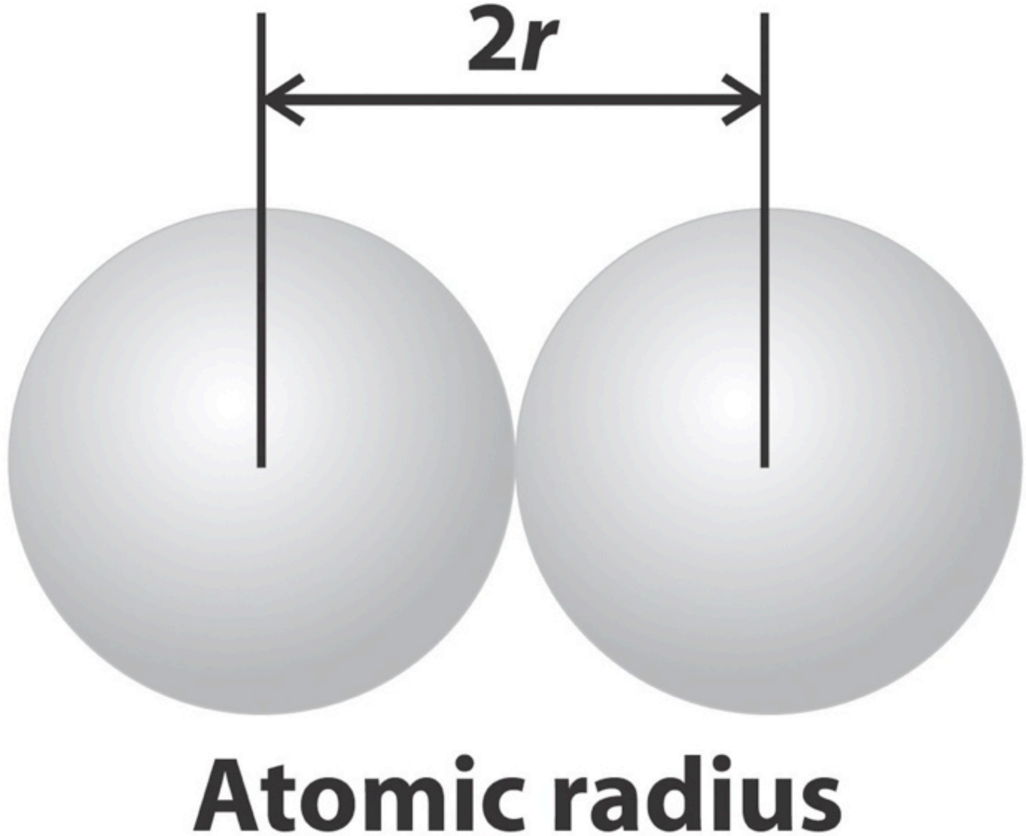
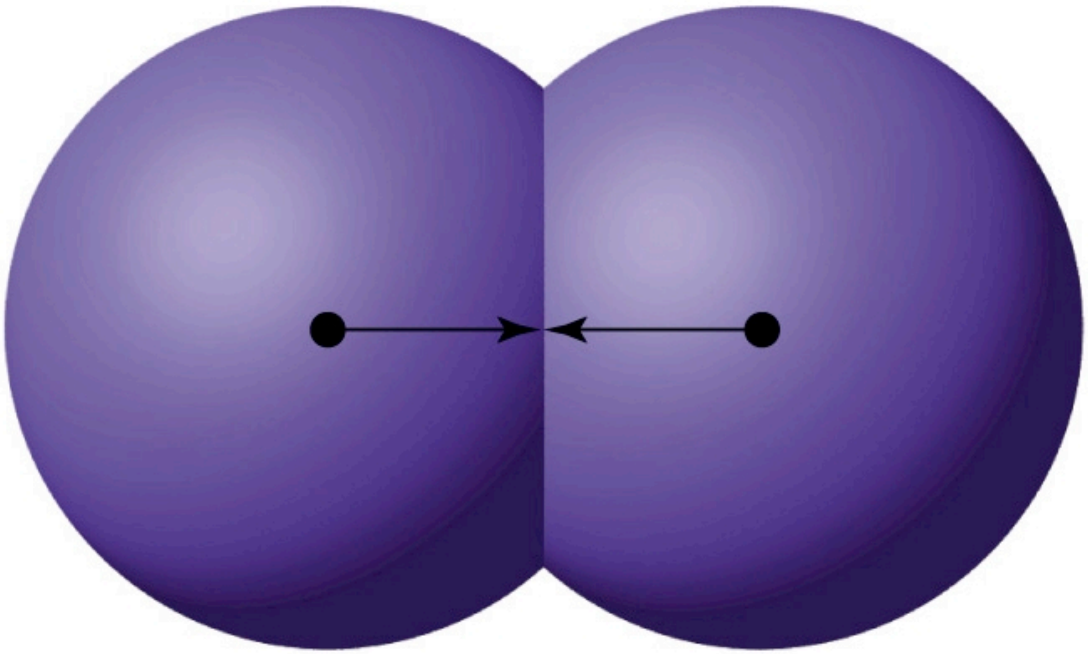
"My name is Bond."



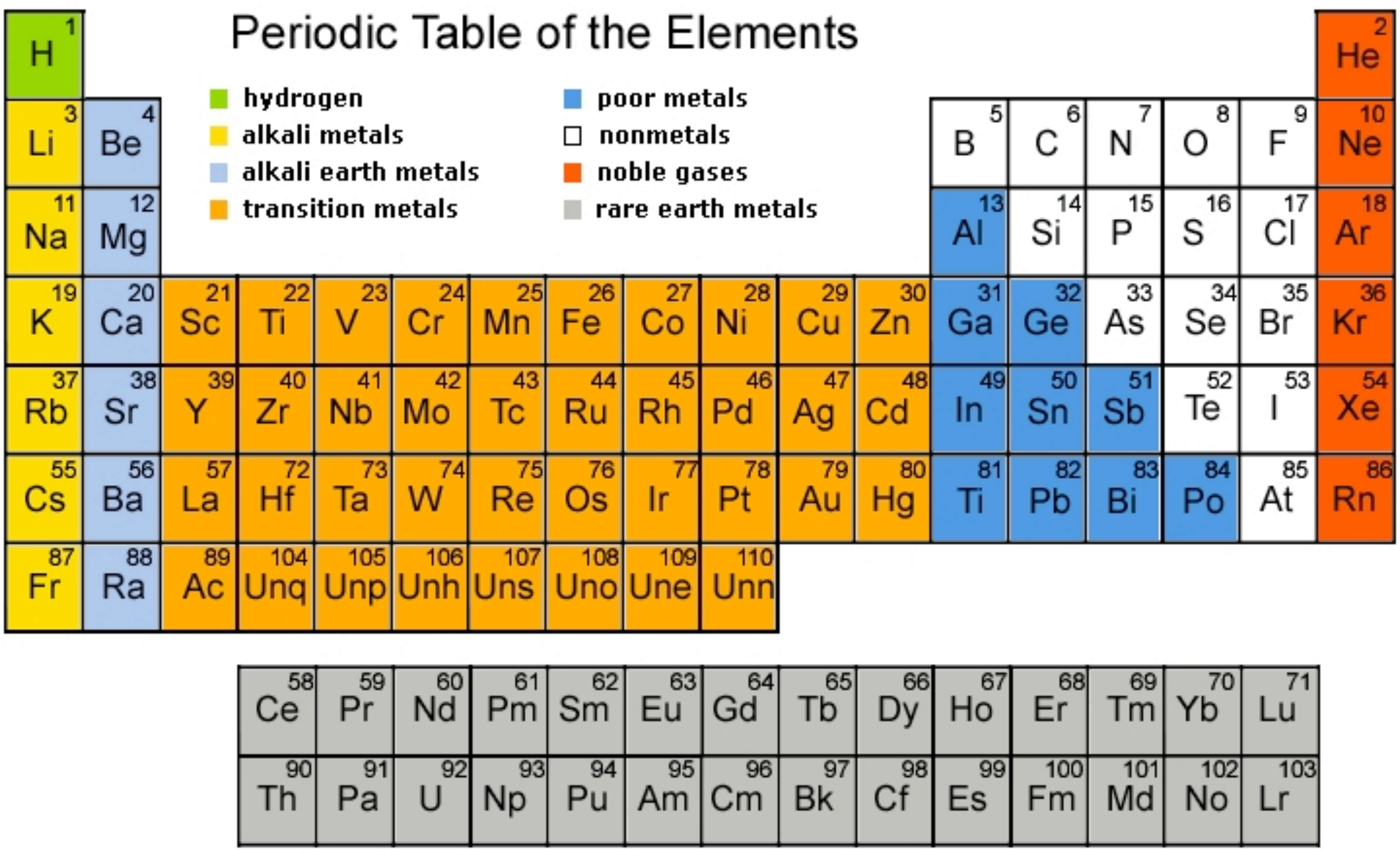
Argon dimer

"James Bond."

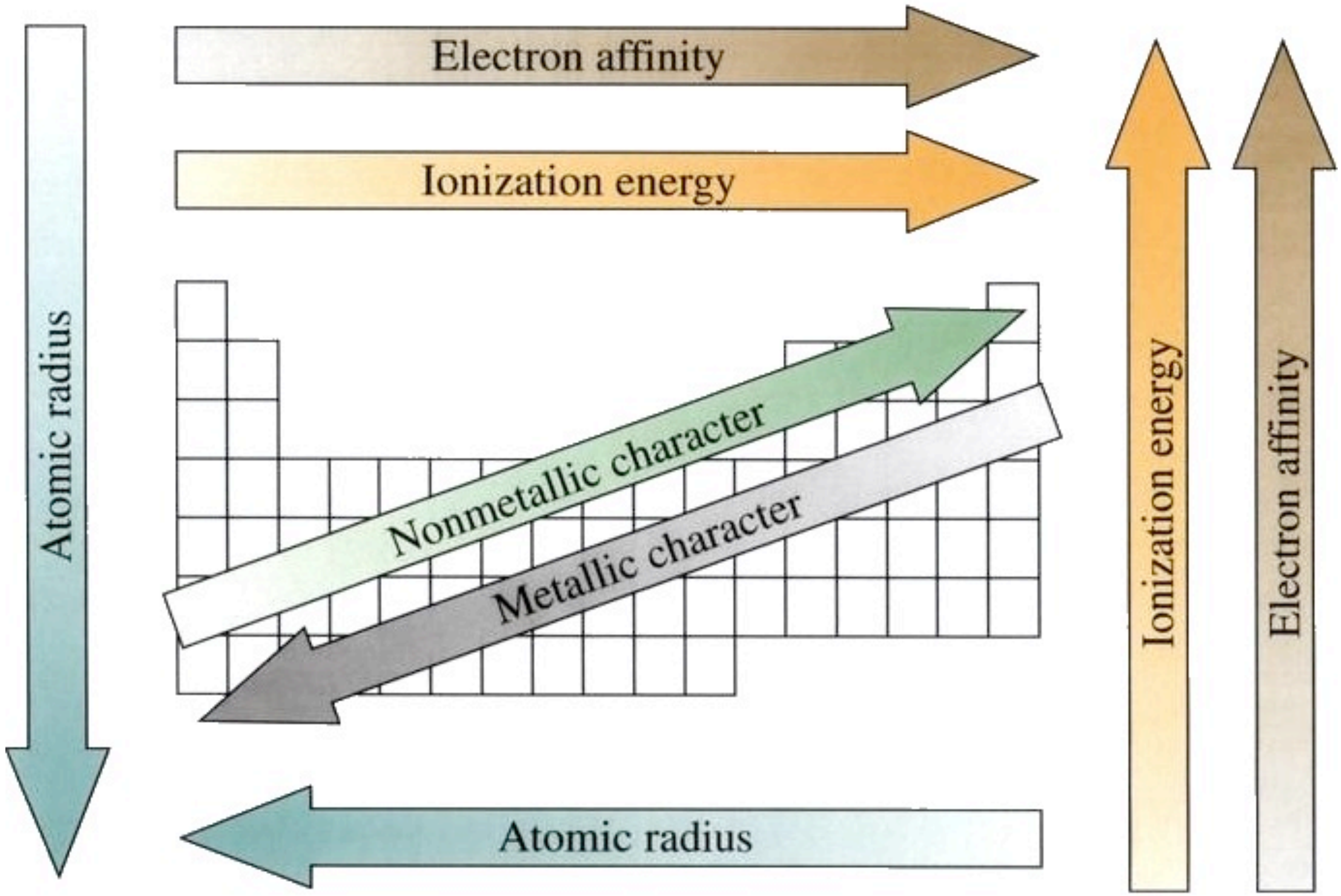


N_2 (Double 07)

Last time we looked at multi-element atoms to get the periodic table.



