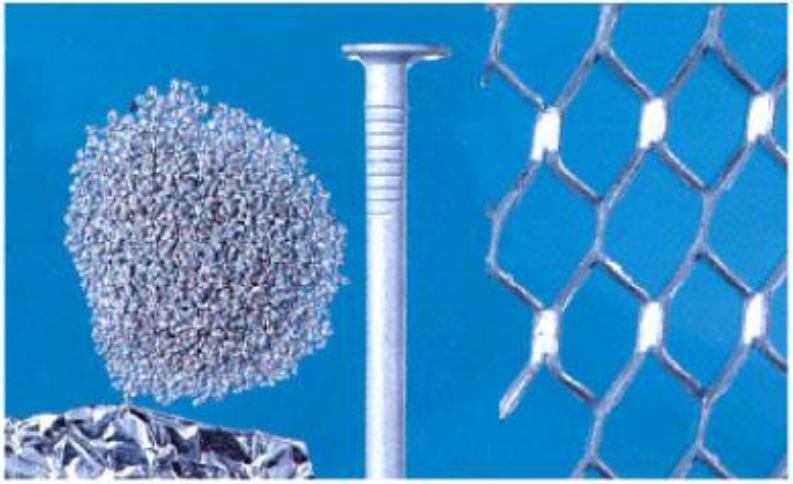
$$2Al_{(s)} + 6H^+_{(aq)} \longrightarrow 2Al^{3+}_{(aq)} + 3H_{2(g)}$$



Unsur Golongan 13 (ns^2np^1, $n \geq 2$)



Boron (B)



Aluminum (Al)

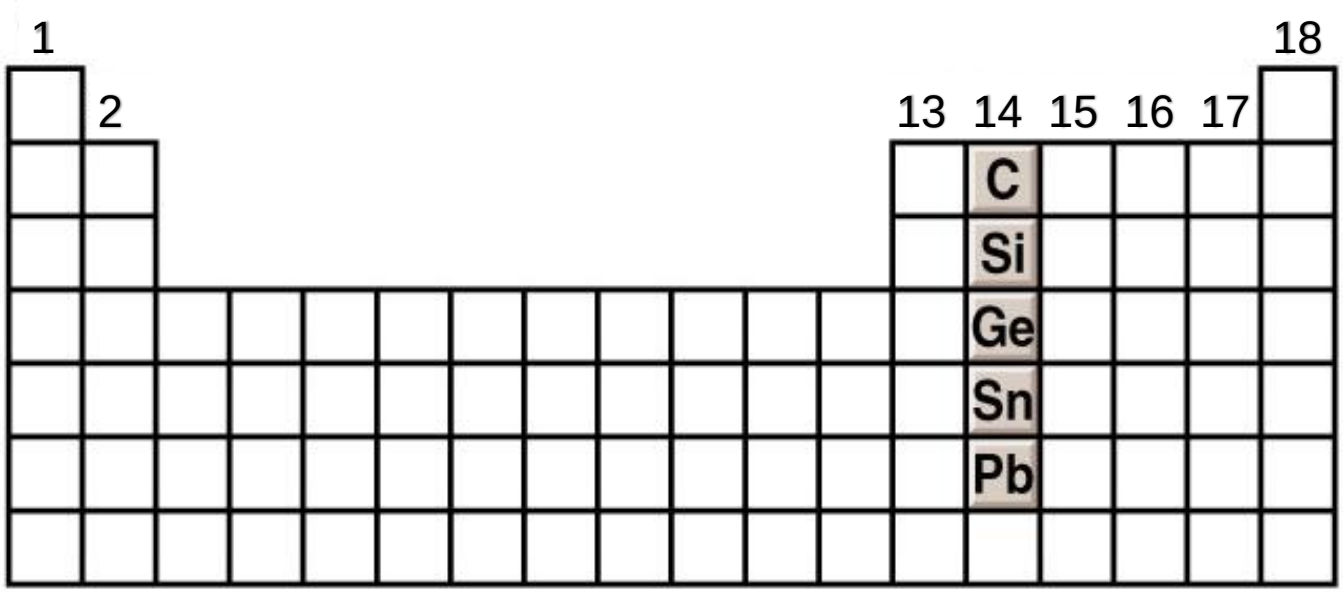
Gallium (Ga)

Indium (In)

