



Lesson 3: The Periodic Trend (1.7)

Atomic Radius (AR)

How is atomic radius measure?

The definition of atomic radius: is the distance from the centre of an atom to the boundary within which the electrons spend 90percent of their time.

Generally, as you go down a group in the periodic table, atomic radius _____ because...

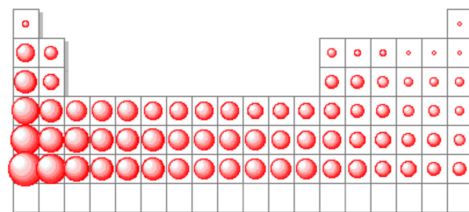
Generally, as you go across a period in the periodic table atomic radius _____ because...

DISPLAY PROPERTY/TREND Chemical Group Block																		2 He Helium Noble Gas																	
1 H Hydrogen Nonmetal Atomic Number Symbol Name Chemical Group Block																																			
3 Li Lithium Alkali Metal		4 Be Beryllium Alkaline E...																5 B Boron Metalloid		6 C Carbon Nonmetal		7 N Nitrogen Nonmetal		8 O Oxygen Nonmetal		9 F Fluorine Halogen		10 Ne Neon Noble Gas							
11 Na Sodium Alkali Metal		12 Mg Magnesium Alkaline E...																13 Al Aluminum Post-Tran...		14 Si Silicon Metalloid		15 P Phosphor... Nonmetal		16 S Sulfur Nonmetal		17 Cl Chlorine Halogen		18 Ar Argon Noble Gas							
19 K Potassium Alkali Metal		20 Ca Calcium Alkaline E...		21 Sc Scandium Transition...		22 Ti Titanium Transition...		23 V Vanadium Transition...		24 Cr Chromium Transition...		25 Mn Manganese Transition...		26 Fe Iron Transition...		27 Co Cobalt Transition...		28 Ni Nickel Transition...		29 Cu Copper Transition...		30 Zn Zinc Transition...		31 Ga Gallium Post-Tran...		32 Ge Germanium Metalloid		33 As Arsenic Metalloid		34 Se Selenium Nonmetal		35 Br Bromine Halogen		36 Kr Krypton Noble Gas	
37 Rb Rubidium Alkali Metal		38 Sr Strontium Alkaline E...		39 Y Yttrium Transition...		40 Zr Zirconium Transition...		41 Nb Niobium Transition...		42 Mo Molybden... Transition...		43 Tc Technetium Transition...		44 Ru Ruthenium Transition...		45 Rh Rhodium Transition...		46 Pd Palladium Transition...		47 Ag Silver Transition...		48 Cd Cadmium Transition...		49 In Indium Post-Tran...		50 Sn Tin Post-Tran...		51 Sb Antimony Metalloid		52 Te Tellurium Metalloid		53 I Iodine Halogen		54 Xe Xenon Noble Gas	
55 Cs Cesium Alkali Metal		56 Ba Barium Alkaline E...		*		72 Hf Hafnium Transition...		73 Ta Tantalum Transition...		74 W Tungsten Transition...		75 Re Rhenium Transition...		76 Os Osmium Transition...		77 Ir Iridium Transition...		78 Pt Platinum Transition...		79 Au Gold Transition...		80 Hg Mercury Transition...		81 Tl Thallium Post-Tran...		82 Pb Lead Post-Tran...		83 Bi Bismuth Post-Tran...		84 Po Polonium Metalloid		85 At Astatine Halogen		86 Rn Radon Noble Gas	
87 Fr Francium Alkali Metal		88 Ra Radium Alkaline E...		**		104 Rf Rutherford... Transition...		105 Db Dubnium Transition...		106 Sg Seaborgi... Transition...		107 Bh Bohrium Transition...		108 Hs Hassium Transition...		109 Mt Meitnerium Transition...		110 Ds Darmstad... Transition...		111 Rg Roentgen... Transition...		112 Cn Copernici... Transition...		113 Nh Nihonium Post-Tran...		114 Fl Flerovium Post-Tran...		115 Mc Moscovium Post-Tran...		116 Lv Livermori... Post-Tran...		117 Ts Tennessine Halogen		118 Og Oganesson Noble Gas	

Practice Problems

7. Using only their location in the periodic table, rank the atoms in each set by decreasing atomic size. Explain your answers.