Periodic Trends



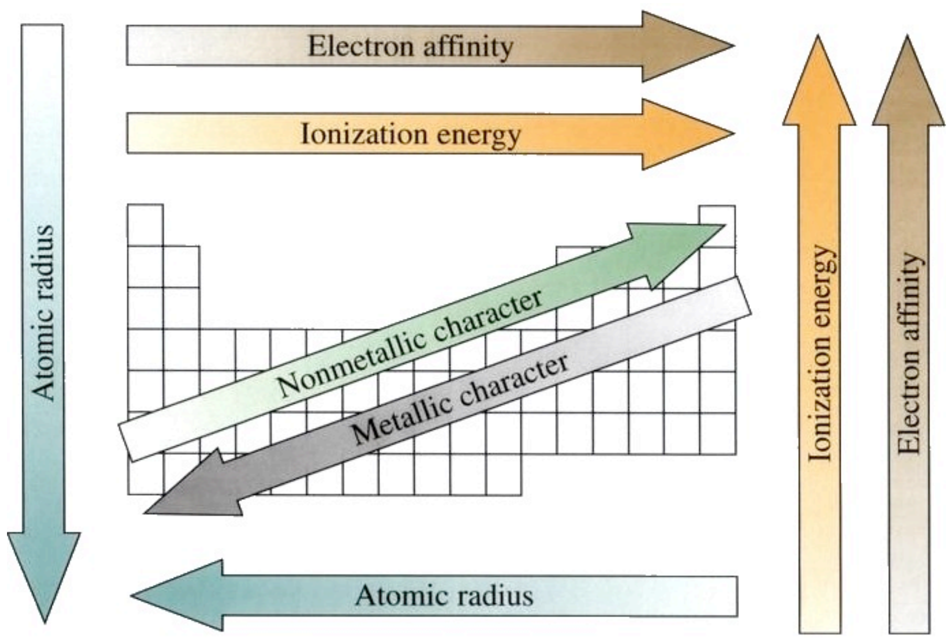
...these are some important trends.
Do you know what these words mean?

Ionization Energy: the energy needed to remove an electron from an atom in the gas phase.

Easy

Electron Affinity: the energy released when an electron is added to a gas phase atom.

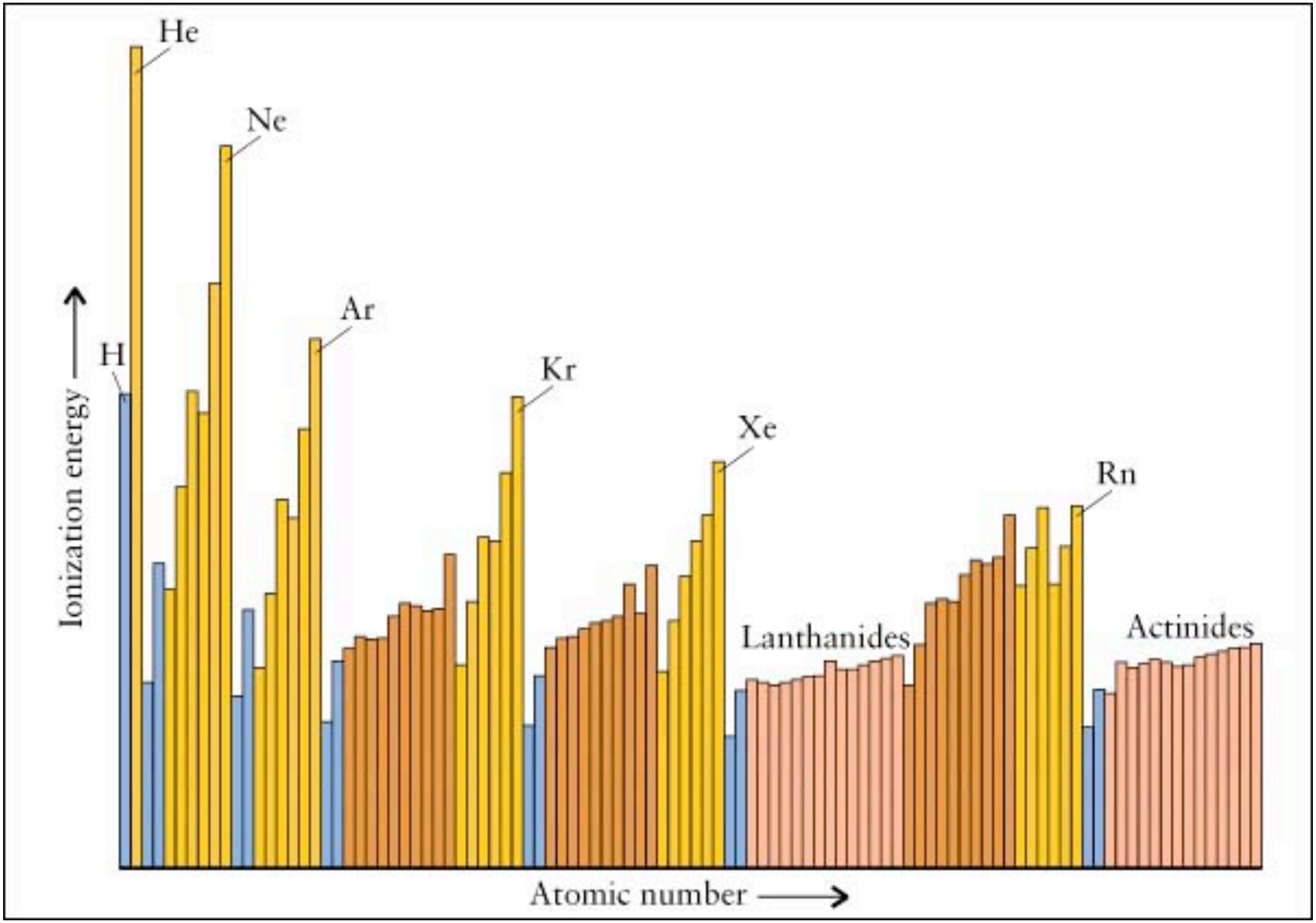
Easy



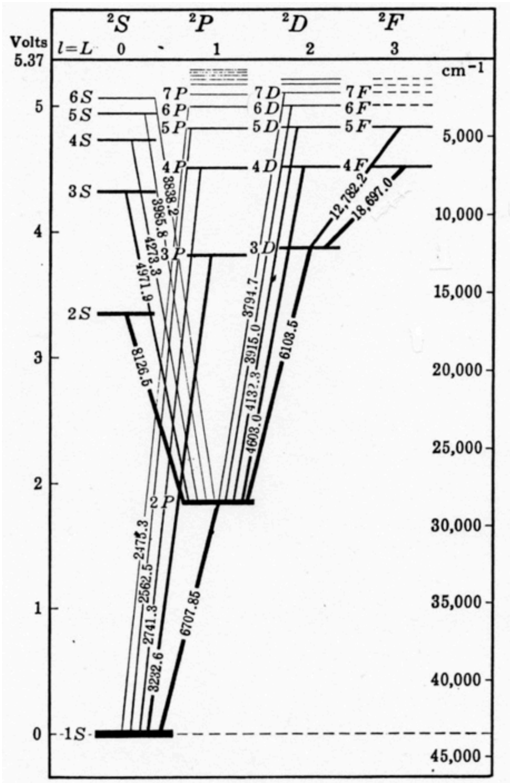
Atomic Radii:
covalent radius
van der Waals radius
ionic radius

Hard

The **ionization energy** of the elements provides one example of a periodic trend...

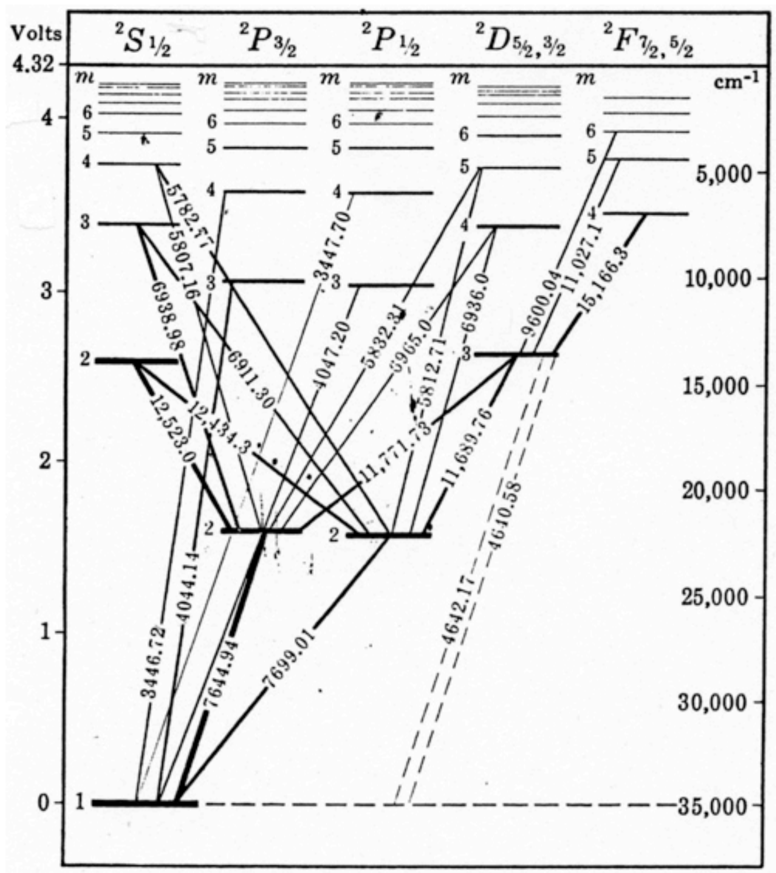


Periodic Trends: Atomic Spectra

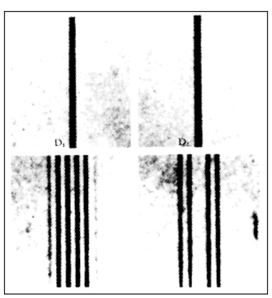


Lithium

^2S - ^2P Transitions:



