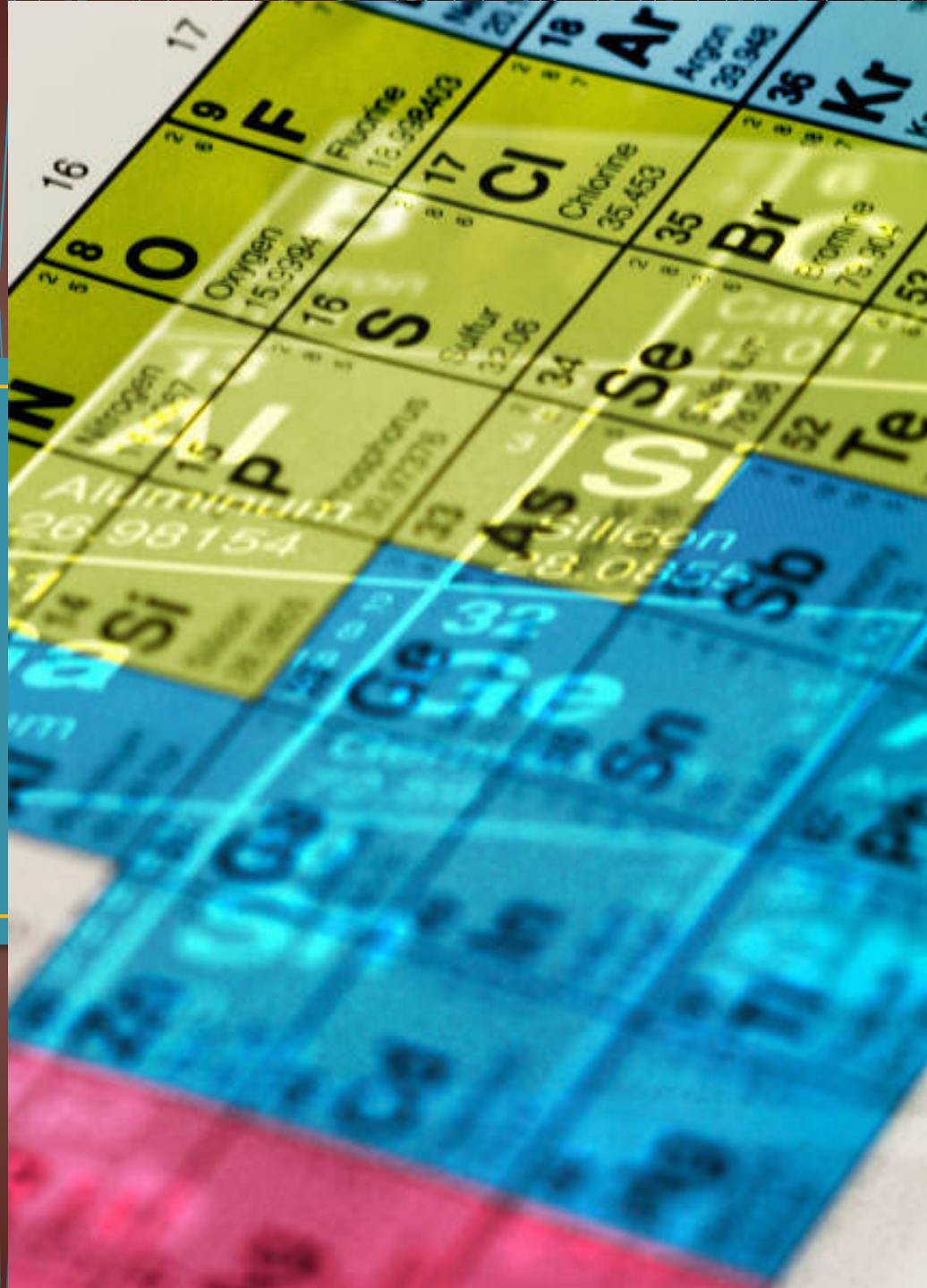
Periodicity

Chapter 5

History

- Mendeleev (1st Periodic Table)
  - Mid-1800's, studied the atomic masses of elements and listed them in columns.
  - He noticed similar physical and chemical properties (periodic) and arranged it so that similar properties were side by side.
  - He left blanks as to where he was predicting a new element to be found with the atomic masses.
- Moseley (Current Periodic Table)
  - Rearranged Mendeleev's periodic table and focused on atomic number (protons). Increasing atomic number going across the periodic table.
  - He noticed that the element's properties lined up in columns.
- Electron Configuration & Periodicity
  - Periodicity in properties matches the outer electron configuration.
  - Elements in the same group react the same way under similar conditions.
  - Block Diagram – groups of elements according to the sublevel that are filled with electrons (s, p, d, f)
  - Notice the trends in the group, same number of valence electrons in all elements in a group.

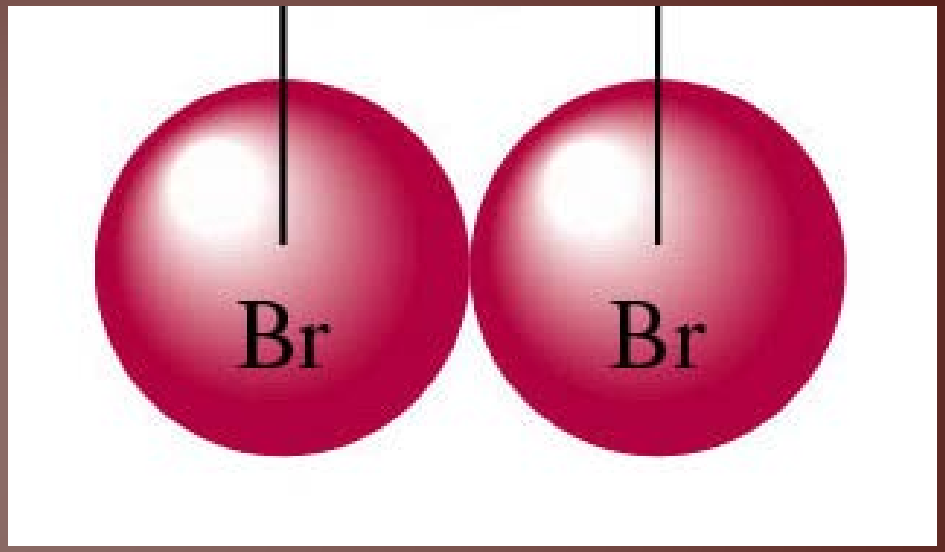
Periodic Trends



What are the Trends (patterns)?