- | | |
|----------------|----------------|
| (a) Mg, Be, Ba | (f) Se, Br, Cl |
| (b) Ca, Se, Ga | (g) Mg, Ca, Li |
| (c) Br, Rb, Kr | (h) Sr, Te, Se |
| (d) Se, Br, Ca | (i) In, Br, I |
| (e) Ba, Sr, Cs | (j) S, Se, O |





Ionic radii for metal cations and non-metal anions

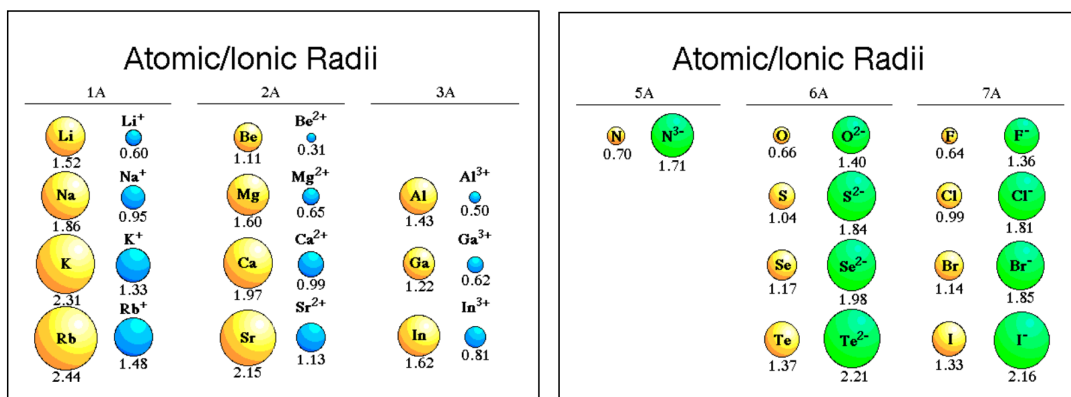


Figure 2: Periodic trend of ionic radii for metal cations and non-metal anions

Ionization Energy (IA)

Define ionization energy: _____.

Generally, as you go down a group in the periodic table, ionization energy _____ because...

Generally, as you go across a period in the periodic table, ionization energy _____ because...

How many ionization energies can an atom have?

First ionization energy: $A(g) + \text{energy} \rightarrow A^+(g) + e^-$

Second ionization energy: $A^+(g) + \text{energy} \rightarrow A^{2+}(g) + e^-$

Practice Problems

8. Using only a periodic table, rank the elements in each set by increasing ionization energy. Explain your answers.

(a) Xe, He, Ar

(d) Kr, Br, K

(b) Sn, In, Sb

(e) K, Ca, Rb

(c) Sr, Ca, Ba

(f) Kr, Br, Rb

9. Using only a periodic table, identify the atom in each of the following pairs with the *lower* first ionization energy.

(a) B, O

(d) F, N

(b) B, In

(e) Ca, K

(c) I, F

(f) B, Tl



Electron Affinity (EA)

Define Electron affinity: _____.

Generally, as you go down a group of elements E.A. _____ which means it is _____ to add an electron because...

Generally, as you go across a period of elements E.A. _____ which means it is _____ to add an electron because...

In which corner of the periodic table is it the highest? _____. Explain why this is so.

How can the type (metal/non-metal) of element tell you its E.A. value?