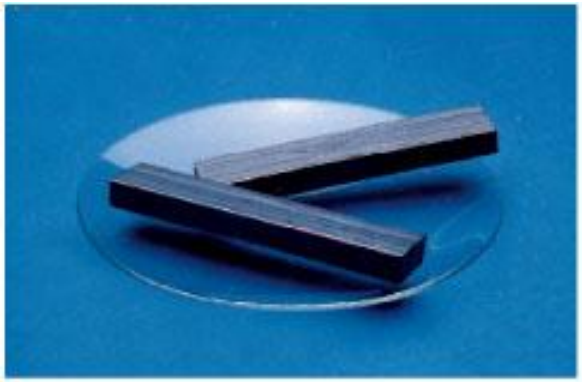
Unsur Golongan 14 (ns^2np^2, $n \geq 2$)

$$Sn_{(s)} + 2H^+_{(aq)} \longrightarrow Sn^{2+}_{(aq)} + H_{2\,(g)}$$

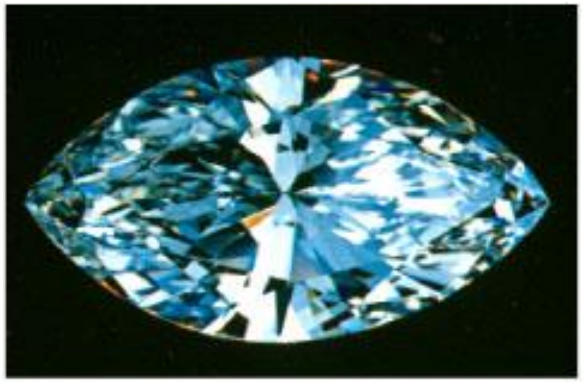
$$Pb_{(s)} + 2H^+_{(aq)} \longrightarrow Pb^{2+}_{(aq)} + H_{2\,(g)}$$



Unsur Golongan 14 (ns^2np^2, $n \geq 2$)

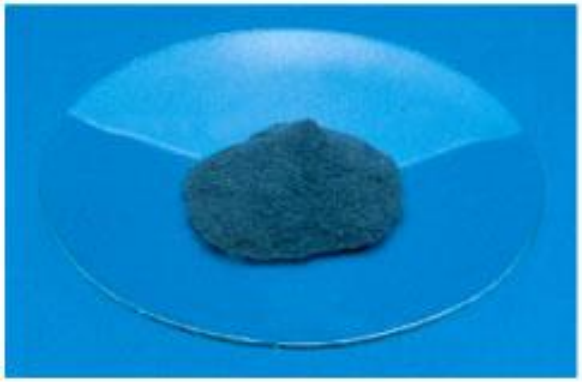


Carbon (graphite)



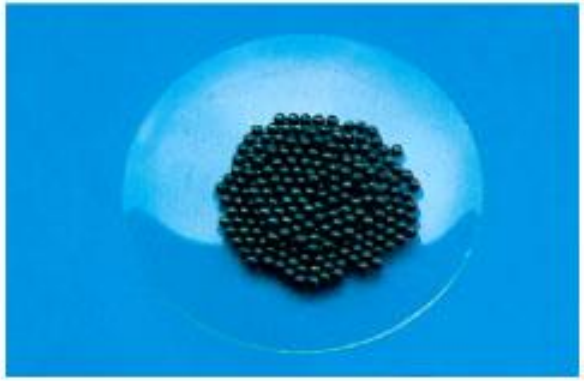
Carbon (diamond)

Silicon (Si)



Germanium (Ge)

Tin (Sn)