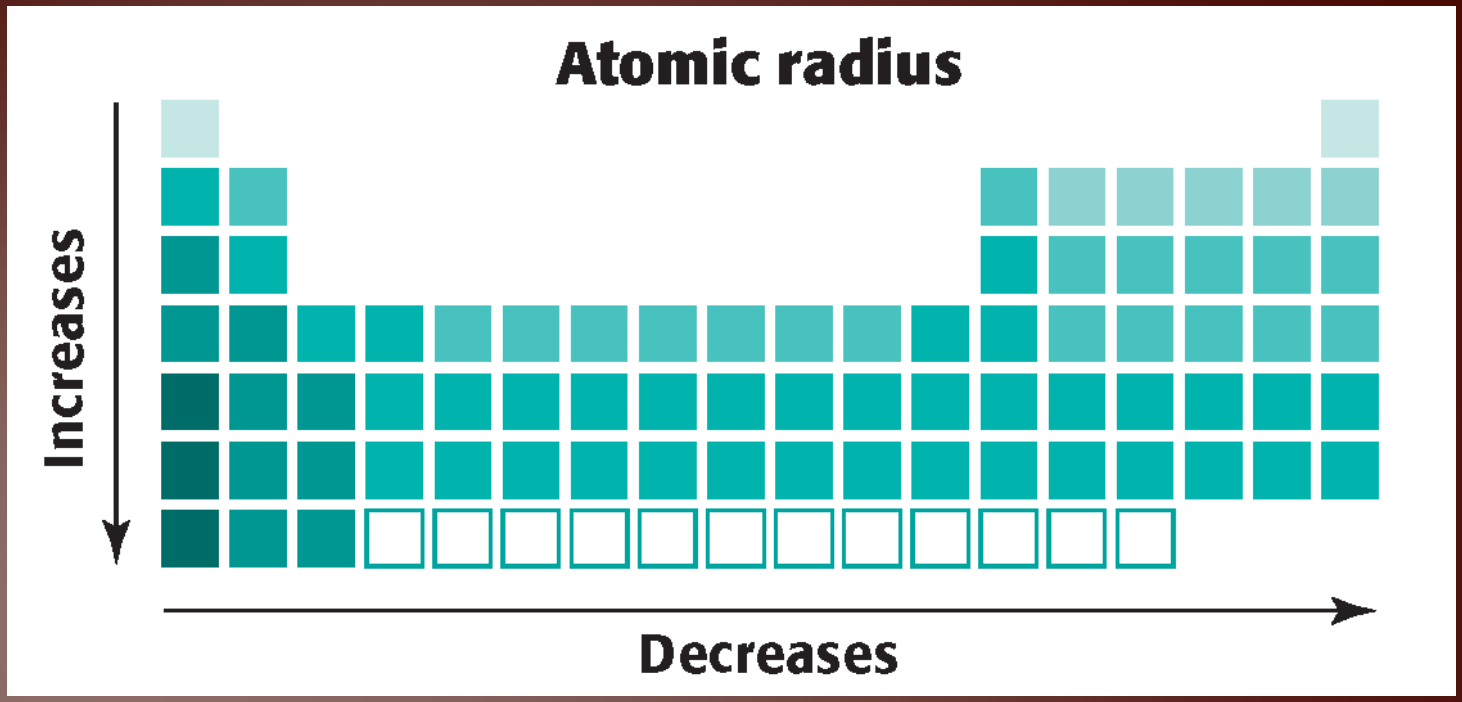
1. Atomic Radius
2. Ionization Energy
3. Ionic Radius
4. Electronegativity

Atomic Radii- (size)



The atomic radius is half of the distance between 2 nuclei of the same element.

- Since atoms are mostly empty space with no fixed outer boundary, the only solid part to measure against is the nucleus.



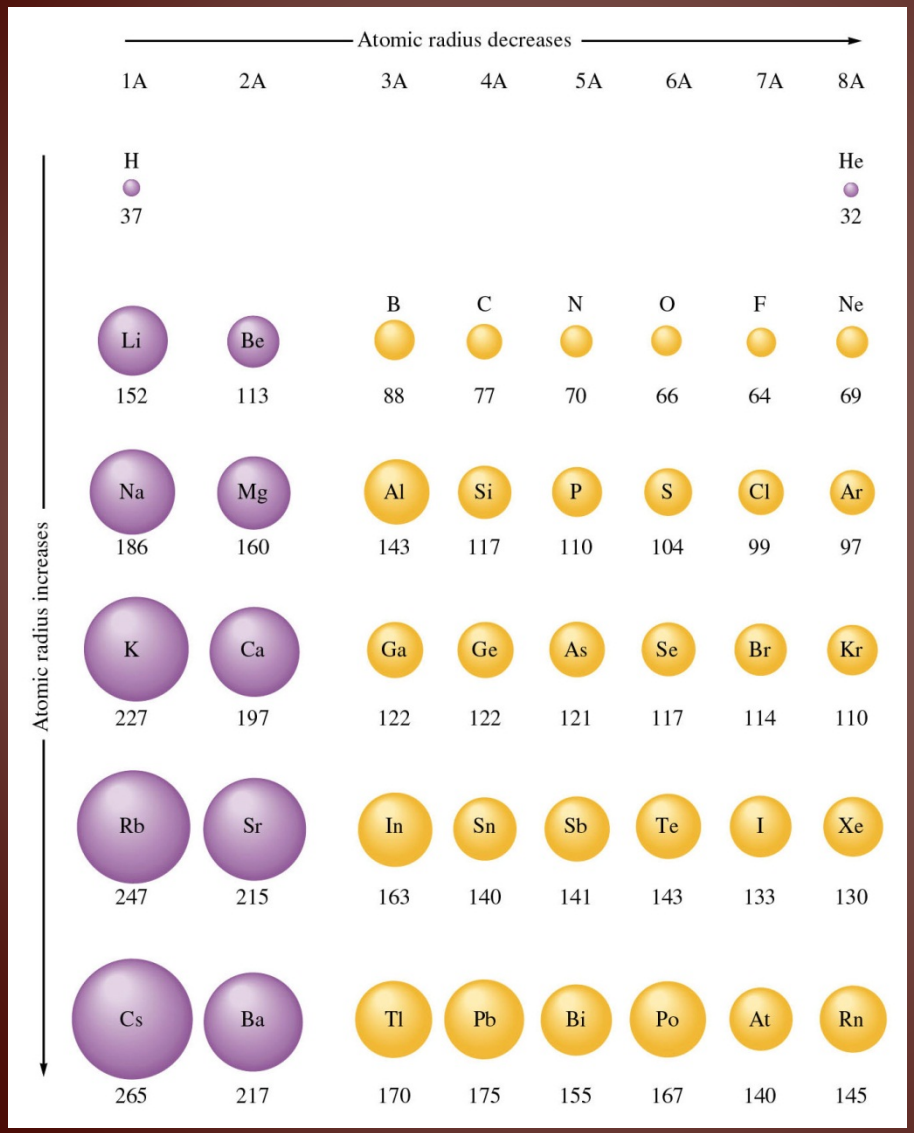
Periodic Trends – going across the PT the radius decreases.

