

Atomic Radius Trends

Atomic Radii of Representative Elements (nm)

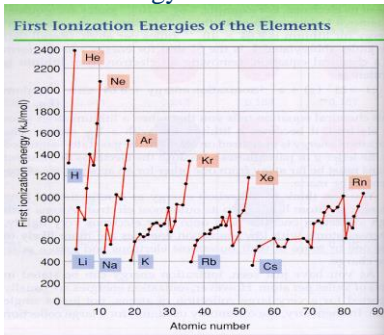
1A	2A	3A	4A	5A	6A	7A
Li 0.152	Be 0.111	B 0.088	C 0.077	N 0.070	O 0.066	F 0.064
Na 0.186	Mg 0.160	Al 0.143	Si 0.117	P 0.110	S 0.104	Cl 0.099
K 0.231	Ca 0.197	Ga 0.122	Ge 0.122	As 0.121	Se 0.116	Br 0.115
Rb 0.244	Sr 0.215	In 0.162	Sn 0.14	Sb 0.141	Te 0.137	I 0.133
Cs 0.262	Ba 0.217	Tl 0.171	Pb 0.175	Bi 0.146	Po 0.14	At 0.140

Periodic Trends

Trends:

- 1) Atomic radius increases down a group.
- 2) Atoms get smaller as you move across the period.
 - Explanation of (2) - As you move left to right across the period, there are more protons which give a stronger pull on the outermost electrons.

Ionization Energy Trends



Ionization Energy Trends

Energy required to remove one of the atom's electrons.

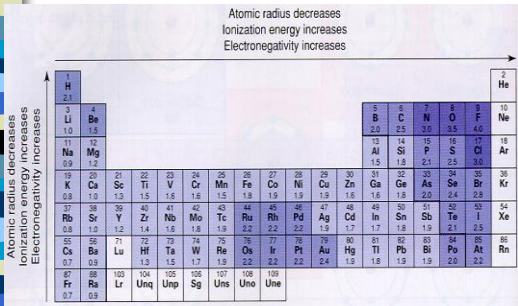
- Ionization energies decrease as you move down a group.
- Ionization energies increase as you move left to right across the period.

Ionization Energies

TABLE 7.2 Successive Values of Ionization Energies, I , for the Elements Sodium Through Argon (kJ/mol)

Element	I_1	I_2	I_3	I_4	I_5	I_6	I_7
Na	496	4560					
Mg	738	1450	7730				(Inner-shell electrons)
Al	578	1820	2750	11,600			
Si	786	1580	3230	4360	16,100		
P	1012	1900	2910	4960	6270	22,200	
S	1000	2250	3360	4560	7010	8500	27,100
Cl	1251	2300	3820	5160	6540	9460	11,000
Ar	1521	2670	3930	5770	7240	8780	12,000

Trends



Electronegativity Trends

Atoms ability to pull electrons towards it.

- Electronegativity decreases as you move down a group.
- Electronegativity increases as you move left to right across the period.

Ionic Size Trends

Ionic Size of Representative Elements (nm)

1A	2A	3A	4A	5A	6A	7A
Li ⁺ 0.060	Ba ²⁺ 0.031	B ³⁺ 0.020	C ⁴⁺ 0.015	N ³⁻ 0.171	O ²⁻ 0.140	F ⁻ 0.136
Na ⁺ 0.095	Mg ²⁺ 0.065	Al ³⁺ 0.050	Si ⁴⁺ 0.041	P ³⁻ 0.212	S ²⁻ 0.184	Cl ⁻ 0.181
K ⁺ 0.133	Ca ²⁺ 0.099	Ga ³⁺ 0.062	Ge ⁴⁺ 0.053	As ³⁻ 0.222	Se ²⁻ 0.198	Br ⁻ 0.195
Rb ⁺ 0.148	Sr ²⁺ 0.113	In ³⁺ 0.081	Sn ⁴⁺ 0.071	Ta ⁵⁻ 0.221	I ⁻ 0.216	
Cs ⁺ 0.169	Ba ²⁺ 0.135					

Ionic Size Trends

- When atoms lose electrons, their radius decreases.
- When atoms gain electrons, their radius increases.
 - Atoms within the same group form the same ions.



Metal Properties

Metals have a luster, conduct heat & electricity, are malleable and most are solid at room temperature.

Compounds of metals and nonmetals tend to be ionic compounds

Metal oxides react with water to form bases.

Metal oxides can be used to neutralize acids.

