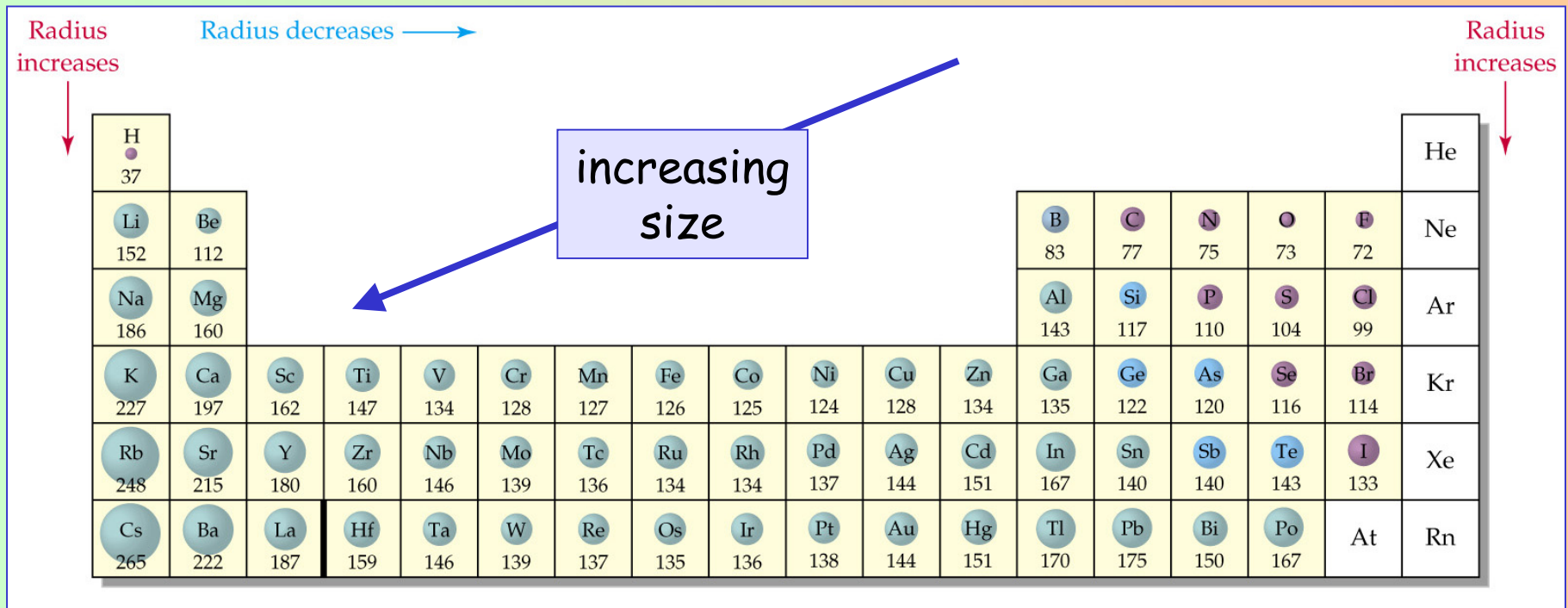


Periodic Properties: Atomic and ionic size

Trends in atomic size

The size of neutral atoms vary according to their location in the periodic table:

- the **size increases from right to left in a period (row)**
- the **size (radius, volume) increases from top to bottom in a group (column)**



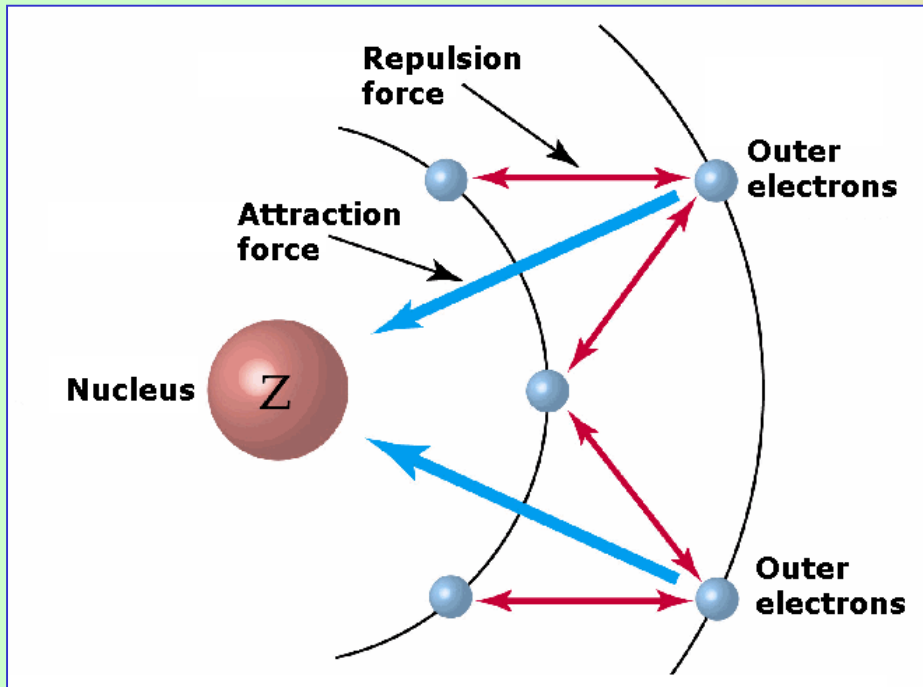
Periodic Properties: Atomic and ionic size