- As you go across a period, more electrons are added into the same energy level.
- The greater the positive charge of the nucleus, the stronger it will be to pull in on the electrons.
- The stronger the nucleus pulls, the closer the electrons get.

Group Trends – going down the PT the radius increases.

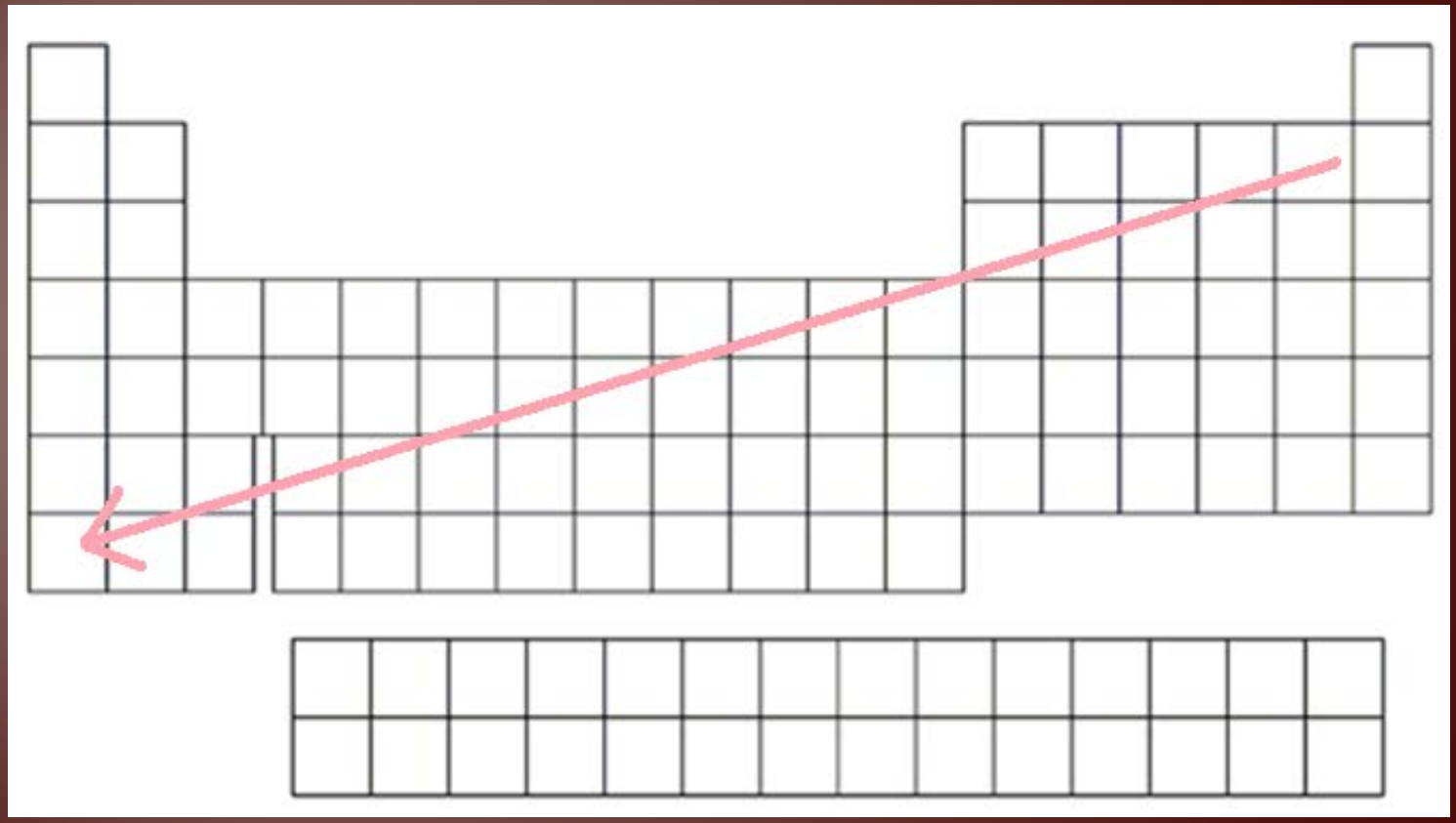
- As you go down a group, you add energy levels.

Atomic Radii



- Decreases across a period.
- Increases down a group

Over all trend for Atomic Radii



Ions

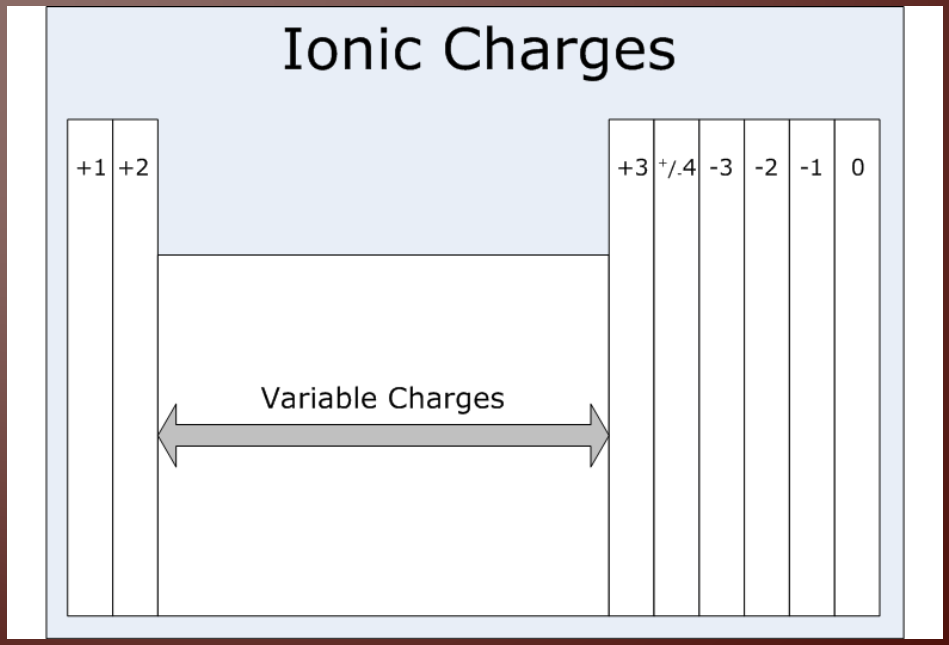
Ionization refers to the measure of energy required to remove an electron from the outermost energy level.