Alkali & Alkali Earth metals react with water to form bases and hydrogen gas



Nonmetal Properties

Nonmetals do not have a luster, do not conduct heat & electricity, are not malleable and are in any state of matter at room temperature.

Compounds of metals and nonmetals tend to be ionic compounds

Compounds of only nonmetals are molecular substances

Nonmetal oxides react with water to form acids.

Nonmetal oxides can be used to neutralize bases.



Origins of the Periodic Table

In 1869, approximately 62 elements were known to exist. Scientists wanted a convenient way to look at these elements. Dmitri Mendeleev proposed a periodic table of elements. It was arranged by increasing mass number and similar properties.

Later, Henry Mosley working with X-ray radiation discovered that the amount of positive charge in the atom (protons) was the proper way to order the elements.

The Periodic Law

- Periodic Law - when elements are arranged in order of increasing atomic number, their physical and chemical properties show a periodic pattern.

Groups

Alkali Metals:

- highly reactive due to single s-orbital electron.
- Forms a +1 charge
- Reacts with oxygen & water rapidly, must be stored in oil.
- Soft metal, very abundant

Alkali Earth Metals:

- Very reactive, but not as much as alkali metals.
- Soft metal, very abundant
- Forms +2 charge

3 Li Lithium 6.941 (He)2s ¹	4 Be Beryllium 9.012182 (He)2s ²
11 Na Sodium 22.989768 (He)3s ¹	12 Mg Magnesium 24.3050 (He)3s ²
19 K Potassium 39.0983 (Ar)4s ¹	20 Ca Calcium 40.078 (Ar)4s ²
37 Rb Rubidium 85.4678 (Kr)5s ¹	38 Sr Strontium 87.62 (Kr)5s ²
55 Cs Cesium 132.9054 (Xe)6s ¹	56 Ba Barium 137.327 (Xe)6s ²
87 Fr Francium 223.0187 (Rn)7s ¹	88 Ra Radium 226.0254 (Rn)7s ²

Groups

Halogens:

- Nonmetals with high reactivity.
- Very common in compound form
- Gas or liquid at room temp.
- Forms a -1 charge.

Noble Gases:

- Gases with a full p-orbital.
- Very few compounds of noble gases made because of stable p-orbital.
- Commonly used in gas tubes for neon-type signs.

9 F Fluorine 18.9984032 (He)2s ² 2p ⁵	10 Ne Neon 20.1797 (He)2s ² 2p ⁶
17 Cl Chlorine 35.453 (Ne)3s ² 3p ⁵	18 Ar Argon 39.948 (Ne)3s ² 3p ⁶
35 Br Bromine 79.904 (Ar)4s ² 4p ⁵	36 Kr Krypton 83.8 (Ar)4s ² 4p ⁶
53 I Iodine 126.90447 (Kr)5s ² 5p ⁵	54 Xe Xenon 131.29 (Kr)5s ² 5p ⁶
85 At Astatine 208.9871 (Xe)6s ² 6p ⁵	86 Rn Radon 222.0176 (Xe)6s ² 6p ⁶