Factors that affect atomic size

The variations in atomic size are the result of two opposing factors:

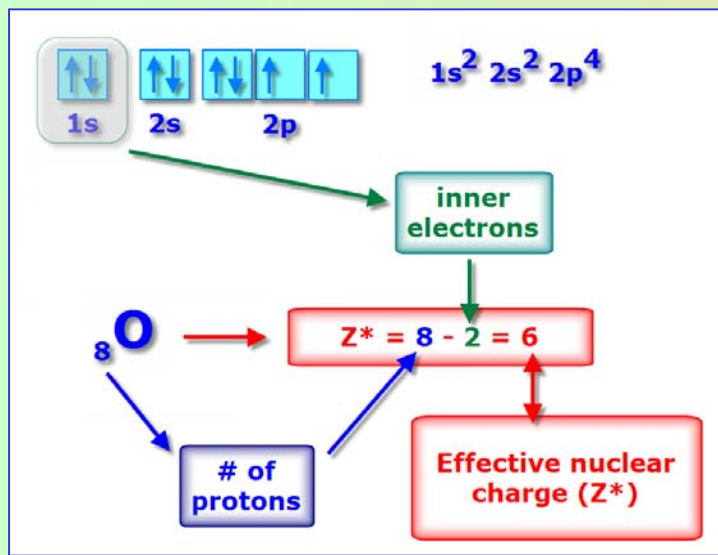
- **Changes in "n"**: as the principal quantum number (n) increases, the electrons spend more time farther from the nucleus, so the atoms tend to be larger

- **Changes in Z^*** : as the effective nuclear charge (Z^*) -the positive charge "felt" by an electron- increases, outer electrons are pulled closer to the nucleus, so the atoms are smaller.



http://wps.prenhall.com/wps/media/objects/602/616516/Media_Assets/Chapter05/Text_Images/FG05_16.JPG

Periodic Properties: Atomic and ionic size



The effective nuclear charge (Z^*)

To determine the effective nuclear charge "felt" by an outer electron we need to consider two main factors:

- the **number of protons** in the nucleus (attraction force)
- the **number of inner electrons** (screening effect)

The expression to calculate the effective nuclear charge is:

$$Z^* = Z - (\# \text{ of inner } e^-)$$

	1 I A	2 II A		13 III A	14 IV A	15 V A	16 VI A	17 VII A	18 VIII A
1	H								He
2	Li	Be		B	C	N	O	F	Ne
3	Na	Mg		Al	Si	P	S	Cl	Ar
4	K	Ca						Br	
5								I	