Potassium



Sodium Doublet

Li: 2s-2p
670.7 nm

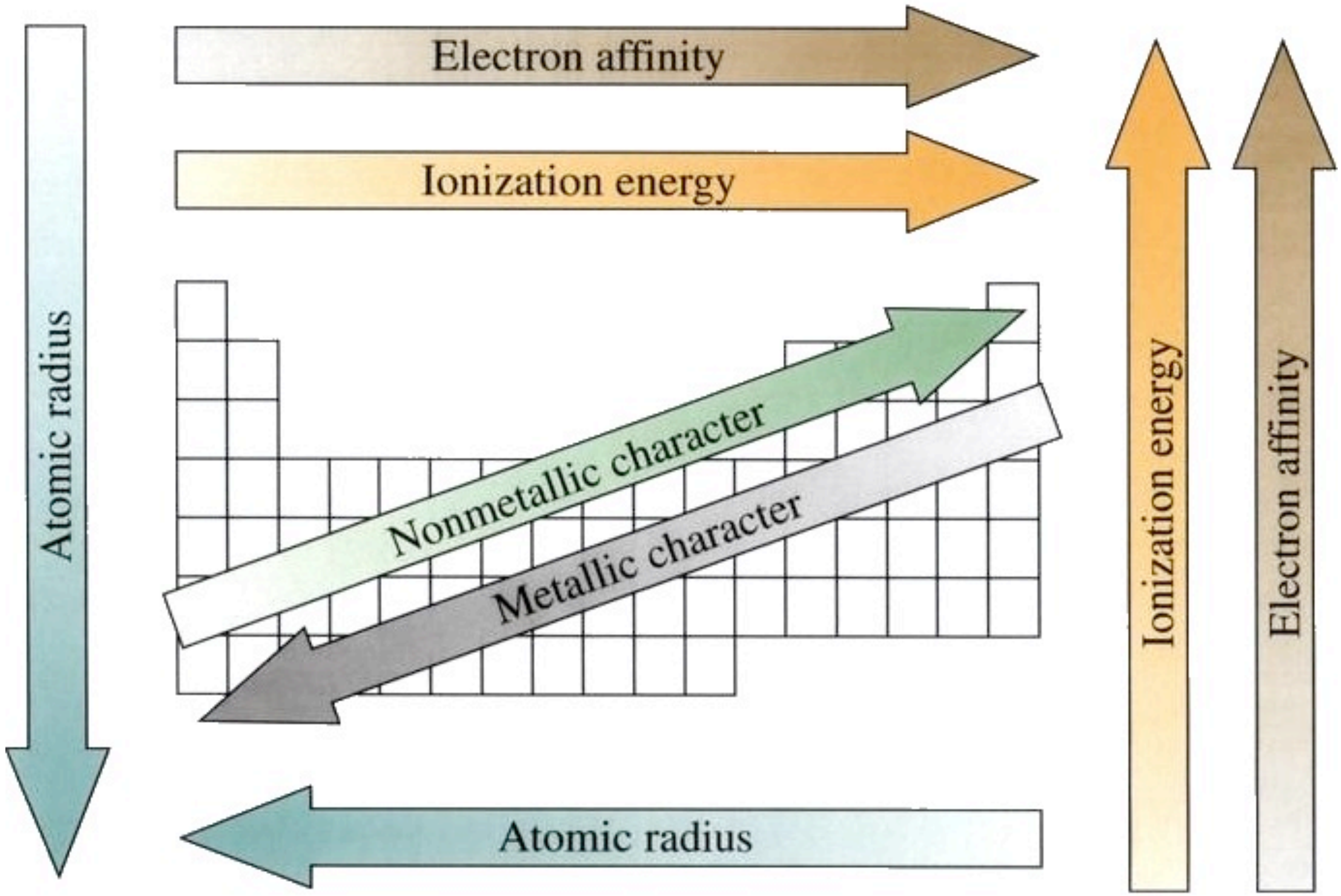
Na: 3s-3p
589.0 nm

K: 4s-4p
766.5 nm

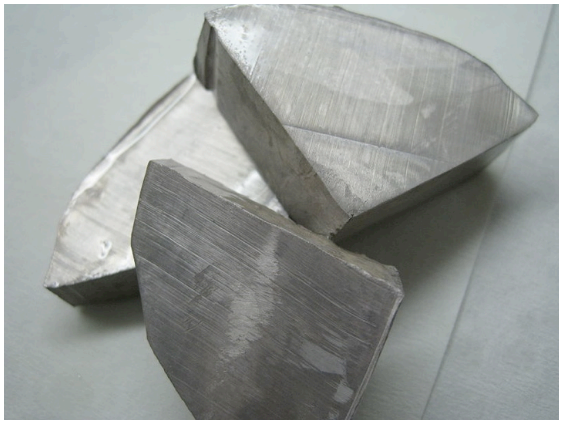
Rb: 5s-5p
780.0 nm

Cs: 6s-6p
852.1 nm

Periodic Trends



What about "metallic character" or "nonmetallic character?



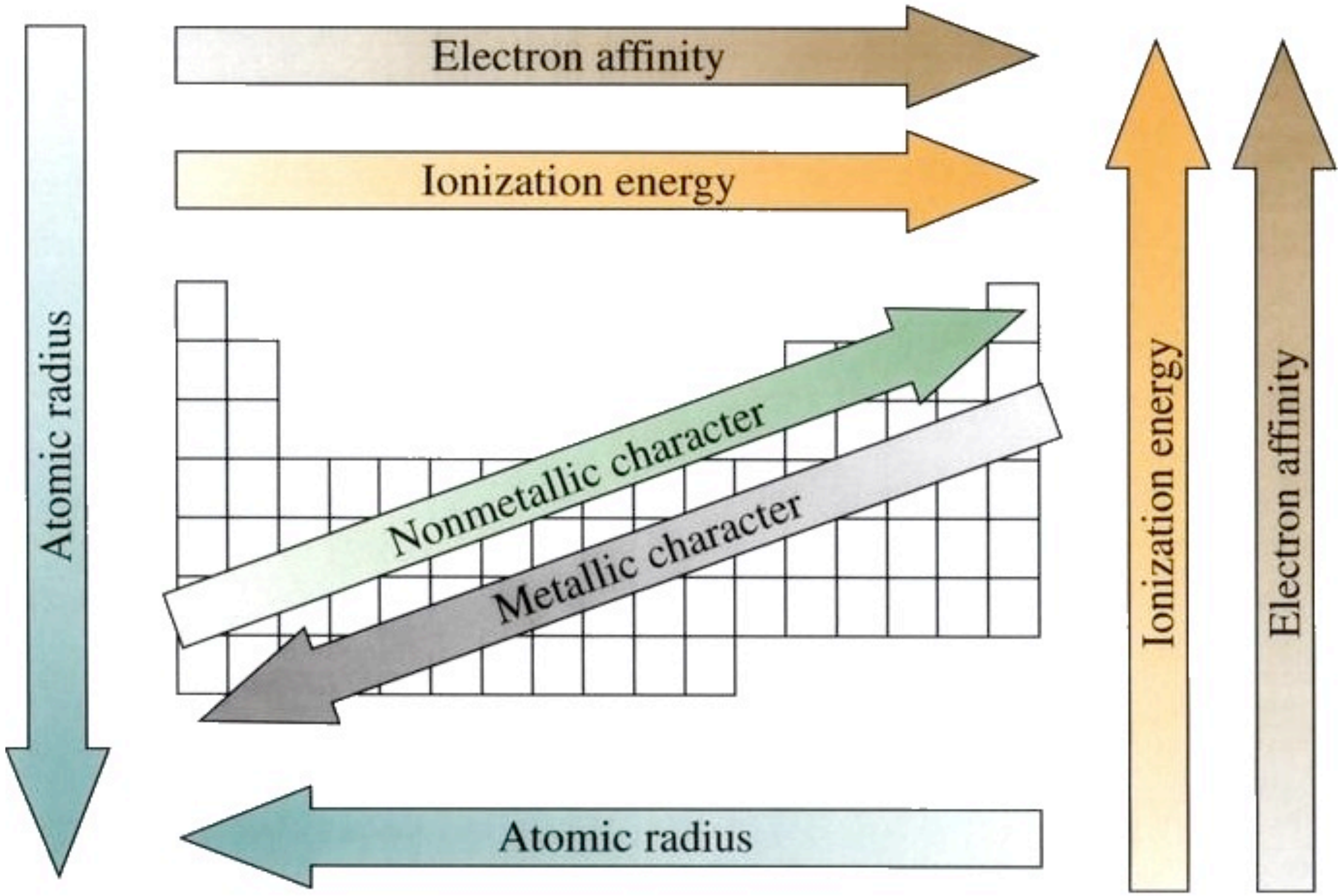
Na

C

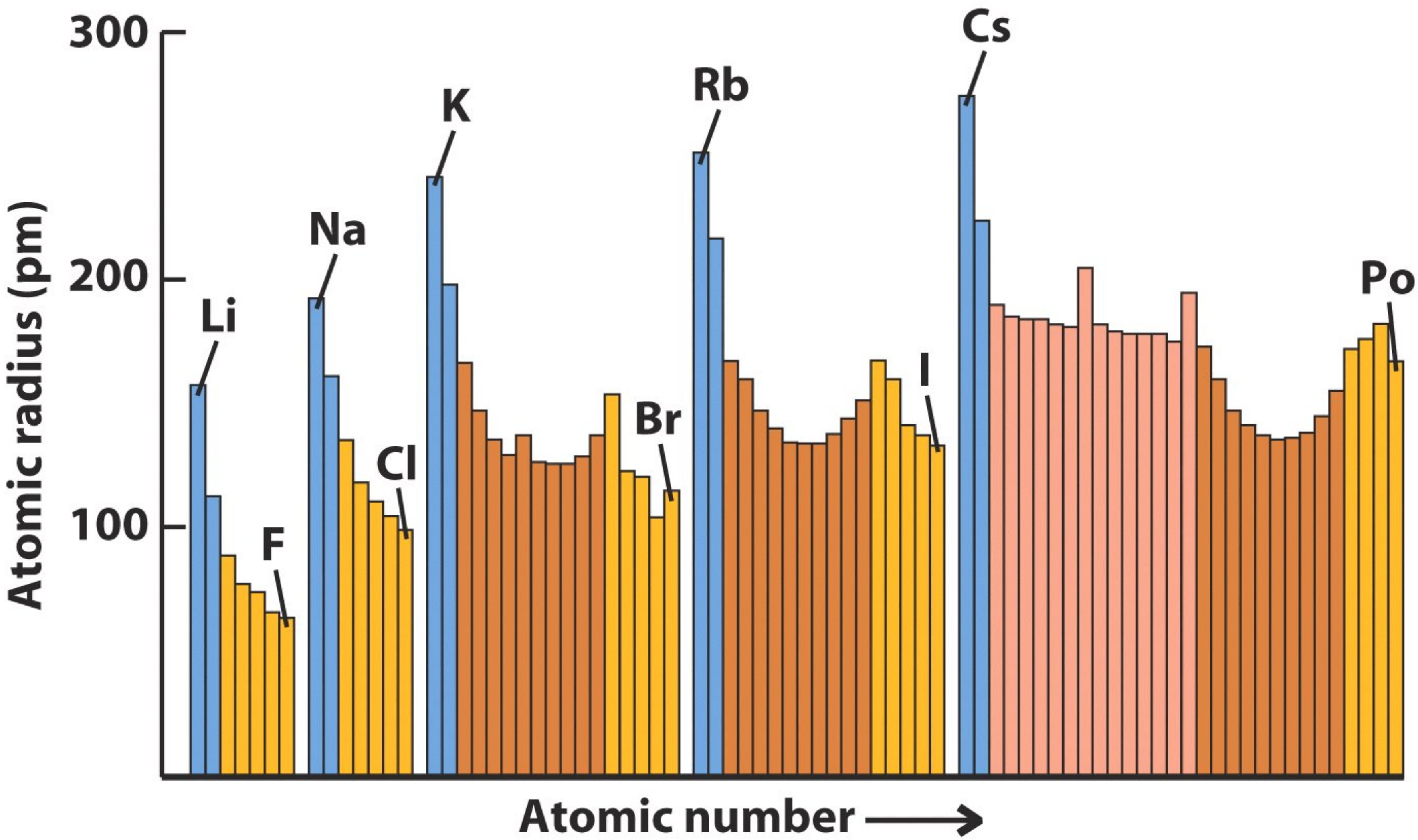
Pd

Ar

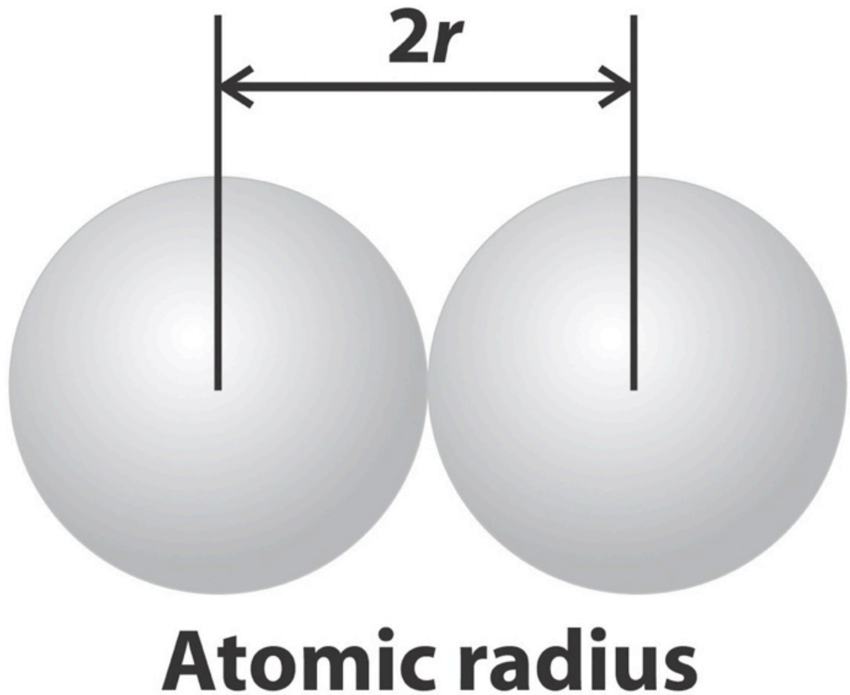
Periodic Trends



The **atomic radii** of the elements is another example of a periodic trend.