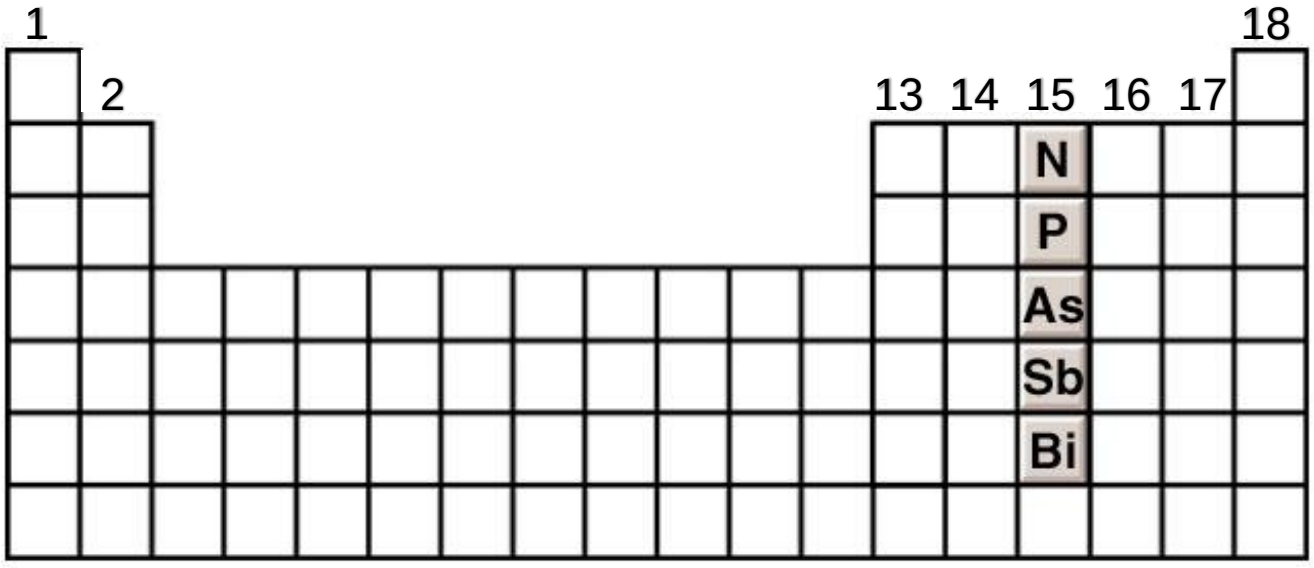


Lead (Pb)

Unsur Golongan 15 (ns^2np^3, $n \geq 2$)

$$N_2O_{5(s)} + H_2O_{(l)} \longrightarrow 2HNO_{3(aq)}$$

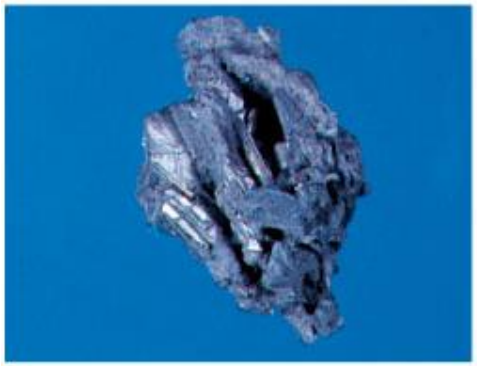
$$P_4O_{10(s)} + 6H_2O_{(l)} \longrightarrow 4H_3PO_{4(aq)}$$



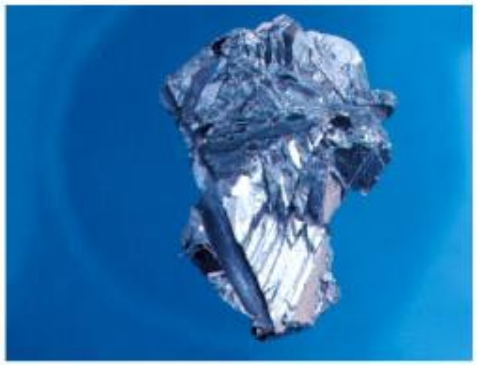
Unsur Golongan 15 (ns^2np^3, $n \geq 2$)

Nitrogen (N_2)

White and red phosphorus (P)



Arsenic (As)