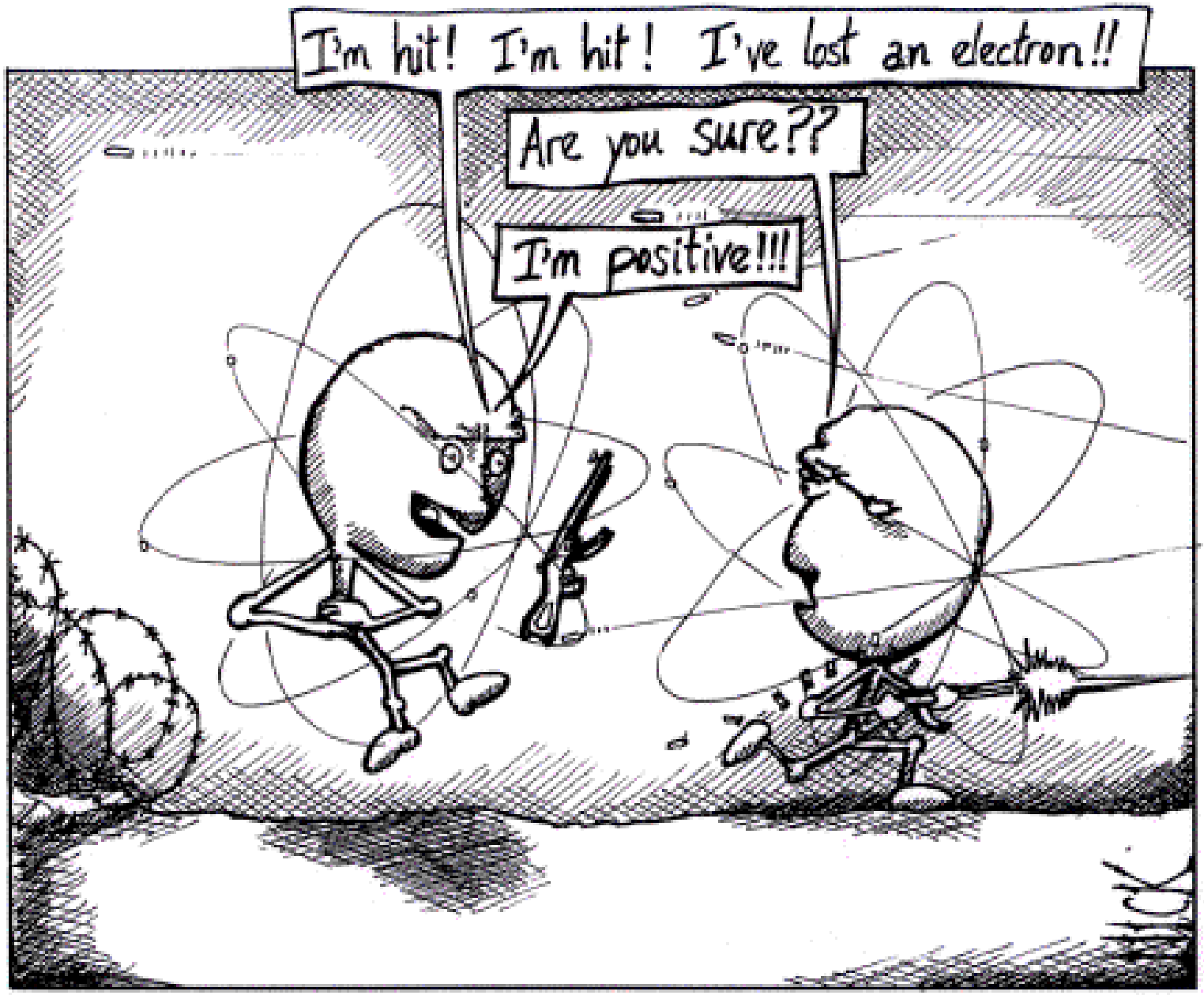
An ion is an atom that has either a net positive or net negative charge, due to gaining or losing electrons. Ask yourself, are the valence electrons closest to 0 or 8. If they are closest to 0 then remove the electrons (+); if they are closest to 8 then add the electrons (-).

What would the charge be on an atom that lost an electron? What would the charge be if an atom gained two electrons?

A: +1 (because your losing an -e)

A: -2 (because you gain 2 -e)