Groups

Se Selenium 34.0858 [Ar] 3d ¹⁰ 4s ² 4p ⁴	Ti Titanium 47.88 [Ar] 3d ² 4s ²	V Vanadium 50.9415 [Ar] 3d ³ 4s ²	Cr Chromium 51.9961 [Ar] 3d ⁵ 4s ¹	Mn Manganese 54.938 [Ar] 3d ⁵ 4s ²	Fe Iron 55.845 [Ar] 3d ⁶ 4s ²	Co Cobalt 58.9332 [Ar] 3d ⁷ 4s ²	Ni Nickel 58.69 [Ar] 3d ⁸ 4s ²	Cu Copper 63.546 [Ar] 3d ¹⁰ 4s ¹	Zn Zinc 65.38 [Ar] 3d ¹⁰ 4s ²
Y Yttrium 88.9062 [Kr] 4d ¹ 5s ²	Zr Zirconium 91.224 [Kr] 4d ² 5s ²	Nb Niobium 92.9063 [Kr] 4d ⁴ 5s ¹	Mo Molybdenum 95.94 [Kr] 4d ⁵ 5s ¹	Tc Technetium 98 [Kr] 4d ⁵ 5s ²	Ru Ruthenium 101.07 [Kr] 4d ⁷ 5s ¹	Rh Rhodium 102.9055 [Kr] 4d ⁸ 5s ¹	Pd Palladium 106.42 [Kr] 4d ¹⁰	Ag Silver 107.8682 [Kr] 4d ¹⁰ 5s ¹	Cd Cadmium 112.411 [Kr] 4d ¹⁰ 5s ²
La Lanthanum 138.9055 [Xe] 5d ¹ 6s ²	Hf Hafnium 178.49 [Xe] 4f ¹⁴ 5d ² 6s ²	Ta Tantalum 180.9479 [Xe] 4f ¹⁴ 5d ³ 6s ²	W Tungsten 183.84 [Xe] 4f ¹⁴ 5d ⁴ 6s ²	Re Rhenium 186.207 [Xe] 4f ¹⁴ 5d ⁵ 6s ²	Os Osmium 190.23 [Xe] 4f ¹⁴ 5d ⁶ 6s ²	Ir Iridium 192.222 [Xe] 4f ¹⁴ 5d ⁷ 6s ²	Pt Platinum 195.084 [Xe] 4f ¹⁴ 5d ⁹ 6s ¹	Au Gold 196.96657 [Xe] 4f ¹⁴ 5d ¹⁰ 6s ¹	Hg Mercury 200.59 [Xe] 4f ¹⁴ 5d ¹⁰ 6s ²
Ac Actinium 227.0377 [Rn] 6d ¹ 7s ²	Unq Unquadrium [Og] 118 [Og] 5f ¹⁴ 6d ¹ 7s ²	Unp Unpentium [Og] 119 [Og] 5f ¹⁴ 6d ² 7s ²	Unh Unhexium [Og] 120 [Og] 5f ¹⁴ 6d ³ 7s ²	Uns Unseptium [Og] 121 [Og] 5f ¹⁴ 6d ⁴ 7s ²	Uno Unoctium [Og] 122 [Og] 5f ¹⁴ 6d ⁵ 7s ²	Une Unennium [Og] 123 [Og] 5f ¹⁴ 6d ⁶ 7s ²			

Transition Metals: (d-orbital)

- Metals found throughout the Earth, sometimes in elemental form.
- Varying charges, most commonly form +2 charge.
- Most applications of industry from these elements

Groups

Inner Transition Metals: (f-orbital)

- Group of highly unstable elements used in nuclear reactions, and lighting.
- Instability due to size of atoms.

Ce Cerium 140.12 [Xe] 4f ¹ 5d ¹ 6s ²	Pr Praseodymium 140.9076 [Xe] 4f ³ 6s ²	Nd Neodymium 144.24 [Xe] 4f ⁴ 6s ²	Pm Promethium [144.9128] [Xe] 4f ⁵ 6s ²	Sm Samarium 150.36 [Xe] 4f ⁶ 6s ²	Eu Europium 151.964 [Xe] 4f ⁷ 6s ²	Gd Gadolinium 157.25 [Xe] 4f ⁷ 5d ¹ 6s ²	Tb Terbium 158.9253 [Xe] 4f ⁹ 6s ²	Dy Dysprosium 162.50 [Xe] 4f ¹⁰ 6s ²	Ho Holmium 164.9303 [Xe] 4f ¹¹ 6s ²	Er Erbium 167.259 [Xe] 4f ¹² 6s ²	Tm Thulium 168.9304 [Xe] 4f ¹³ 6s ²	Yb Ytterbium 173.0547 [Xe] 4f ¹⁴ 6s ²	Lu Lutetium 174.967 [Xe] 4f ¹⁴ 5d ¹ 6s ²
Th Thorium 232.0377 [Rn] 6d ² 7s ²	Pa Protactinium 231.03688 [Rn] 5f ² 6d ¹ 7s ²	U Uranium 238.02891 [Rn] 5f ³ 6d ¹ 7s ²	Np Neptunium 237.04817 [Rn] 5f ⁴ 6d ¹ 7s ²	Pu Plutonium 244.0642 [Rn] 5f ⁶ 6d ¹ 7s ²	Am Americium 243.0613 [Rn] 5f ⁷ 7s ²	Cm Curium 247.07538 [Rn] 5f ⁷ 6d ¹ 7s ²	Bk Berkelium 247.07125 [Rn] 5f ⁹ 7s ²	Cf Californium 251.0825 [Rn] 5f ¹⁰ 7s ²	Es Einsteinium 252.0833 [Rn] 5f ¹¹ 7s ²	Fm Fermium 257.0951 [Rn] 5f ¹² 7s ²	Md Mendelevium 258.1052 [Rn] 5f ¹³ 7s ²	No Nobelium 259.1063 [Rn] 5f ¹⁴ 7s ²	Lr Lawrencium 260.1053 [Rn] 5f ¹⁴ 6d ¹ 7s ²