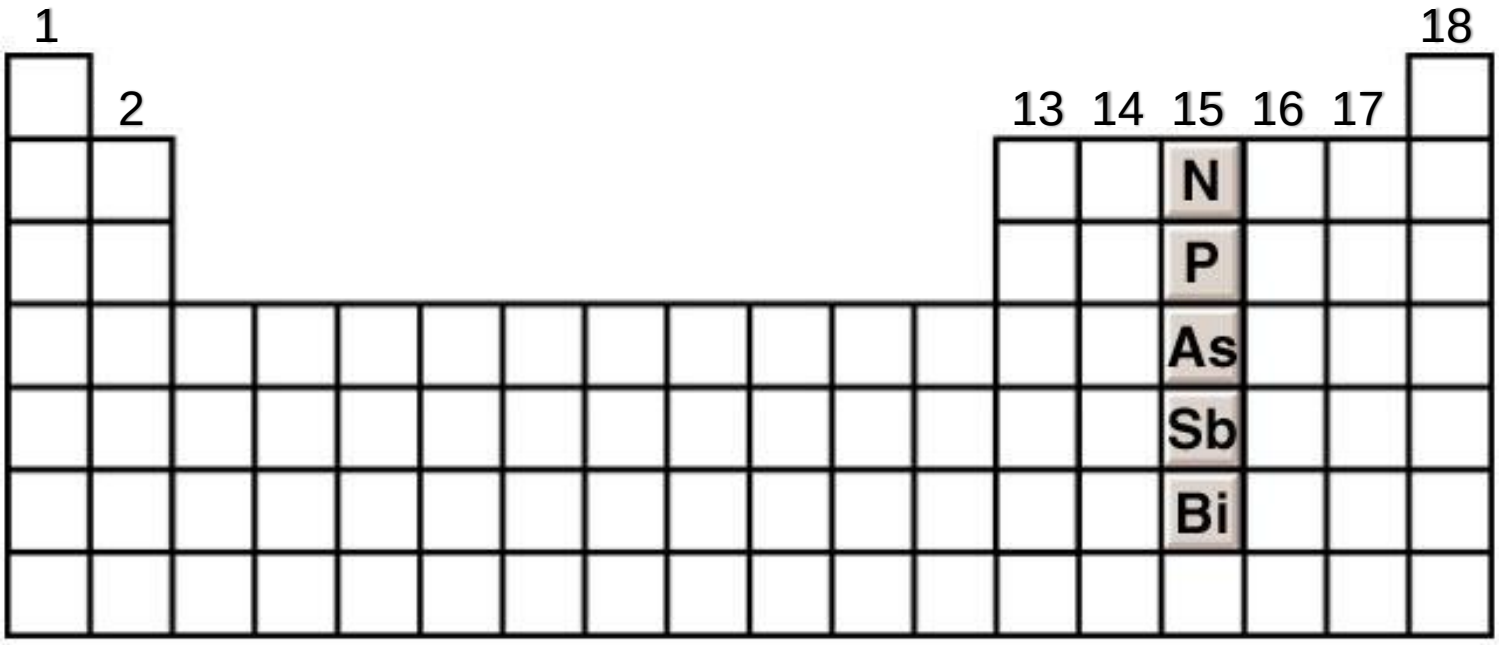


Antimony (Sb)

Bismuth (Bi)

Unsur Golongan 16 (ns^2np^4, $n \geq 2$)

$$SO_{3(g)} + H_2O_{(l)} \longrightarrow H_2SO_{4(aq)}$$



Unsur Golongan 16 (ns^2np^4, $n \geq 2$)

Sulfur (S_8)

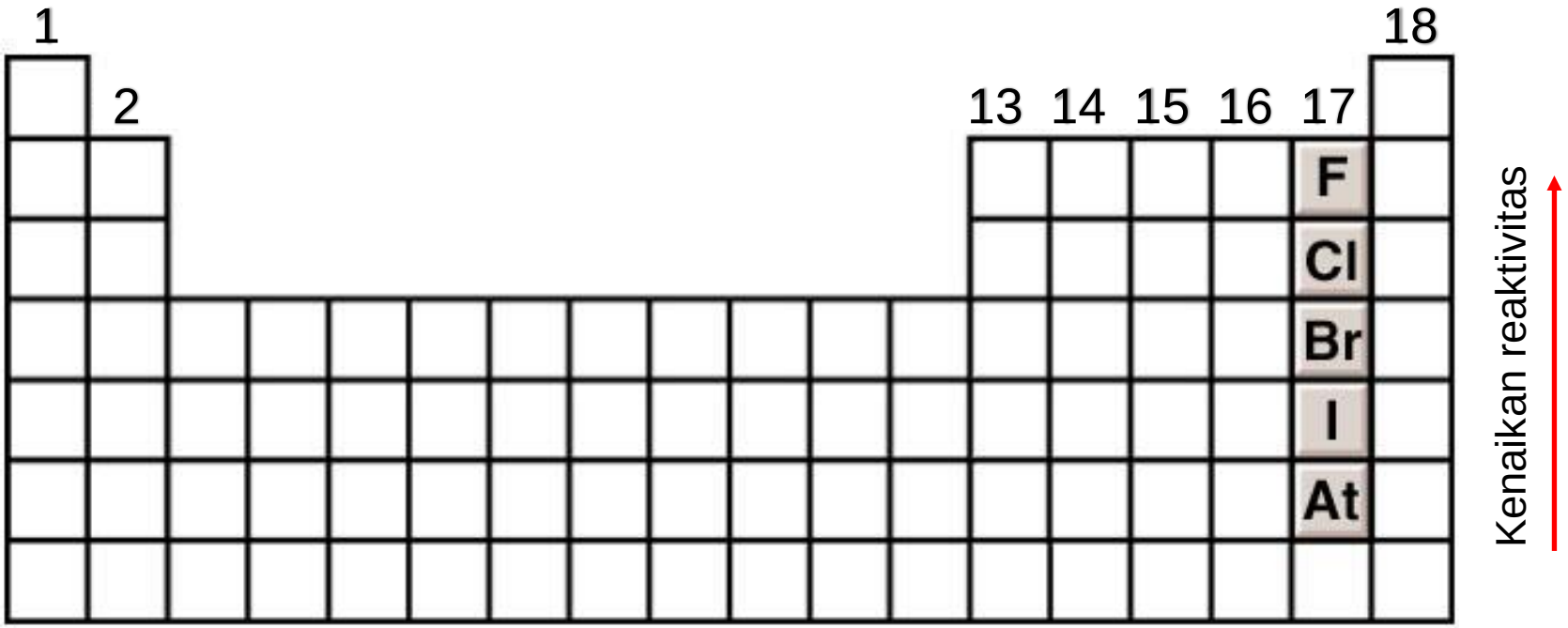
Selenium (Se_8)