Electronegativity

H 2.1		Pauling Electronegativity Values															He
Li 1.0		Be 1.6										B 2.0	C 2.5	N 3.0	O 3.5	F 4.0	Ne
Na 0.9		Mg 1.3										Al 1.5	Si 1.9	P 2.2	S 2.6	Cl 3.0	Ar
K 0.8	Ca 1.0	Sc 1.4	Ti 1.5	V 1.6	Cr 1.7	Mn 1.5	Fe 1.8	Co 1.9	Ni 1.9	Cu 1.9	Zn 1.6	Ga 1.8	Ge 2.0	As 2.2	Se 2.6	Br 2.8	Kr
Rb 0.8	Sr 0.9	Y 1.2	Zr 1.3	Nb 1.6	Mo 2.2	Tc 1.9	Ru 2.2	Rh 2.3	Pd 2.2	Ag 1.9	Cd 1.7	In 1.8	Sn 2.0	Sb 2.1	Te 2.1	I 2.5	Xe

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Higher the value, higher the electronegativity, stronger the ability to pull the electrons toward itself when form a covalent bond.



Section Wrap-up

Despite some irregularities and exceptions, the following periodic trends summarize the relationships among atomic size, ionization energy, and electron affinity:

- Trends for atomic size are the reverse of trends for ionization energy and electron affinity. Larger atoms tend to have lower ionization energies and lower electron affinities.
- Group 16 (VIA) and 17 (VIIA) elements attract electrons strongly. They do not give up electrons readily. In other words, they have a strong tendency to form negative ions. Thus, they have high ionization energies and high electron affinities.
- Group 1 (IA) and 2 (IIA) elements give up electrons readily. They have low or no attraction for electrons. In other words, they have a strong tendency to form positive ions. Thus, they have low ionization energies and low electron affinities.
- Group 18 (VIIIA) elements do not attract electrons and do not give up electrons. In other words, they do not naturally form ions. (They are very stable.) Thus, they have very high ionization energies and very low electron affinities.

1 (IA)						18 (VIIIA)
H -72.8	2 (IIA)					He (+21)
Li -59.6	Be (+241)	13 (IIIA)	14 (IVA)	15 (VA)	16 (VIA)	17 (VIIA)
		B -26.7	C -122	N 0	O -141	F -328
Na -52.9	Mg (+230)	Al -42.5	Si -134	P -72.0	S -200	Cl -349
K -48.4	Ca (+156)	Ga -28.9	Ge -119	As -78.2	Se -195	Br -325
Rb -46.9	Sr (+167)	In -28.9	Sn -107	Sb -103	Te -190	I -295
Cs -45.5	Ba (+52)	Tl -19.3	Pb -35.1	Bi -91.3	Po -183	At -270
						Rn (+41)

Figure 2.18 The units for electron affinity are the same as the units for ionization energy: kJ/mol. High negative numbers mean a high electron affinity. Low negative numbers and any positive numbers mean a low electron affinity.

Practice:

- 1 K/U** How does your understanding of electron arrangement and forces in atoms help you explain the following periodic trends?
(a) atomic radius (c) electron affinity
(b) ionization energy
- 2 K/U** Using only their location in a periodic table, rank each of the following sets of elements in order of increasing atomic size. Explain your answer in each case.
(a) Mg, S, Cl (d) Rb, Xe, Te
(b) Al, B, In (e) P, Na, F
(c) Ne, Ar, Xe (f) O, S, N
- 3 K/U** Using only their location in a periodic table, rank each of the following sets of elements in order of decreasing ionization energy. Explain your answer in each case.
(a) Cl, Br, I (d) Na, Li, Cs
(b) Ga, Ge, Se (e) S, Cl, Br
(c) K, Ca, Kr (f) Cl, Ar, K
- 4 K/U** Which element in each of the following pairs will have the lower electron affinity? Explain your answer in each case.
(a) K or Ca (c) S or Se
(b) O or Li (d) Cs or F



Overall periodic trend.