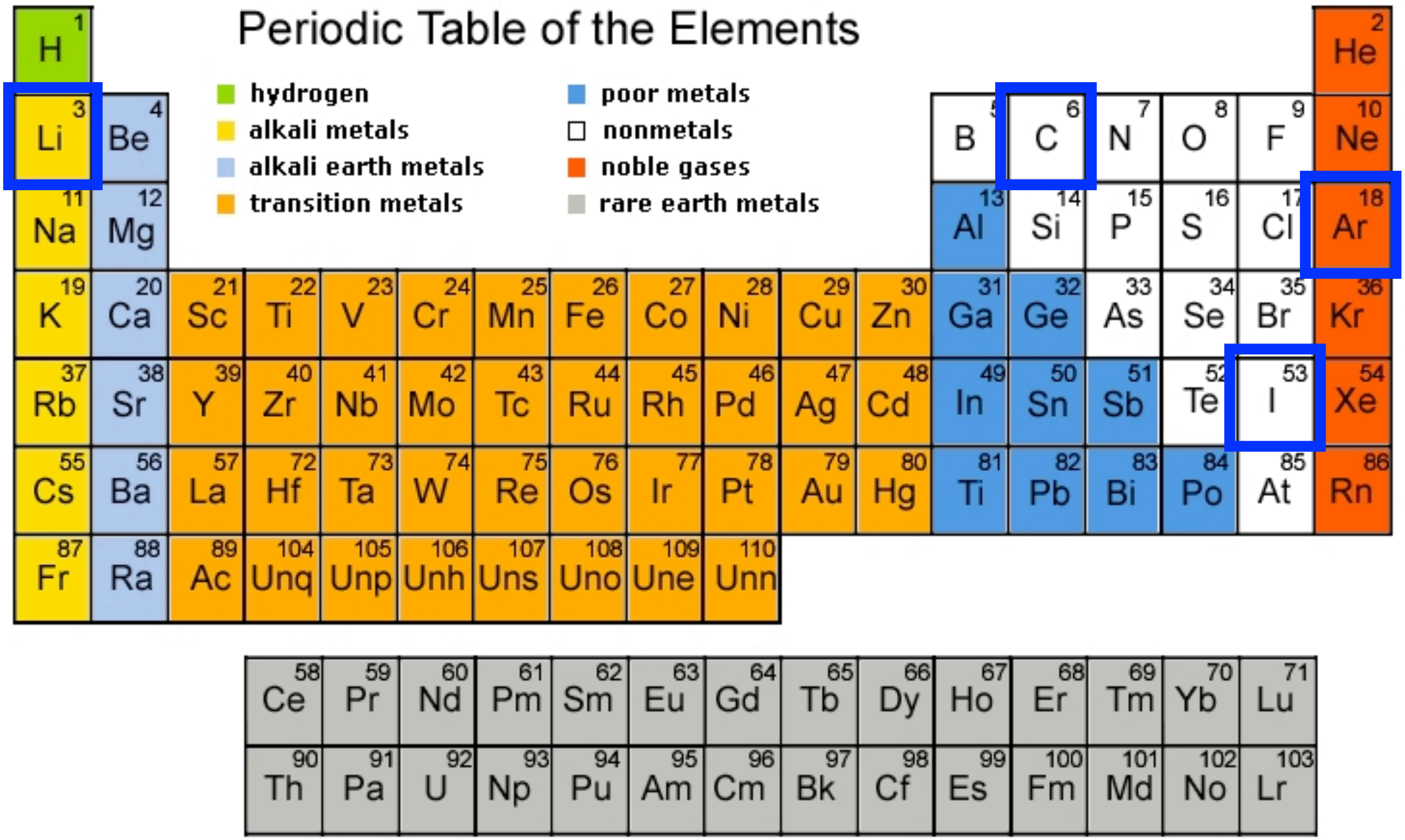


How do we measure the atomic radius?

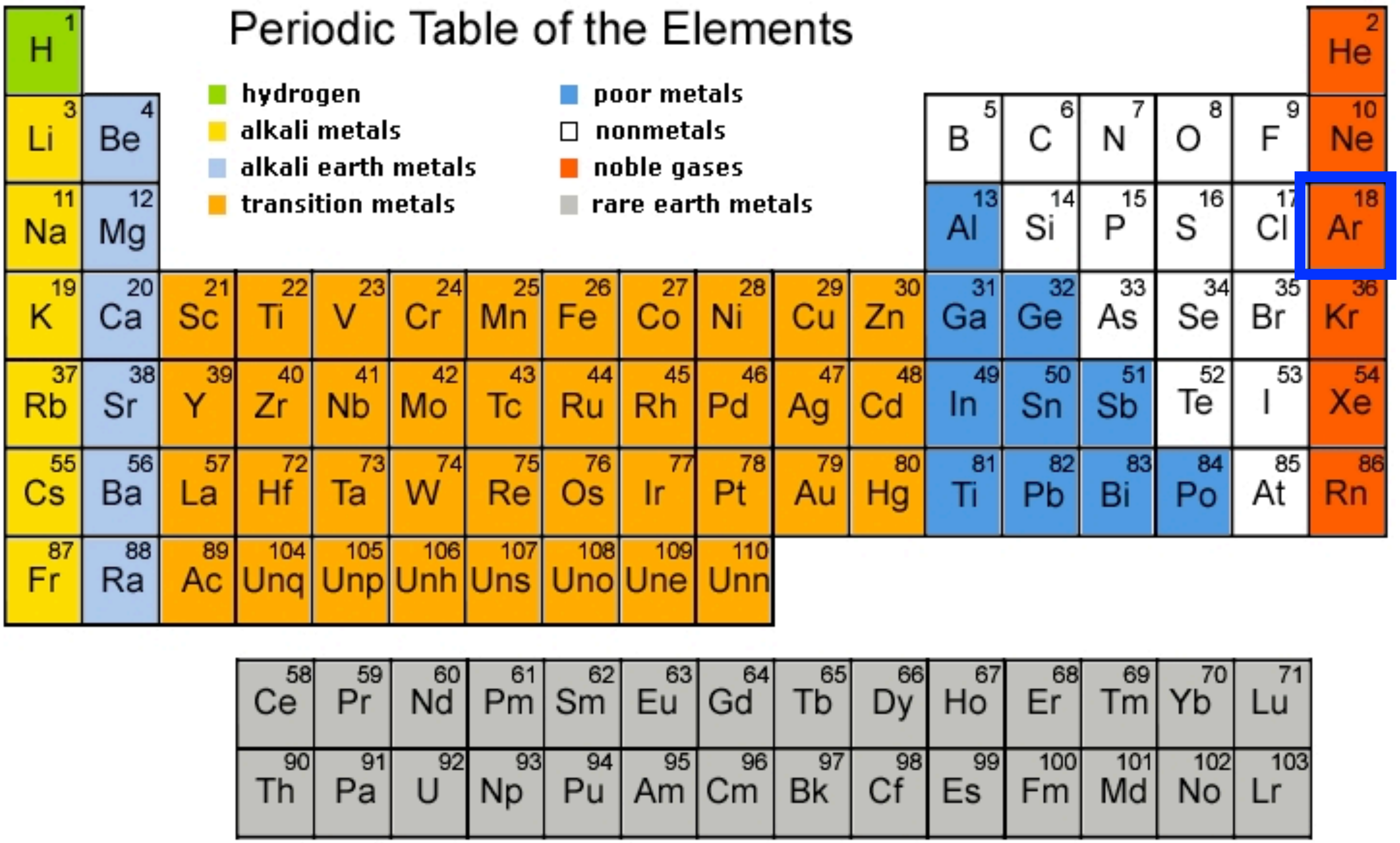


The answer to this question leads us to our next BIG topic: forming chemical bonds.

A Periodic Tour



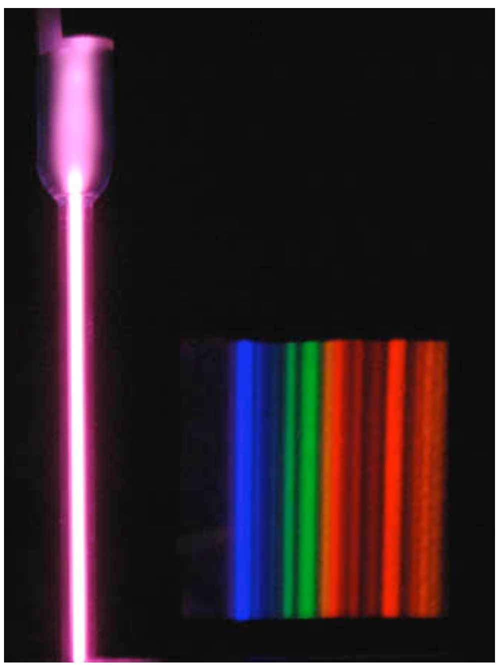
Element 18: Argon



Element 18: Argon

electron configuration: [Ne]$3s^2 3p^6$

The outermost electron shell is called the valence shell. The electron in the outermost shell are called valence electrons.



Argon's valence shell is full. It is very unreactive and called a Noble gas.

Excited Argon Gas

Element 18: Argon

$[Ne]3s^2 3p^6$

Actually, Argon exists as a either a solid, liquid or gas.