ANOTHER CASUALTY IN THE WAR OF THE SODIUM ATOMS

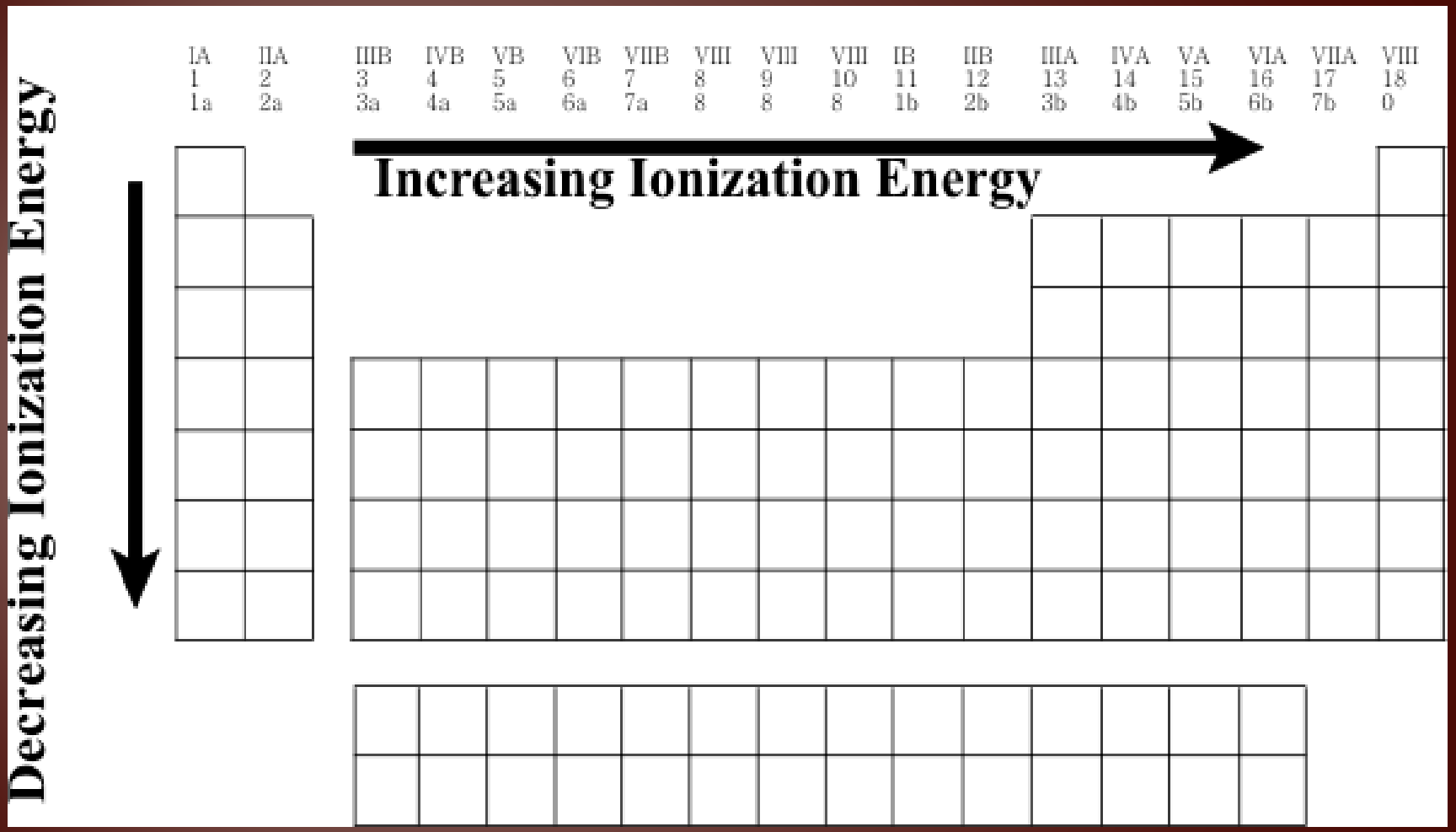
Ionization Energy

The energy required to remove one electron from a neutral atom of an element is the **ionization energy.**

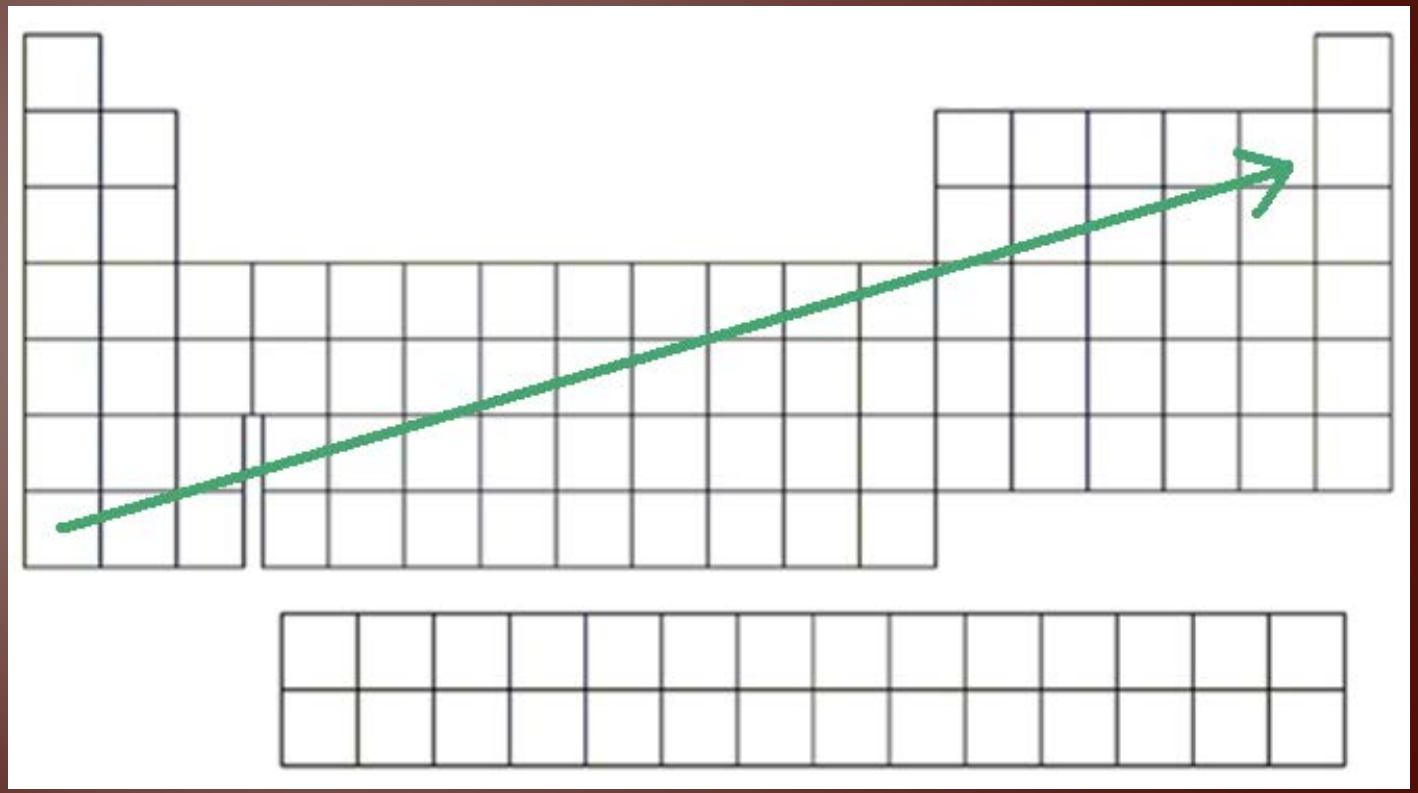
- If an atom has higher ionization energy it gets to keep its e-; if it is lower it loses its e-.
- Smaller atoms hold e- more tightly & therefore the trend going across the table is increasing.
- Larger atoms can't hold their own e- ; going down the table the Ionization energy decreases.