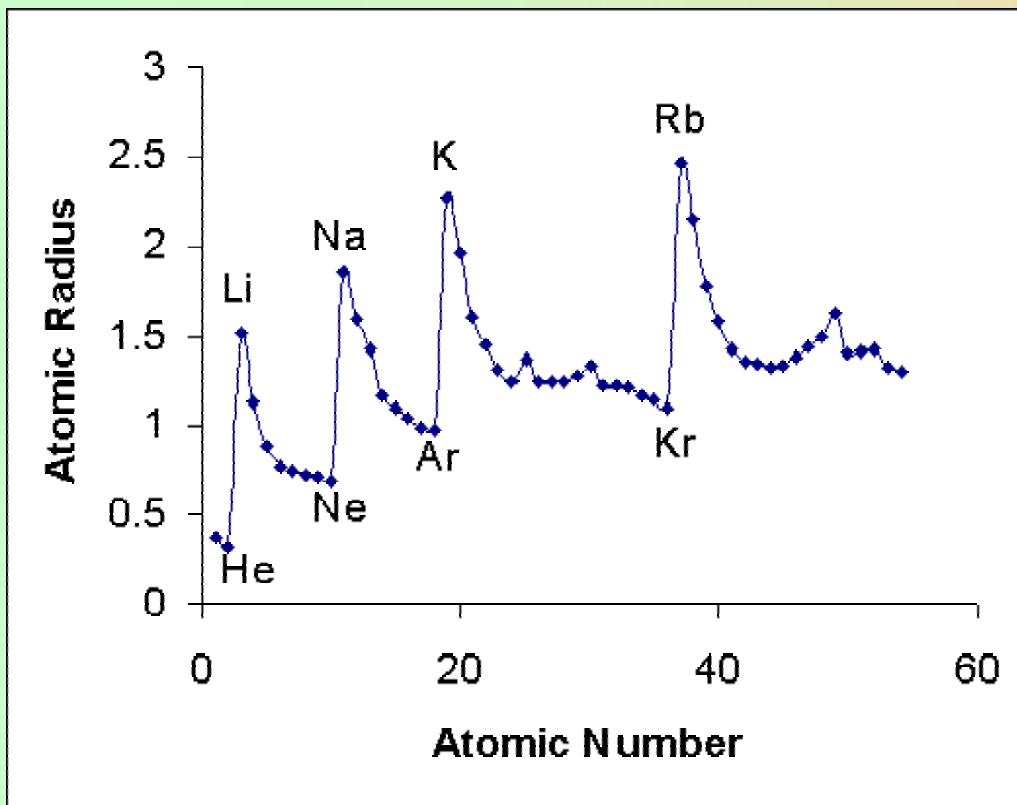


Periodic Properties: Atomic and ionic size

Periodicity of atomic radius

A plot of atomic radius vs. atomic number shows a periodic change:

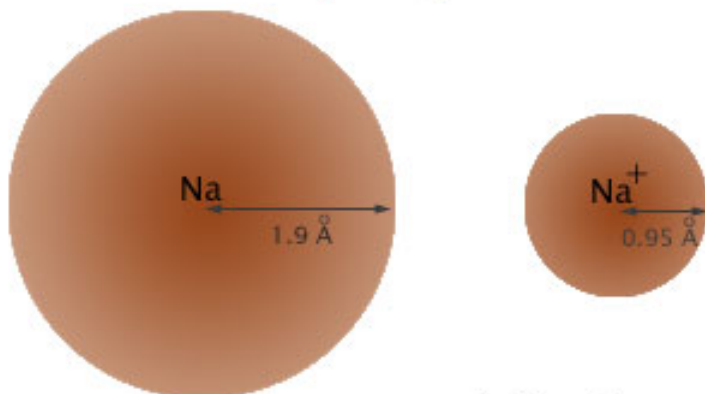
the radius generally decreases through a period to the noble gases and then increases suddenly to the next alkali metal.



<http://facultyfp.salisbury.edu/dfrieck/htdocs/212/rev/table/trends.htg/img.gif>

Periodic Properties: Atomic and ionic size

The radius of a metal ion is roughly half that of the corresponding metal atom.



Sodium atom:
11 protons
11 electrons

Sodium ion:
11 protons
10 electrons

<http://nobel.scas.bcit.ca/chem0010/unit4/images/metalionRadius.jpg>

Size of ions

Positive ions are smaller than the atoms they come from.

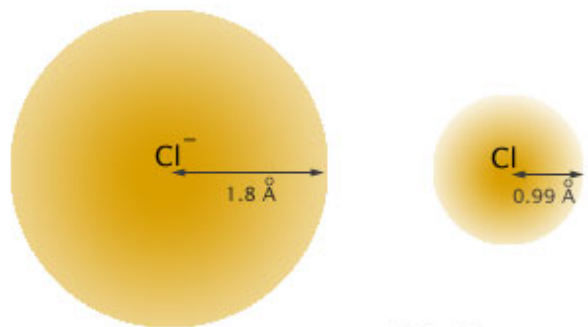
Atomic/Ionic Radii

1A		2A		3A	
Li 1.52	Li⁺ 0.60	Be 1.11	Be²⁺ 0.31		
Na 1.86	Na⁺ 0.95	Mg 1.60	Mg²⁺ 0.65	Al 1.43	Al³⁺ 0.50
K 2.31	K⁺ 1.33	Ca 1.97	Ca²⁺ 0.99	Ga 1.22	Ga³⁺ 0.62
Rb 2.44	Rb⁺ 1.48	Sr 2.15	Sr²⁺ 1.13	In 1.62	In³⁺ 0.81

<http://intro.chem.okstate.edu/AP/2003SanAntonio/Chapter7/Ionic%20Radii2.GIF>

Periodic Properties: Atomic and ionic size

The radius of a nonmetal ion is roughly twice that of the corresponding nonmetal atom.



Chloride ion:
17 protons
18 electrons



















Chloride atom:
17 protons
17 electrons

<http://nobel.scas.bcit.ca/chem0010/unit4/images/anionRadius.jpg>

Size of ions

Negative ions are larger than the atoms they come from.

Atomic/Ionic Radii

5A		6A		7A	
 N 0.70	 N ³⁻ 1.71	 O 0.66	 O ²⁻ 1.40	 F 0.64	 F ⁻ 1.36
		 S 1.04	 S ²⁻ 1.84	 Cl 0.99	 Cl ⁻ 1.81
		 Se 1.17	 Se ²⁻ 1.98	 Br 1.14	 Br ⁻ 1.85
		 Te 1.37	 Te ²⁻ 2.21	 I 1.33	 I ⁻ 2.16

<http://intro.chem.okstate.edu/1314F97/Chapter8/Ionic%20Radii3.Gif>

Periodic Properties: Atomic and ionic size

Size of isoelectronic ions

As the charge of the nucleus increases, the size of the ion decreases.