Argon Liquid and Solid

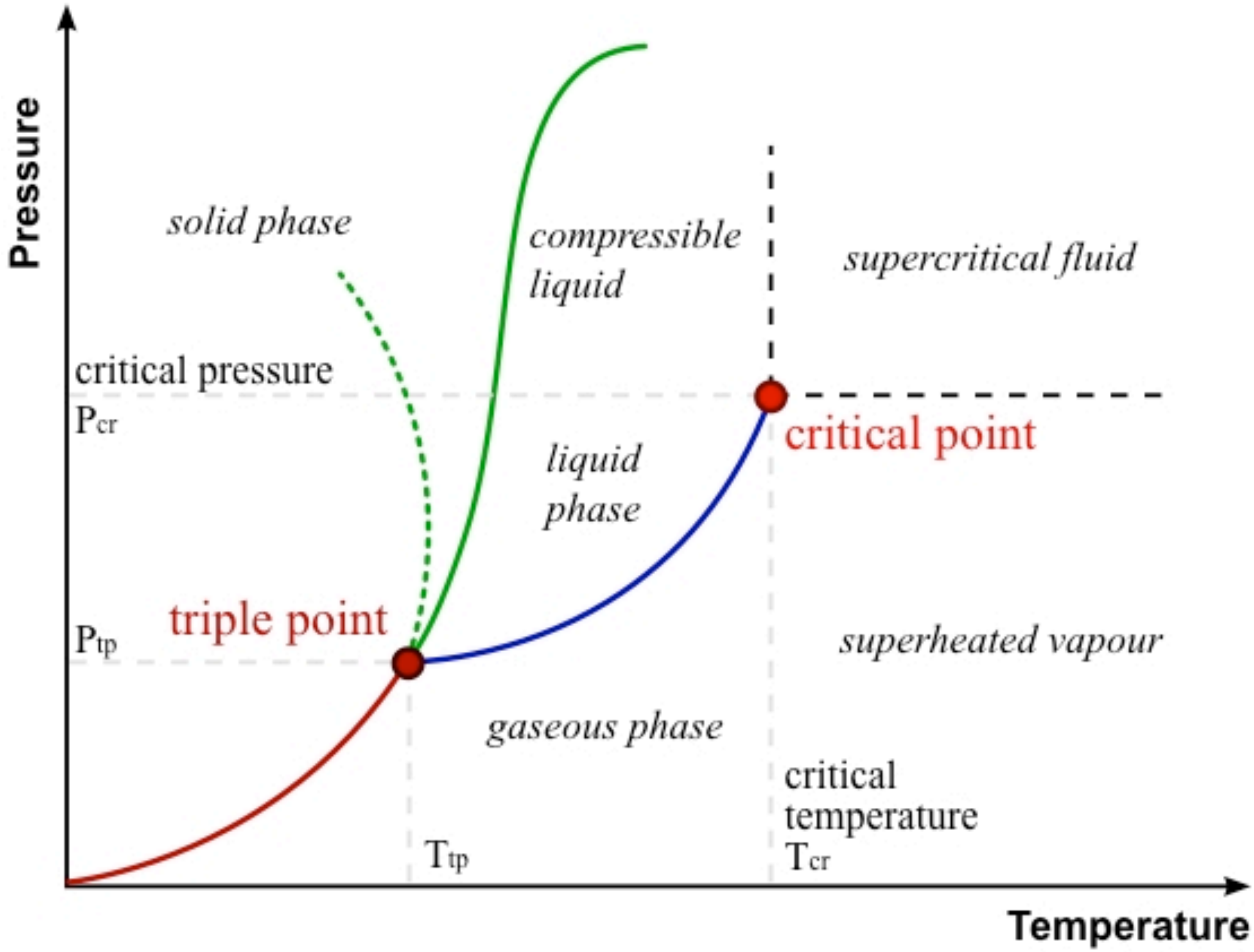
Melting Point: 83.80 K

Boiling Point: 87.30 K

Triple Point: ???
83.80 K, 69 kPa

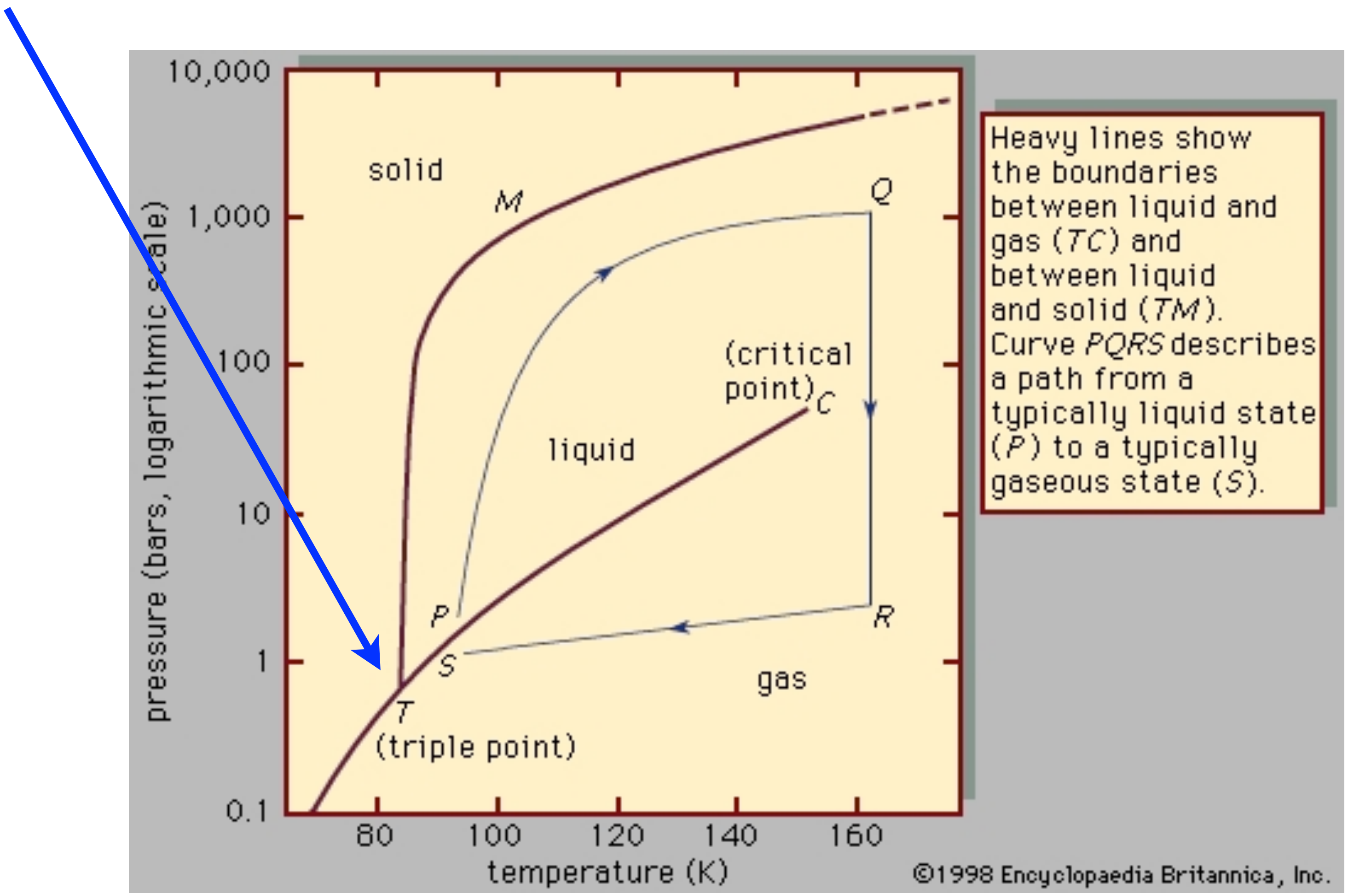
Critical Point: ???
150.9 K, 4.898 MPa

Element 18: Argon

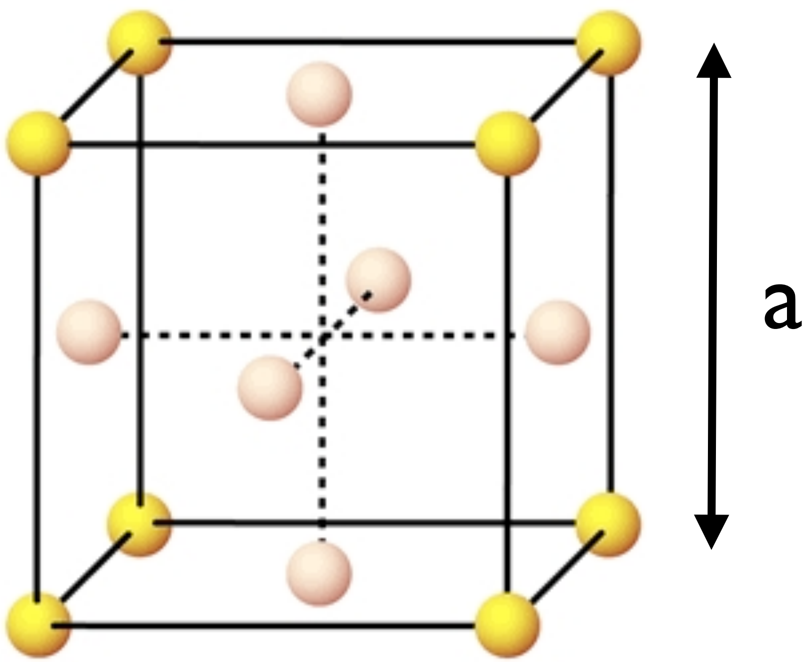


Element 18: Argon

Triple Point: 83.80 K, 69 kPa

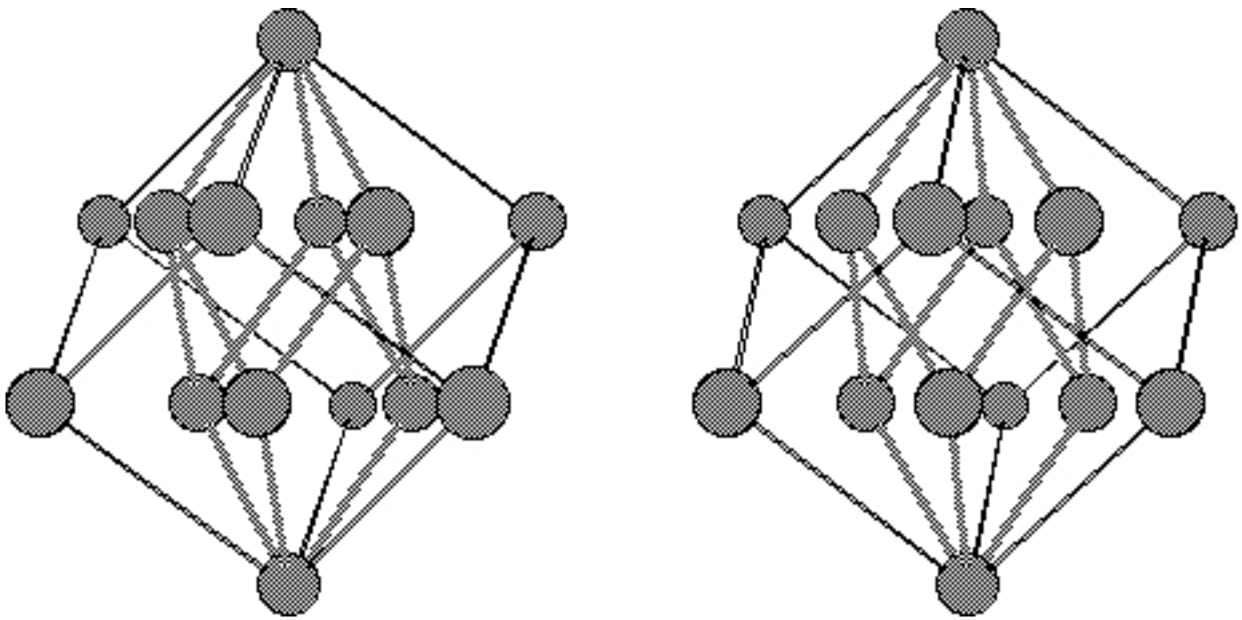


Solid Argon crystallizes in a "face-centered cubic" (fcc) lattice.



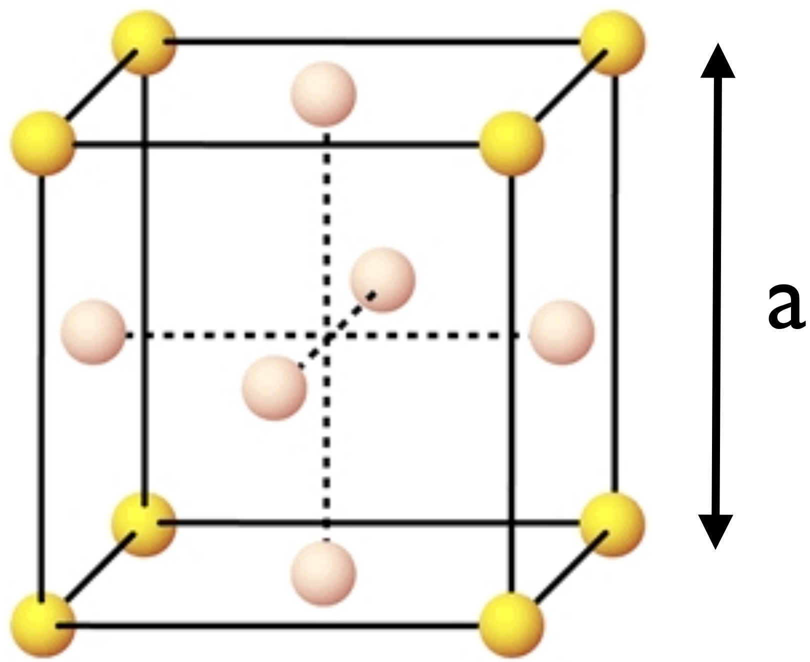
The lattice parameter "a" defines the unit cell size: for Argon, a = 526.0 pm

Solid Argon crystalizes in a "face-centered cubic" (fcc) lattice.