Ionization Energy

- Periodic Trends – Going across the PT the ionization energy increases as it becomes more difficult to remove electrons.
  - A small atom holds its electrons very tightly – strong attraction to nucleus
  - These electrons need a lot of additional energy to escape their nuclear attraction.
  - When an atom loses an electron it becomes ionized (ion) with a positive charge because there are now more protons than electrons.
- Group Trends – Going down the PT the ionization energy decreases.
  - A big atom has electrons that are far away from the nucleus. These electrons only need a little more energy to escape the attraction of the nucleus.
  - 1^{st} ionization energy is the energy needed for one electron to escape.
  - After the first electron has escaped, the nucleus is holding on tighter to the remaining electrons.
  - 2^{nd} ionization energy must be even greater than 1^{st} ionization energy for the next electron to escape. 2^{nd} ionization energy – energy needed for a second electron to escape.
  - This pattern continues with increase ionization energy needed for more electrons to escape.


IA 1 1a
IIA 2 2a
IIIB 3 3a
IVB 4 4a
VB 5 5a
VIB 6 6a
VIIB 7 7a
VIII 8 8
VIII 9 8
VIII 10 8
IB 11 1b
IIB 12 2b
IIIA 13 3b
IVA 14 4b
VA 15 5b
VIA 16 6b
VIIA 17 7b
VIII 18 0
Increasing Ionization Energy
Decreasing Ionization Energy

Over all trend for Ionization Energy



largest

smallest

Indx

Ionic Radii

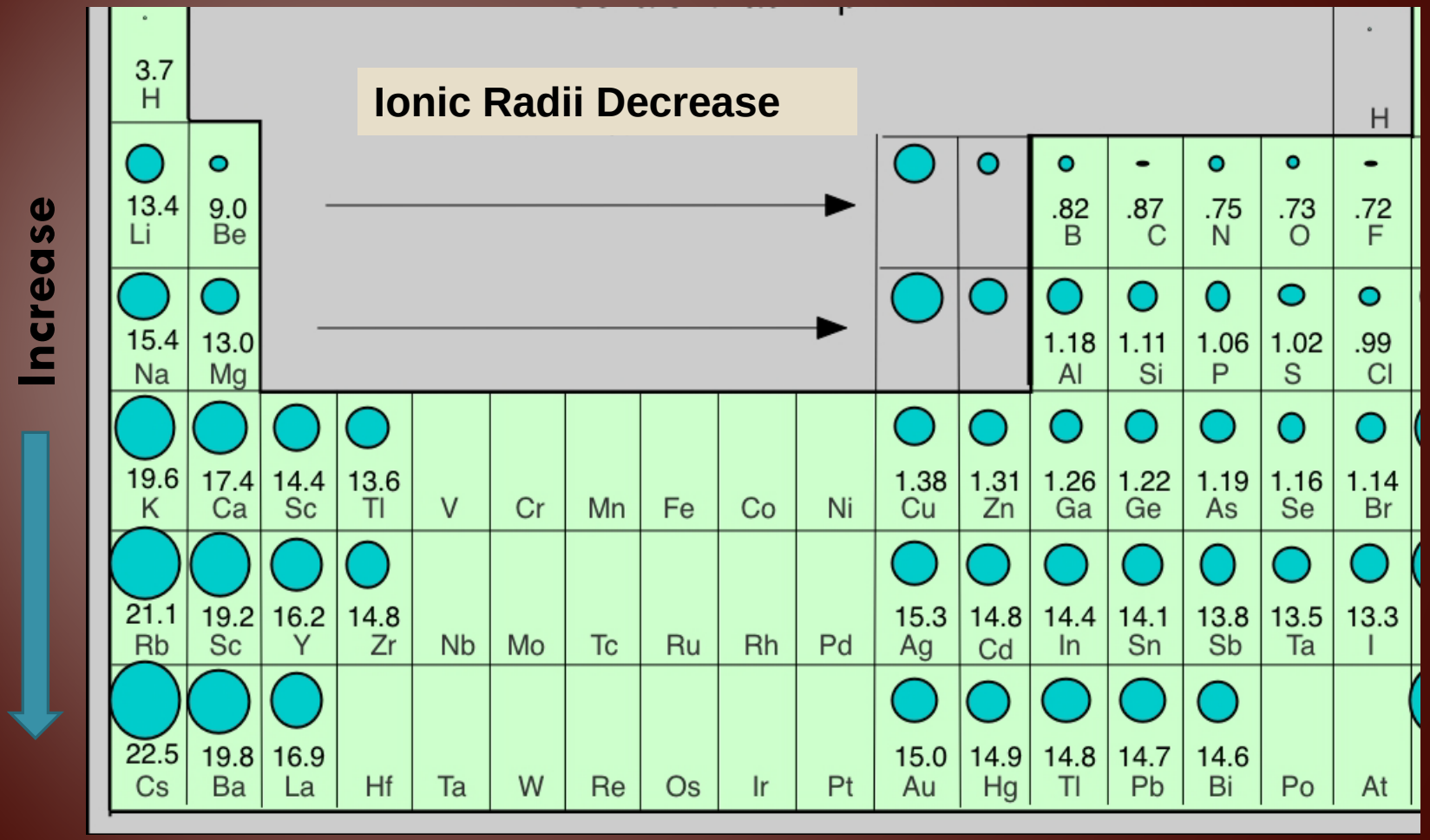
the size of a charged "atom"

- Charged atoms are called ions.
- A positive ion is known as a **cation**
  - Formed by loss of electrons
- A negative ion is known as an **anion**
  - Formed by gain of electrons