Tellurium (Te)

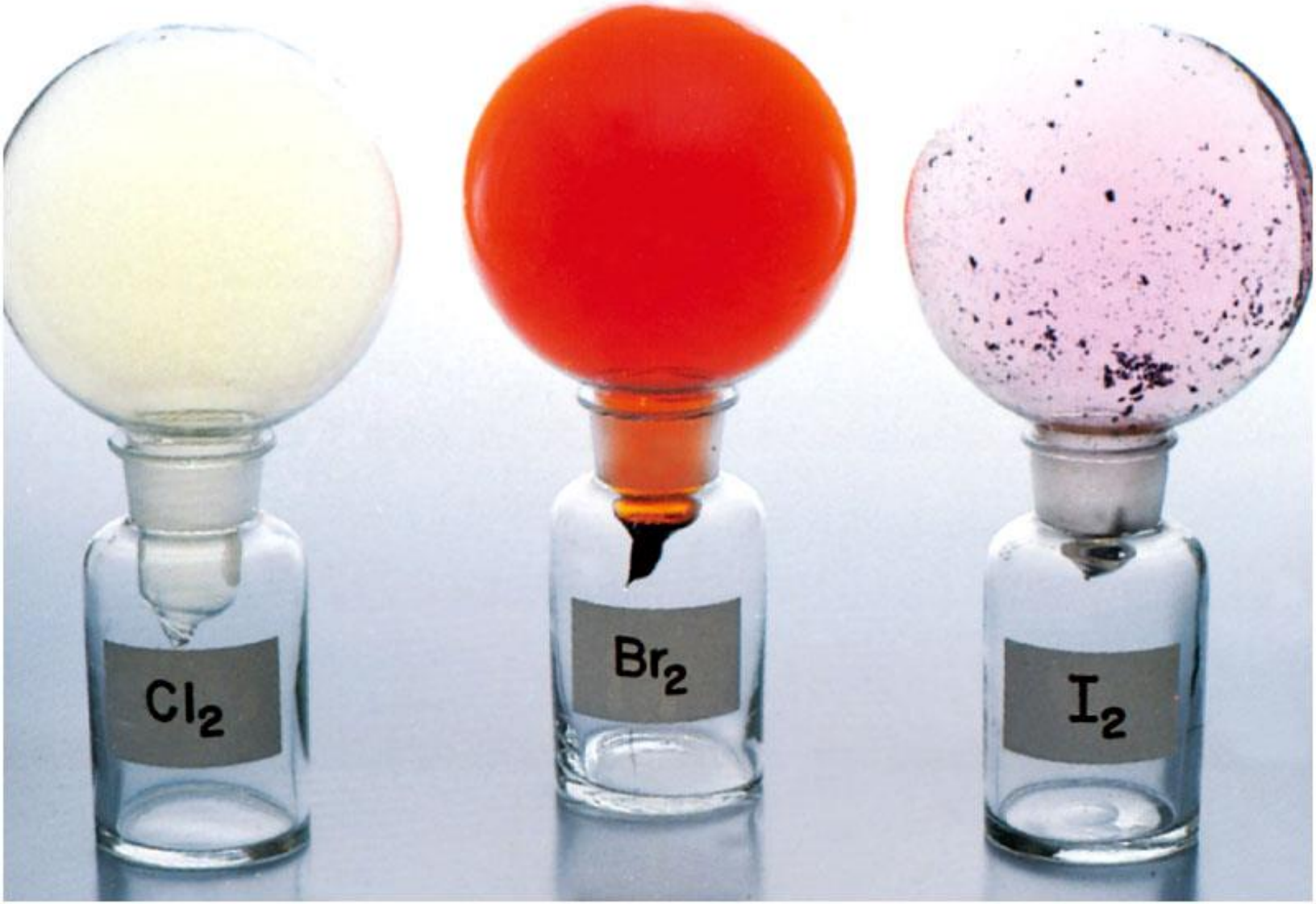
Unsur Golongan 17 (ns^2np^5, $n \geq 2$)