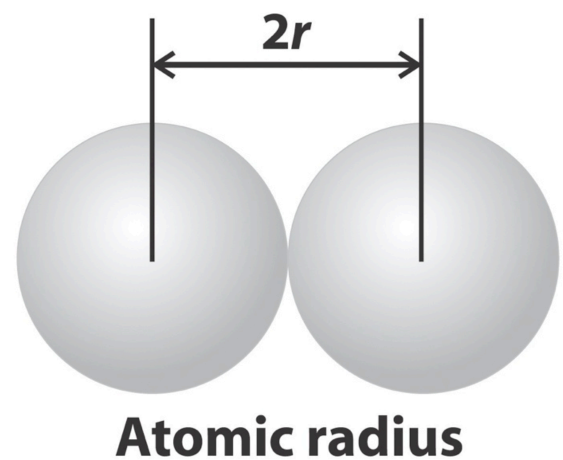
This is a stereo image -- cross your eyes!

Use the packing dimensions in solid Ar to determine an atomic radius:



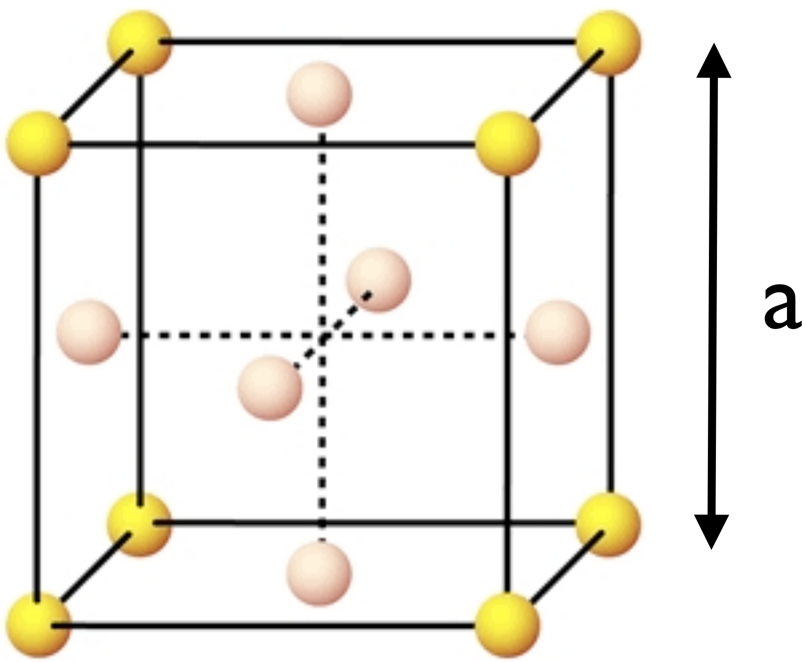
fcc Argon

a = 526.0 pm



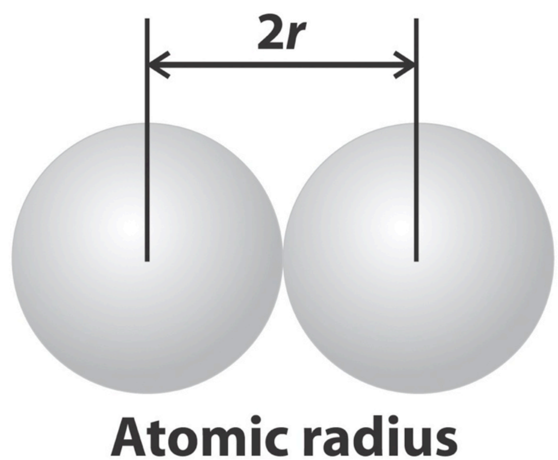
Can you calculate r?

Use the packing dimensions in solid Ar to determine an atomic radius:



fcc Argon

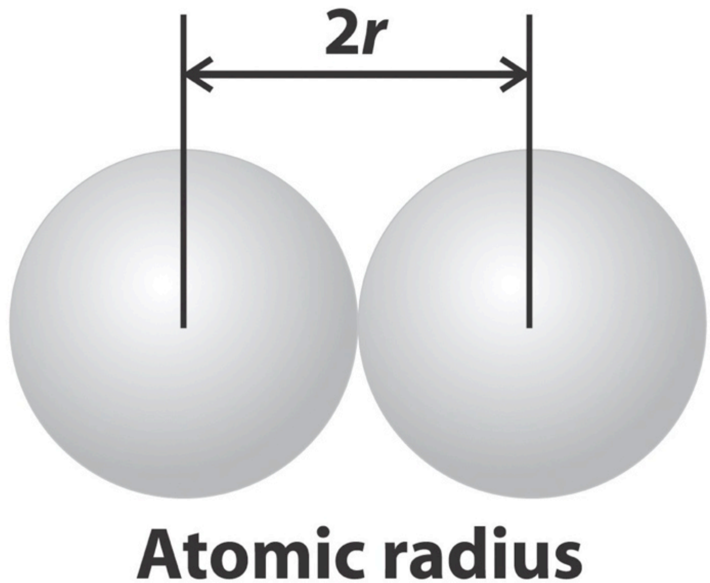
$a = 526.0$ pm



$r = 186.0$ pm

$(= a/\sqrt{8})$

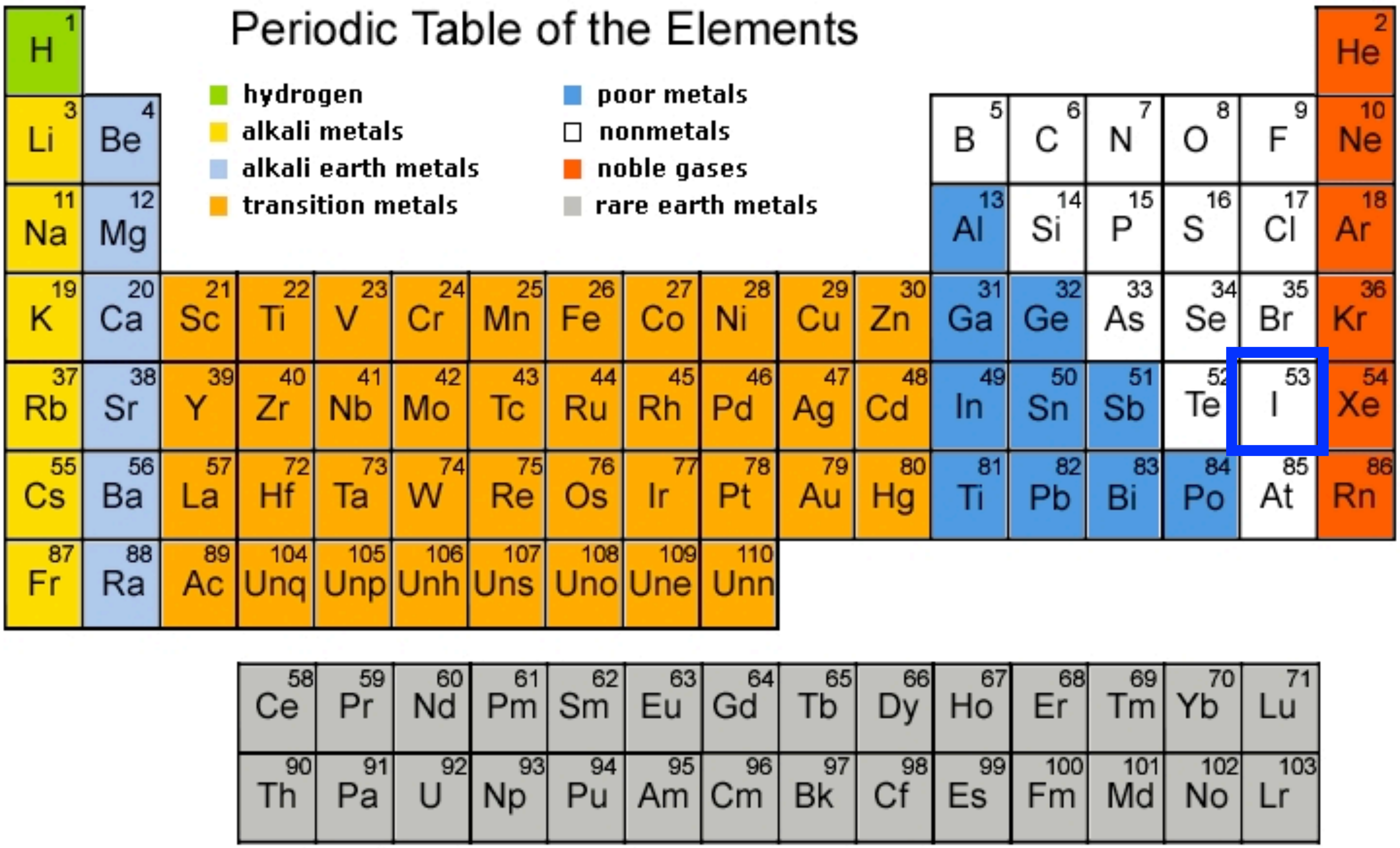
This is called a "van der Waals radius"



r = 186.0 pm

vdW forces in Ar only arise from induced dipole-induced dipole interactions between the two atoms. Very weak attractive force.

Element 53: Iodine



Element 53: Iodine

electron configuration: [Kr]$4d^{10}5s^25p^5$

Iodine's valence shell is NOT full -- it needs one more electron to become Xe.

Solid Iodine

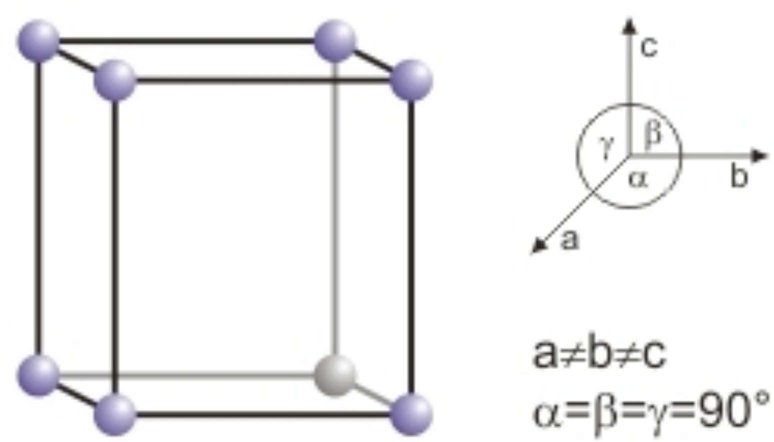
Melting Point:
386.9 K (113.7 C)

Boiling Point:
457.4 K (184.3 C)

Triple Point:
386.7 K, 12.1 kPa

Critical Point:
819 K, 11.7 MPa

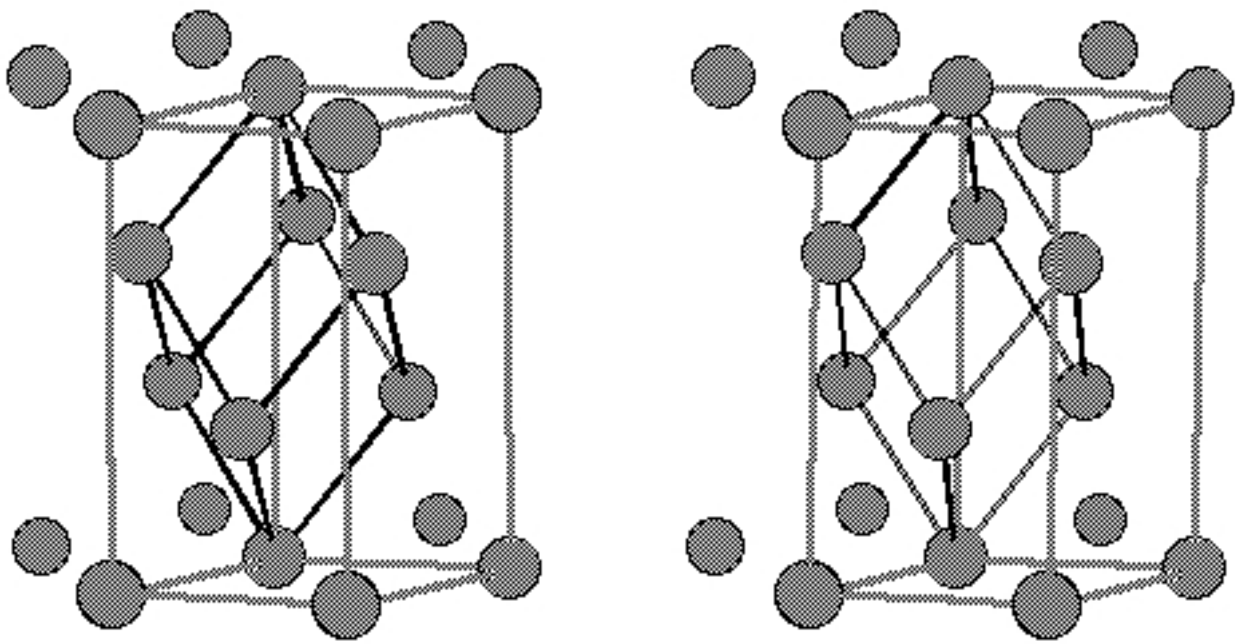
Solid Iodine crystallizes in an "orthorhombic" crystal lattice.