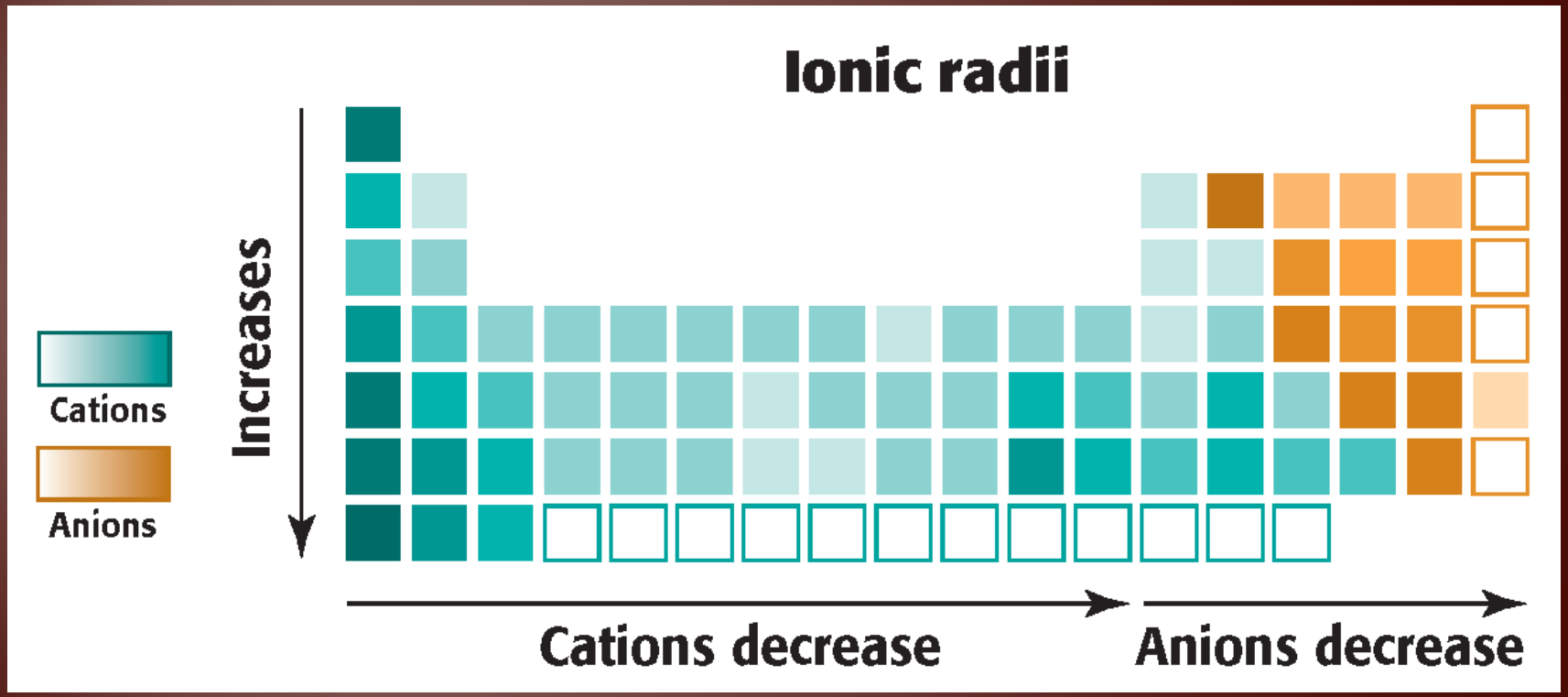
Periodic Trends – Going down the PT the ionic size increases. The more energy levels the fatter the ion so the nucleus cannot hold the electrons tightly.

Group Trends – Going across the PT the ionic size decreases. Remaining electrons can be held tighter by the nucleus whose strength has remained the same.

Ionic Radii trends



Ionic Radii


Ionic radii
Increases
Cations
Anions
Cations decrease
Anions decrease

Electronegativity

Electronegativity is the tendency for the atom to attract electrons when chemically combined with atoms of another element.

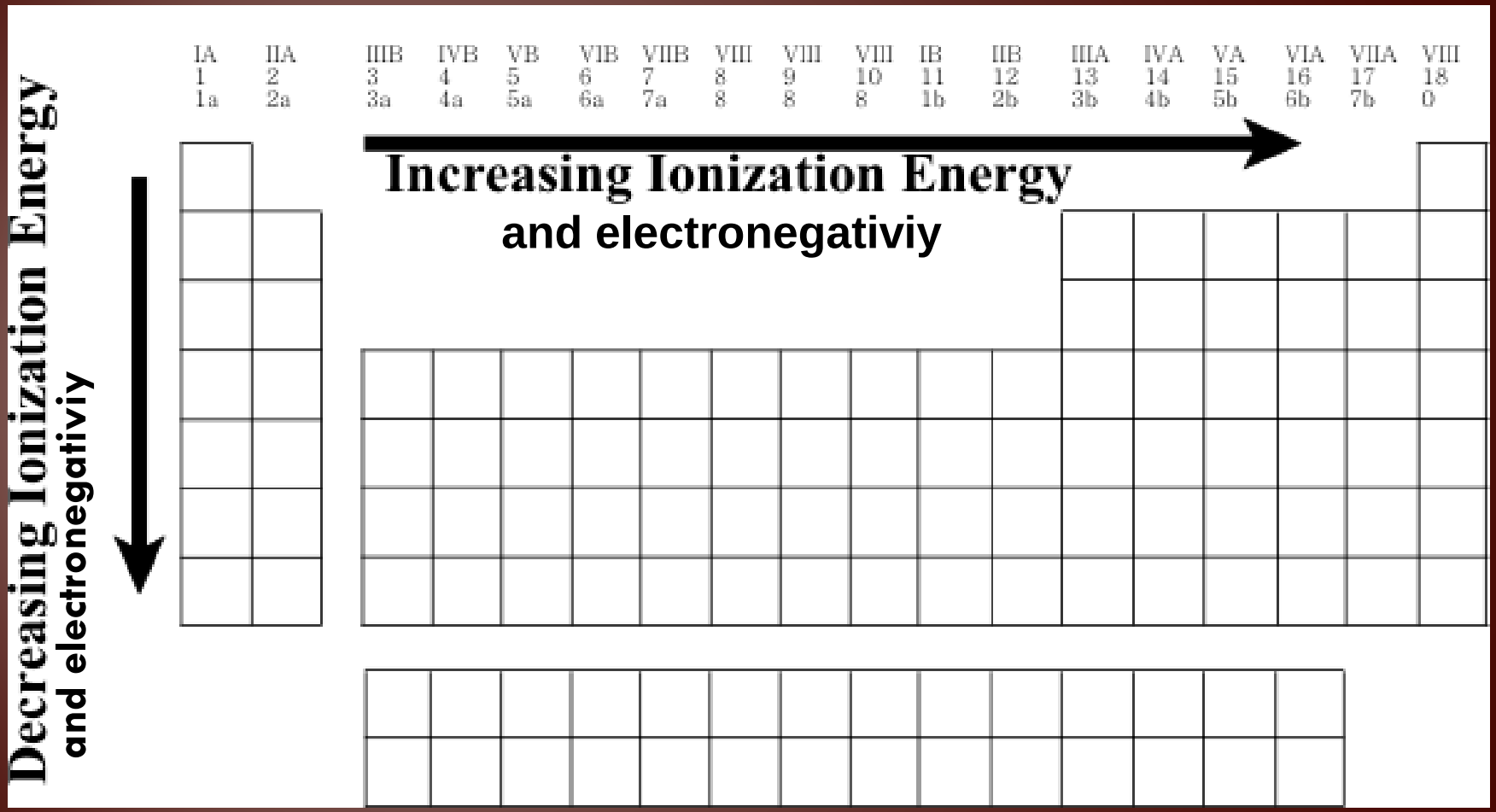
- Corresponds to the ionization energy
- If hard to lose, an electron from self (high ionization energy) then easy to pull an electron away from another (high electronegativity)
- If easy to lose an electron from self (low ionization energy) then hard to pull an electron from another (low electronegativity)