$$X + 1e^- \longrightarrow X^{-1}$$

$$X_{2(g)} + H_{2(g)} \longrightarrow 2HX_{(g)}$$

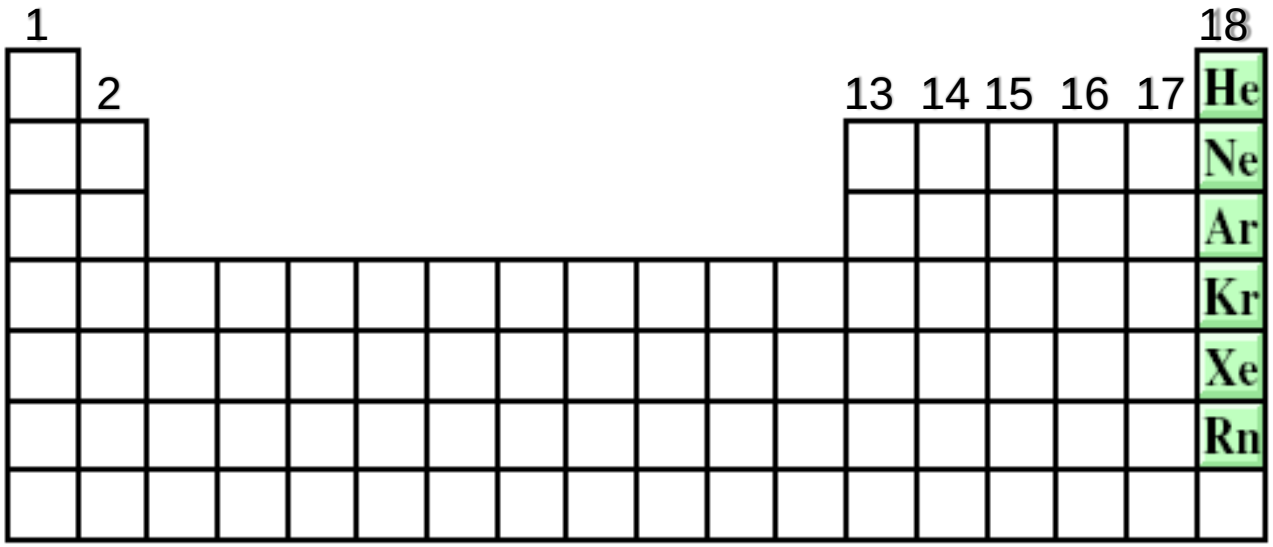


Unsur Golongan 17 (ns^2np^5, $n \geq 2$)

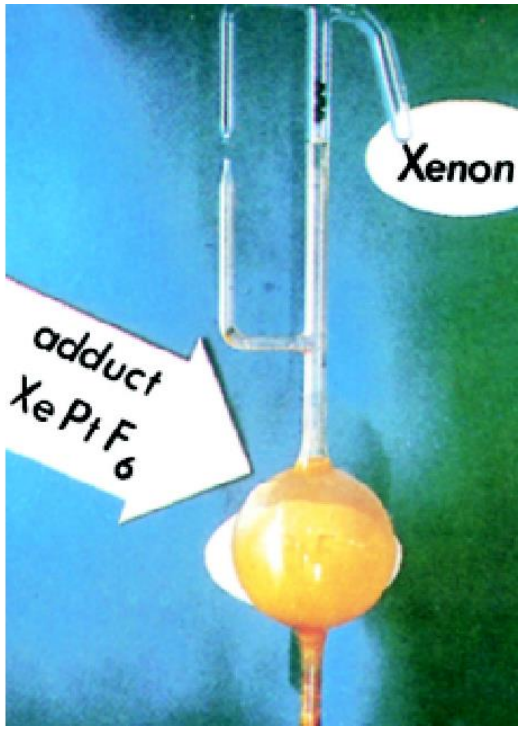


Unsur Golongan 18 (ns^2np^6, $n \geq 2$)

Subkulit ns dan np terisi penuh.
Energi ionisasi tertinggi dari semua unsur.
Tidak ada kecenderungan untuk menerima elektron tambahan.