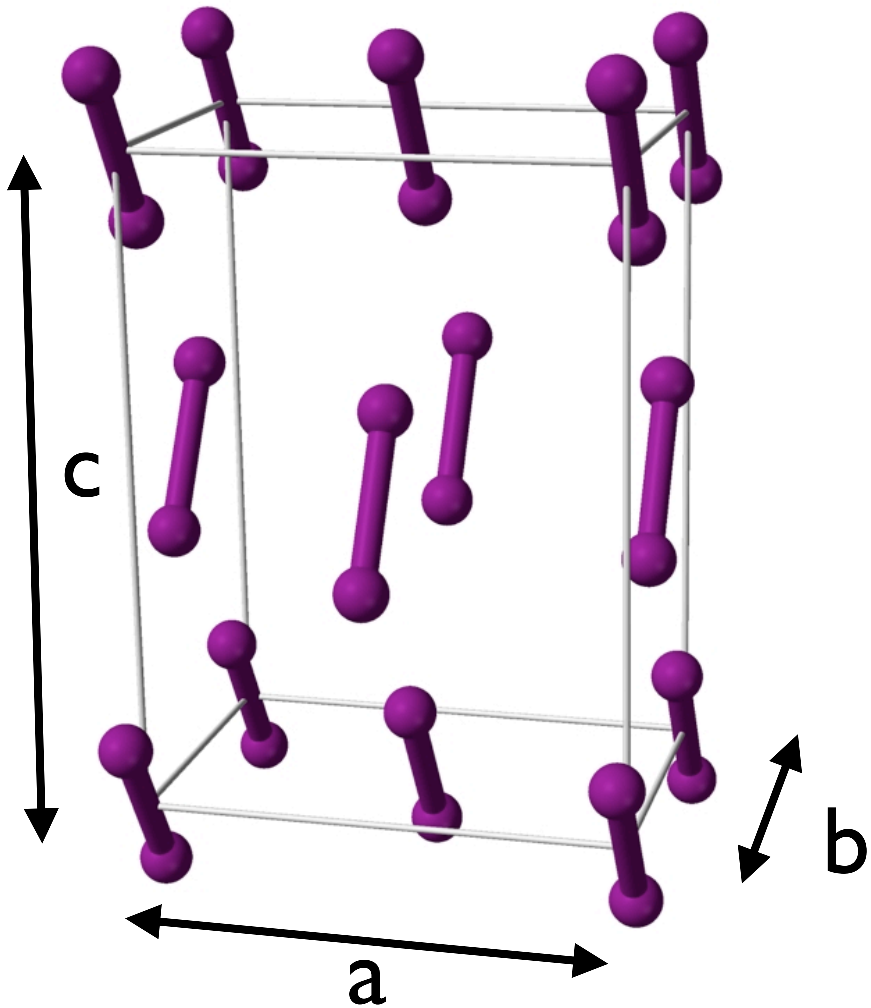
Three lattice parameters:

a: 718.02 pm
b: 471.02 pm
c: 981.03 pm

Solid Iodine crystallizes in an "orthorhombic" crystal lattice.



Solid Iodine crystallizes in an "orthorhombic" crystal lattice.

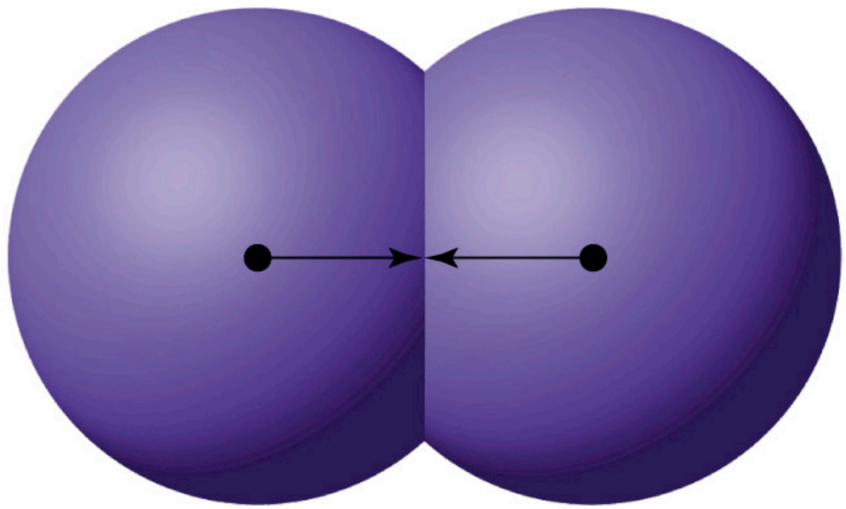


Three lattice parameters:

a: 718.02 pm
b: 471.02 pm
c: 981.03 pm

Diatomic Molecules!!

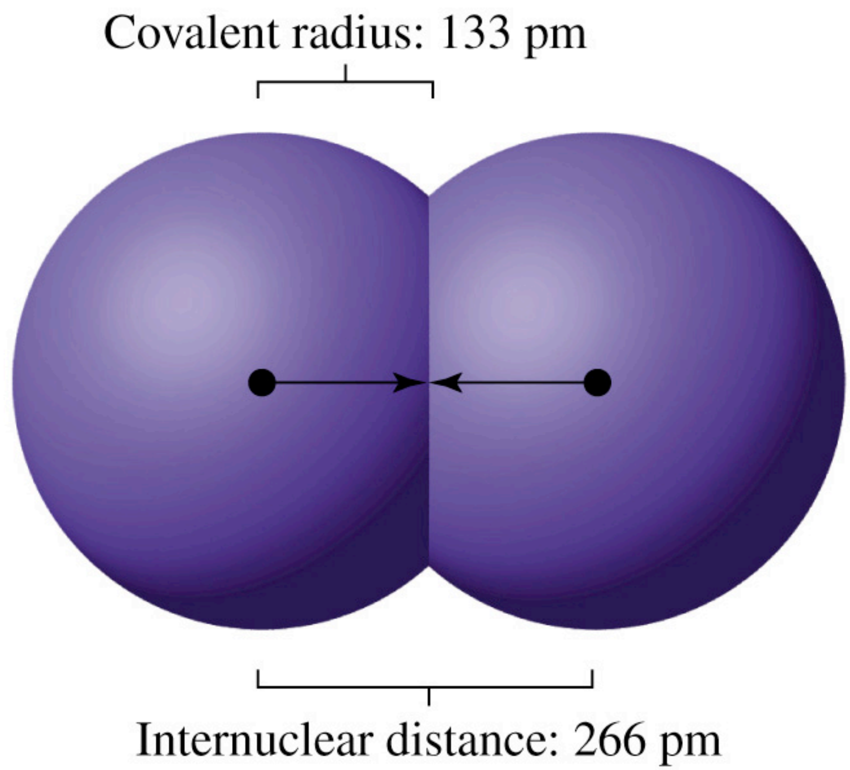
I_2 Molecules



133 pm (I)
vs.
186 pm (Ar)

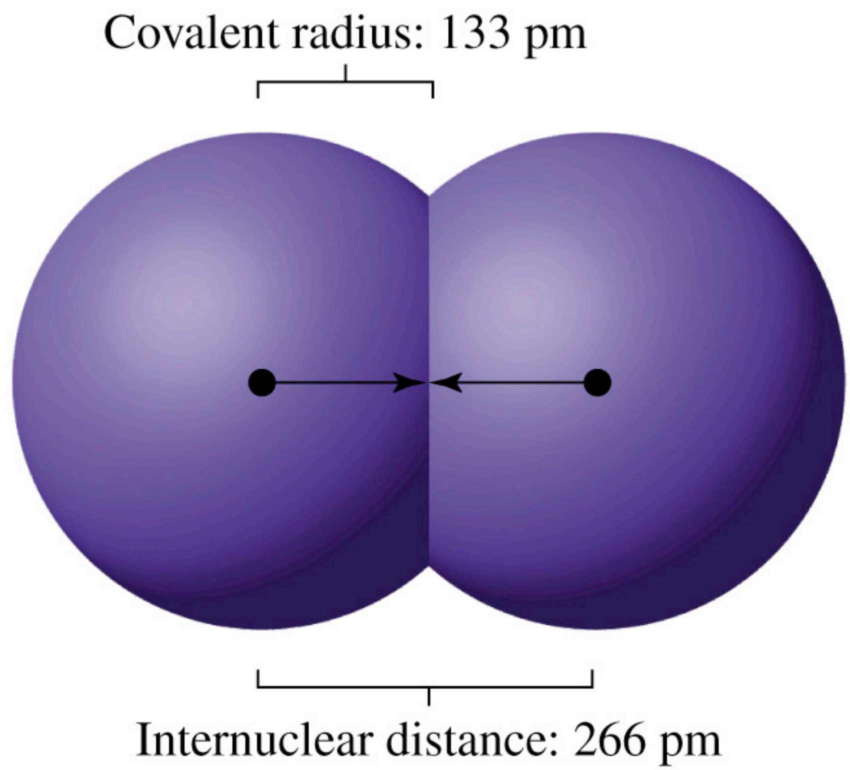
Iodine is a diatomic even in the gas phase.