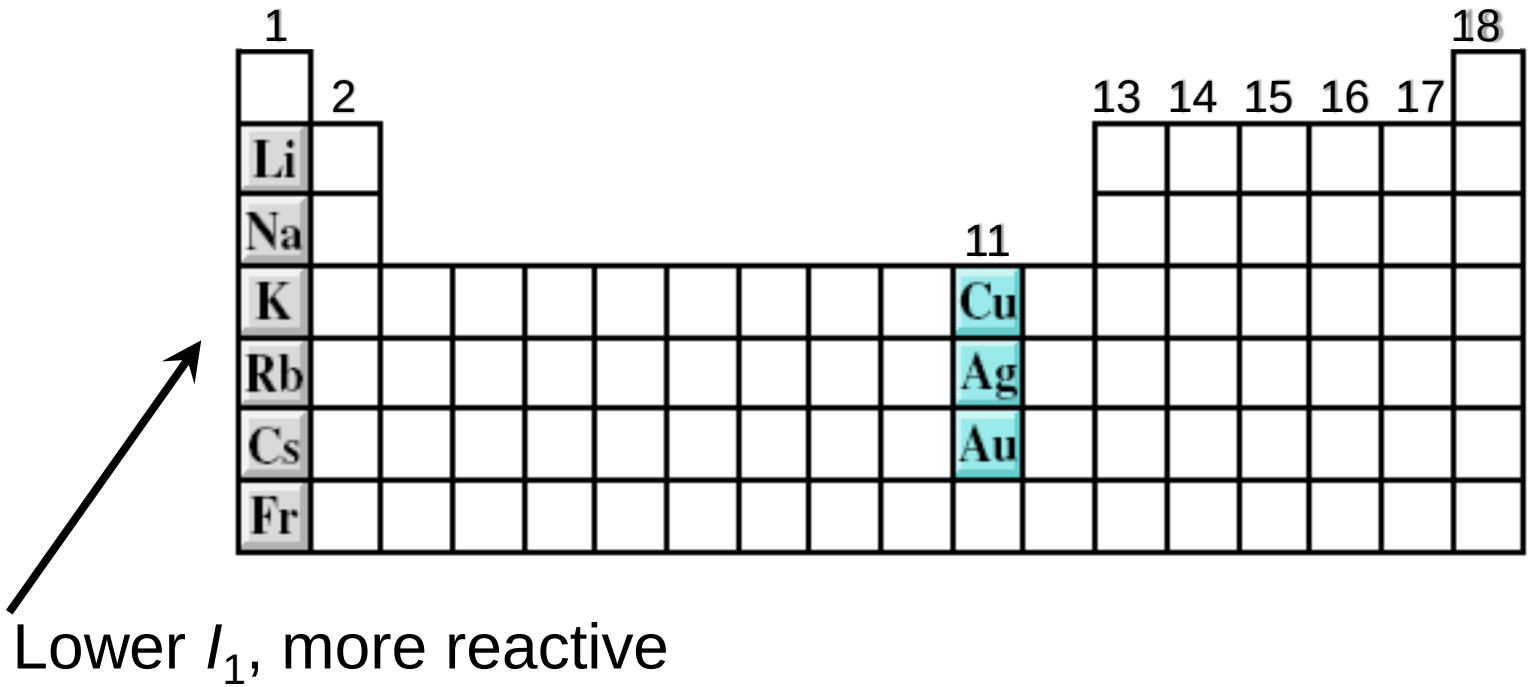
Senyawa Gas Mulia



Sejumlah senyawa xenon XeF_4, XeO_3, XeO_4, $XeOF_4$ ada.
Beberapa senyawa kripton (KrF_2, misalnya) telah dibuat.

Perbandingan Golongan 1 dan 11

Logam dalam kedua golongan ini memiliki konfigurasi elektron terluar yang serupa, dengan satu elektron berada pada orbital s terluar.
Sifat kimia sangat berbeda karena perbedaan energi ionisasi.



Sifat Oksida dalam Suatu Periode

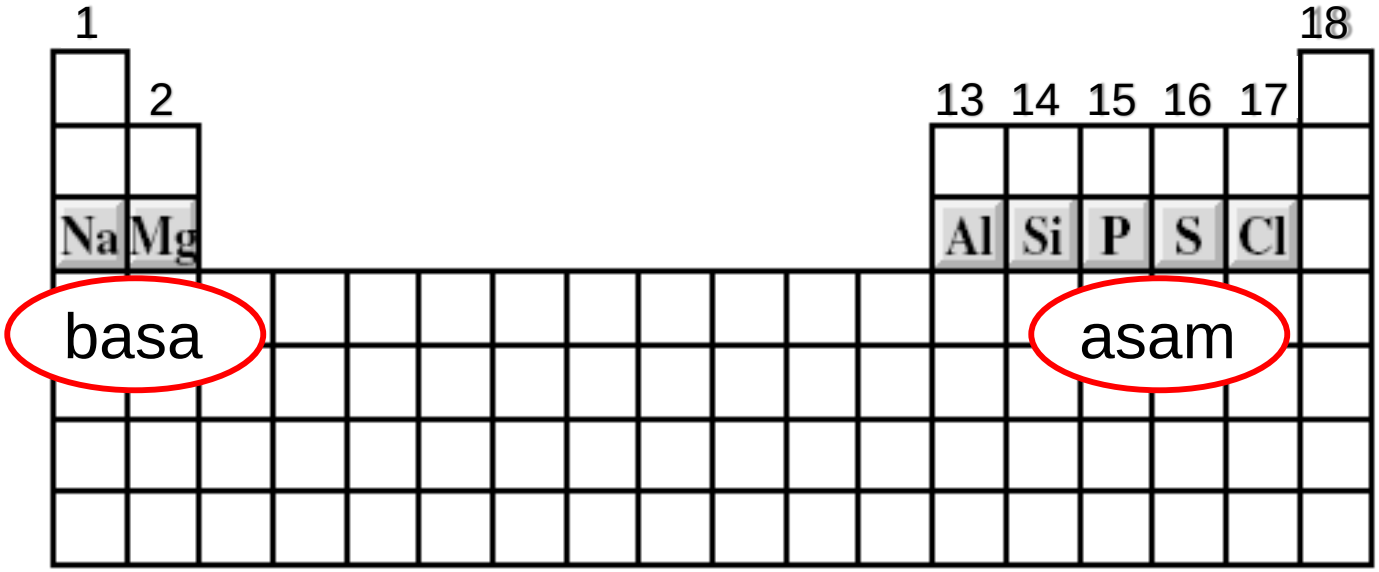
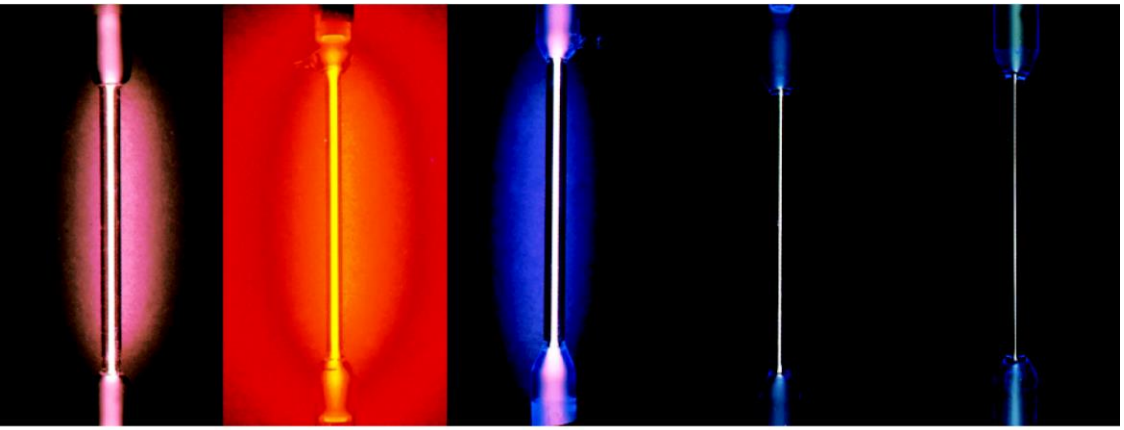


TABLE 8.4 Some Properties of Oxides of the Third-Period Elements

	Na_2O	MgO	Al_2O_3	SiO_2	P_4O_{10}	SO_3	Cl_2O_7
Type of compound	← Ionic →			← Molecular →			
Structure	← Extensive three-dimensional →			← Discrete molecular units →			
Melting point (°C)	1275	2800	2045	1610	580	16.8	−91.5
Boiling point (°C)	?	3600	2980	2230	?	44.8	82
Acid-base nature	Basic	Basic	Amphoteric	← Acidic →			

Kimia "*in Action*": Penemuan Gas Mulia



Helium (He) Neon (Ne) Argon (Ar) Krypton (Kr) Xenon (Xe)

Sir William Ramsay