I_2 Molecules



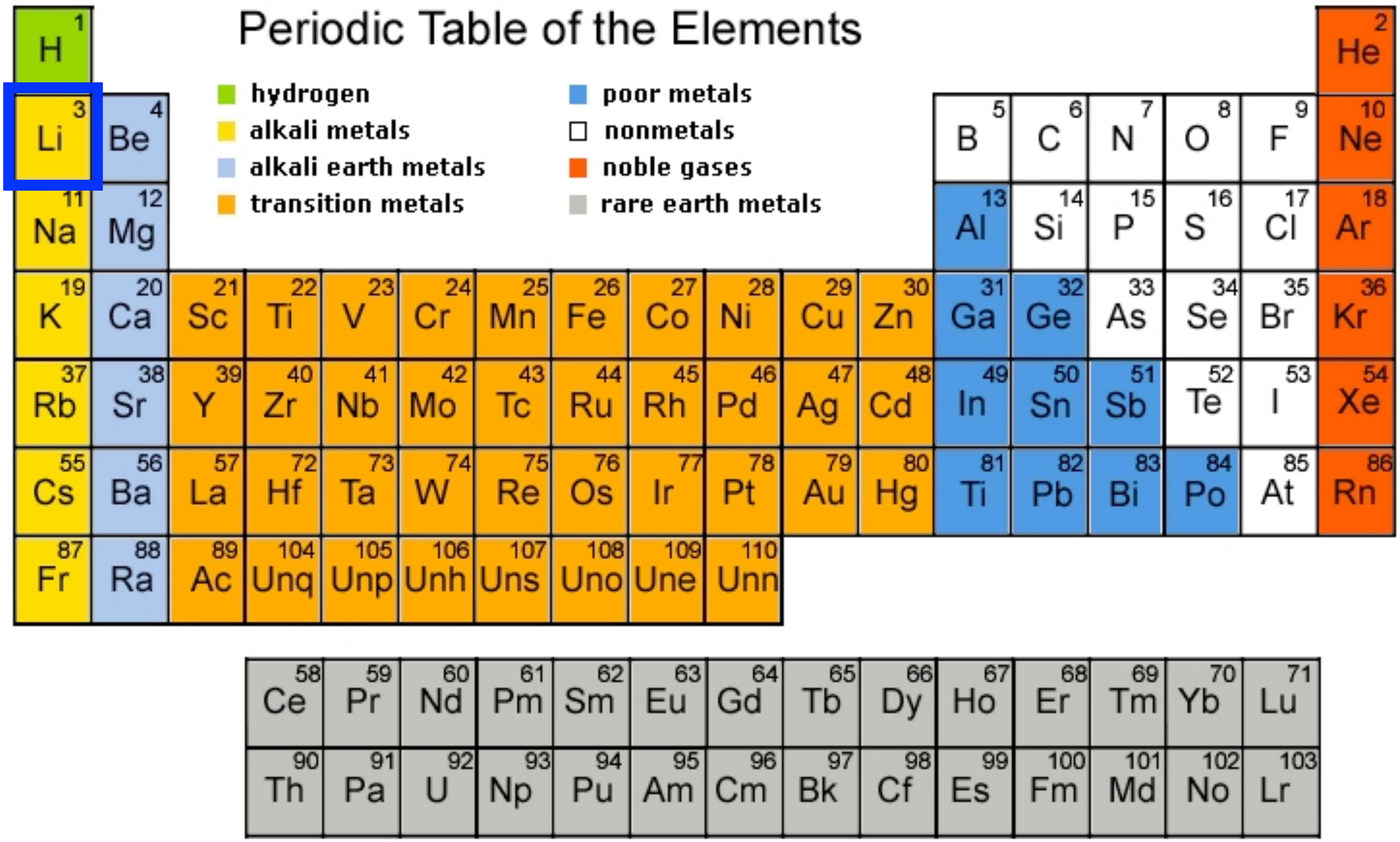
A covalent bond can be defined as a sharing of electrons -- G. N. Lewis

I_2 Molecules



Quantum Mechanics can be used to describe the electronic states (orbitals) involved in bonding -- L. Pauling

Element 3: Lithium



Element 3: Lithium

electron configuration: $[He]2s^1$

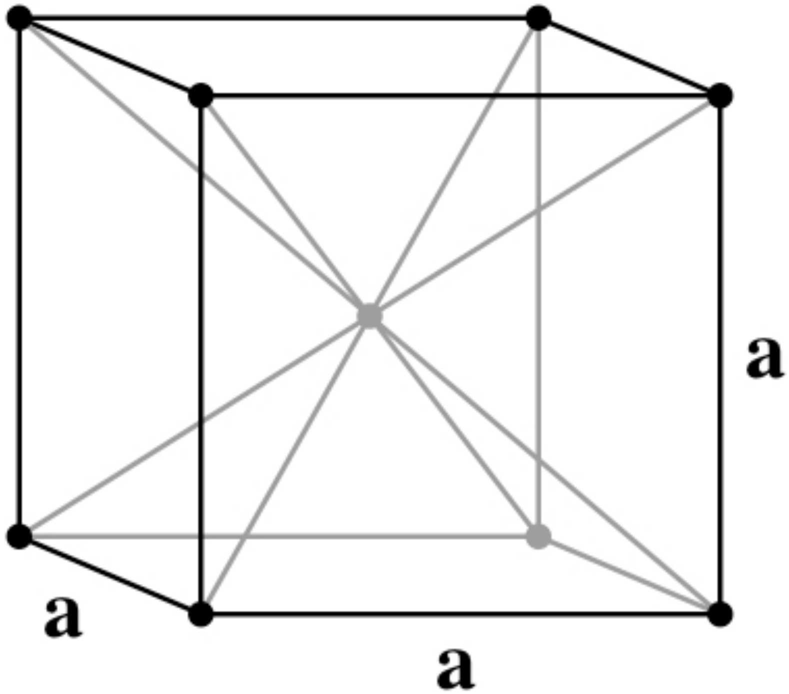
Lithium's valence shell is NOT full -- it needs seven more electrons to become Ne.

Solid Lithium

Melting Point:
453.7 K (180.5 C)

Boiling Point:
1615 K (1342 C)

Solid Lithium crystallizes in an "body-centered cubic" (bcc) crystal lattice.

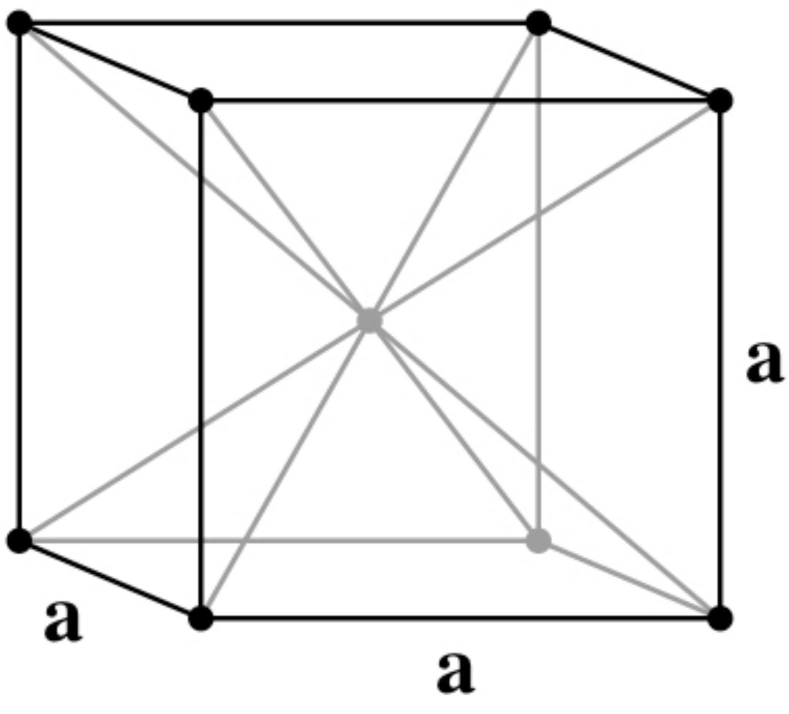


bcc Lithium
a = 349.0 pm

r = ?

Can you calculate r?

Solid Lithium crystallizes in an "body-centered cubic" (bcc) crystal lattice.



bcc Lithium

a = 349.0 pm

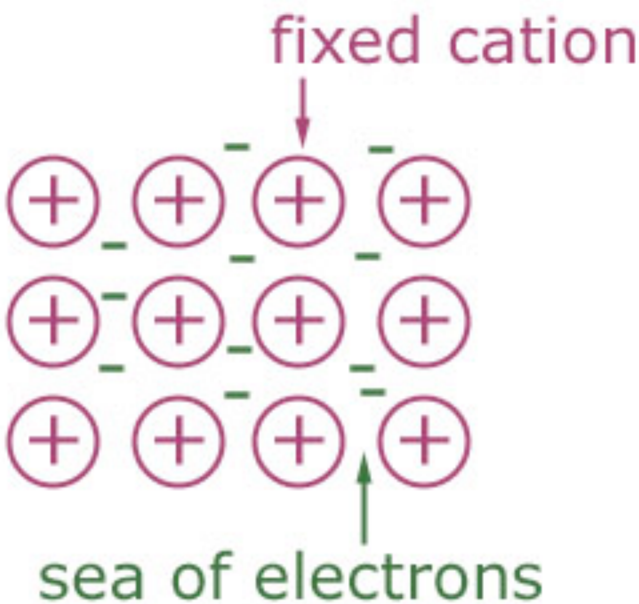
r = 151.1 pm

$(4r = a\sqrt{3})$

Element 3: Lithium

electron configuration: [He]$2s^1$

Metallic Bonding: fixed cations and a sea of electrons.



Lithium shares its valence electrons with ALL of its neighbors. It is a metal.

Lithium IP is 5.39 eV.

We will need very fancy QM for this.

"My name is Bond."

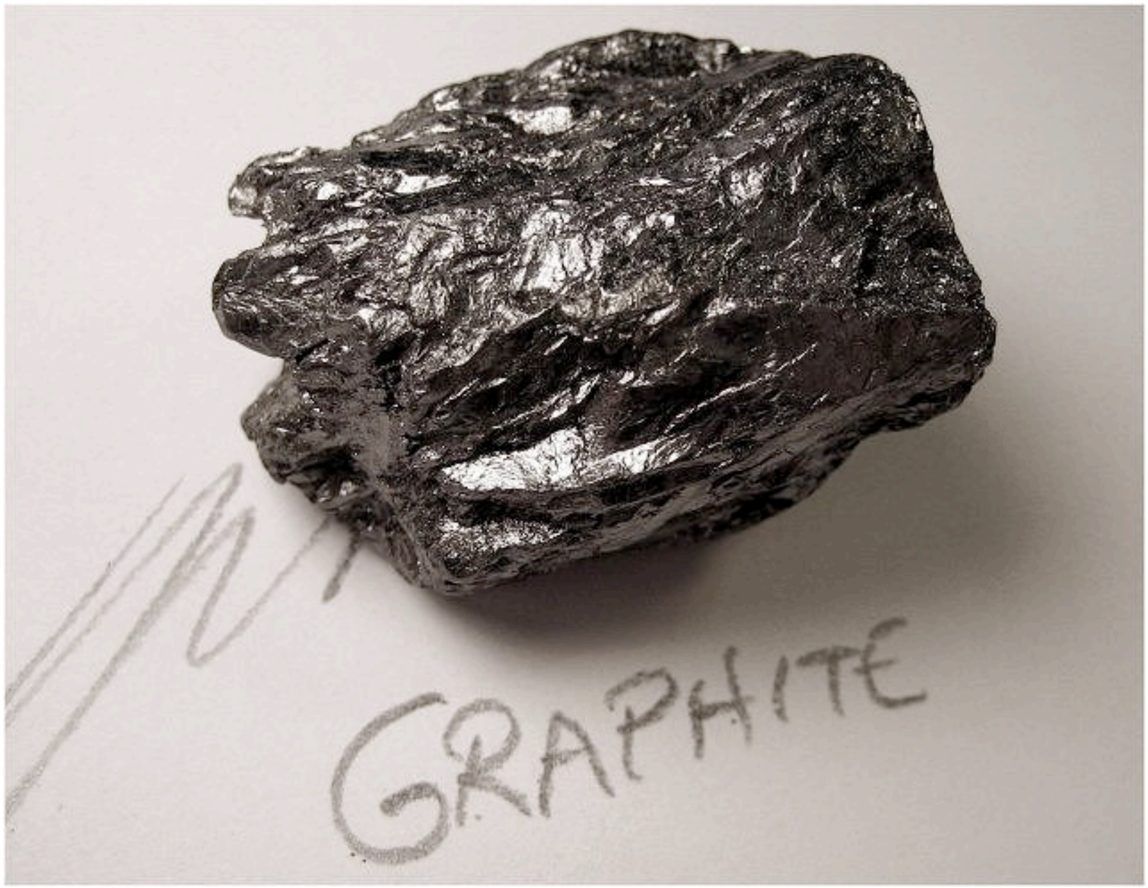
So, in this lecture we have identified three types of molecular bonding:

van der Waals Interactions (Ar)

Covalent Bonding (I_2)

Metallic Bonding (Li)

"My name is Bond."



So what about Carbon?

"My name is Bond."

N_2 says: "Diamonds are Forever"