Periodic Trends – going across the PT the electronegativity increases

- If the element has a high electronegativity it will pull electrons from an element with a lower electronegativity.
- Fluorine has the highest electronegativity.

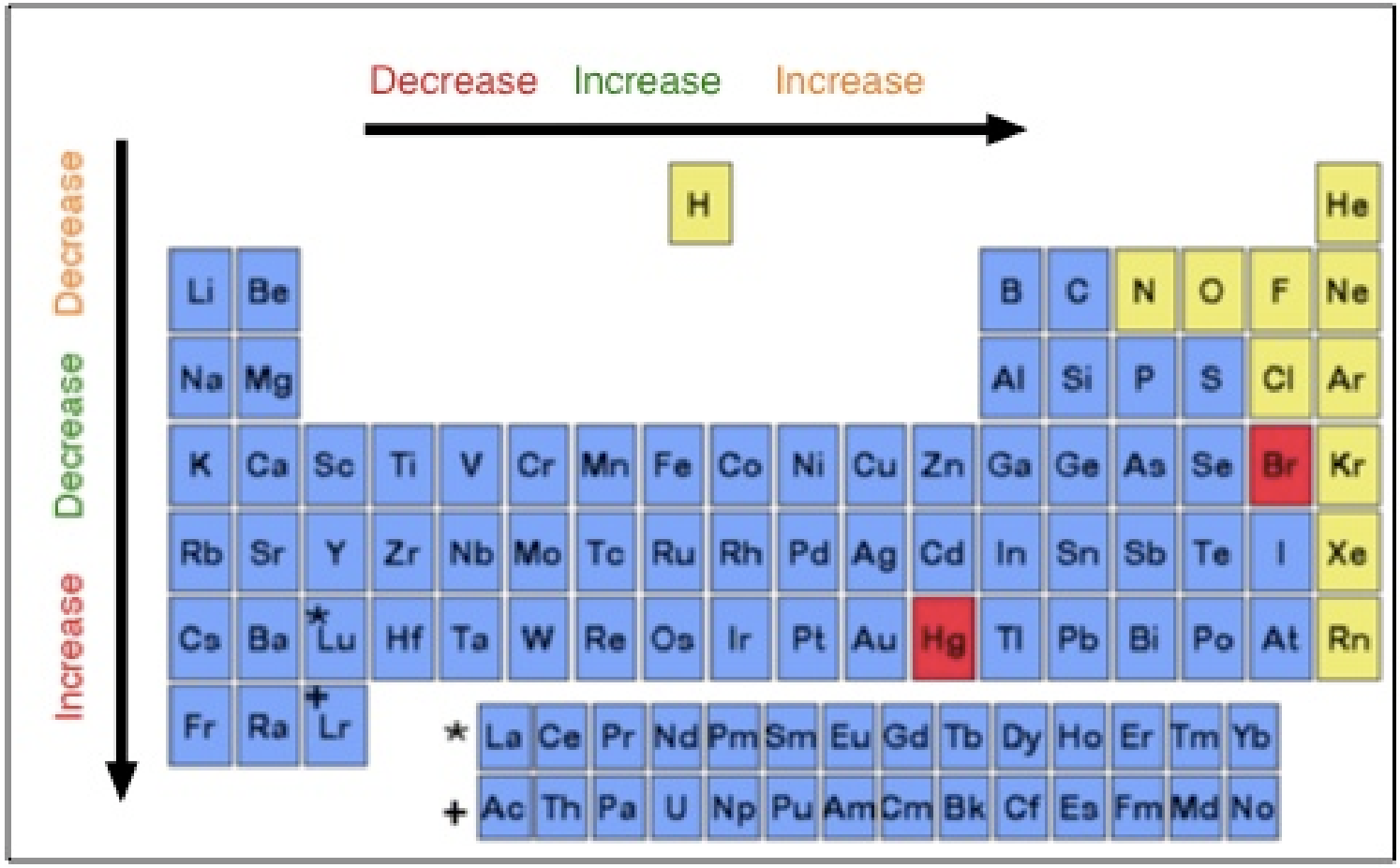
Group Trends – going down the PT electronegativity decreases

- If the element has a low electronegativity it will NOT be able to pull electrons away from an element with a higher electronegativity.
- Cesium has the lowest electronegativity.


IA 1 1a
IIA 2 2a
IIIB 3 3a
IVB 4 4a
VB 5 5a
VIB 6 6a
VIIB 7 7a
VIII 8 8
VIII 9 8
VIII 10 8
IB 11 1b
IIB 12 2b
IIIA 13 3b
IVA 14 4b
VA 15 5b
VIA 16 6b
VIIA 17 7b
VIII 18 0
Increasing Ionization Energy
and electronegativiy
Decreasing Ionization Energy
and electronegativiy

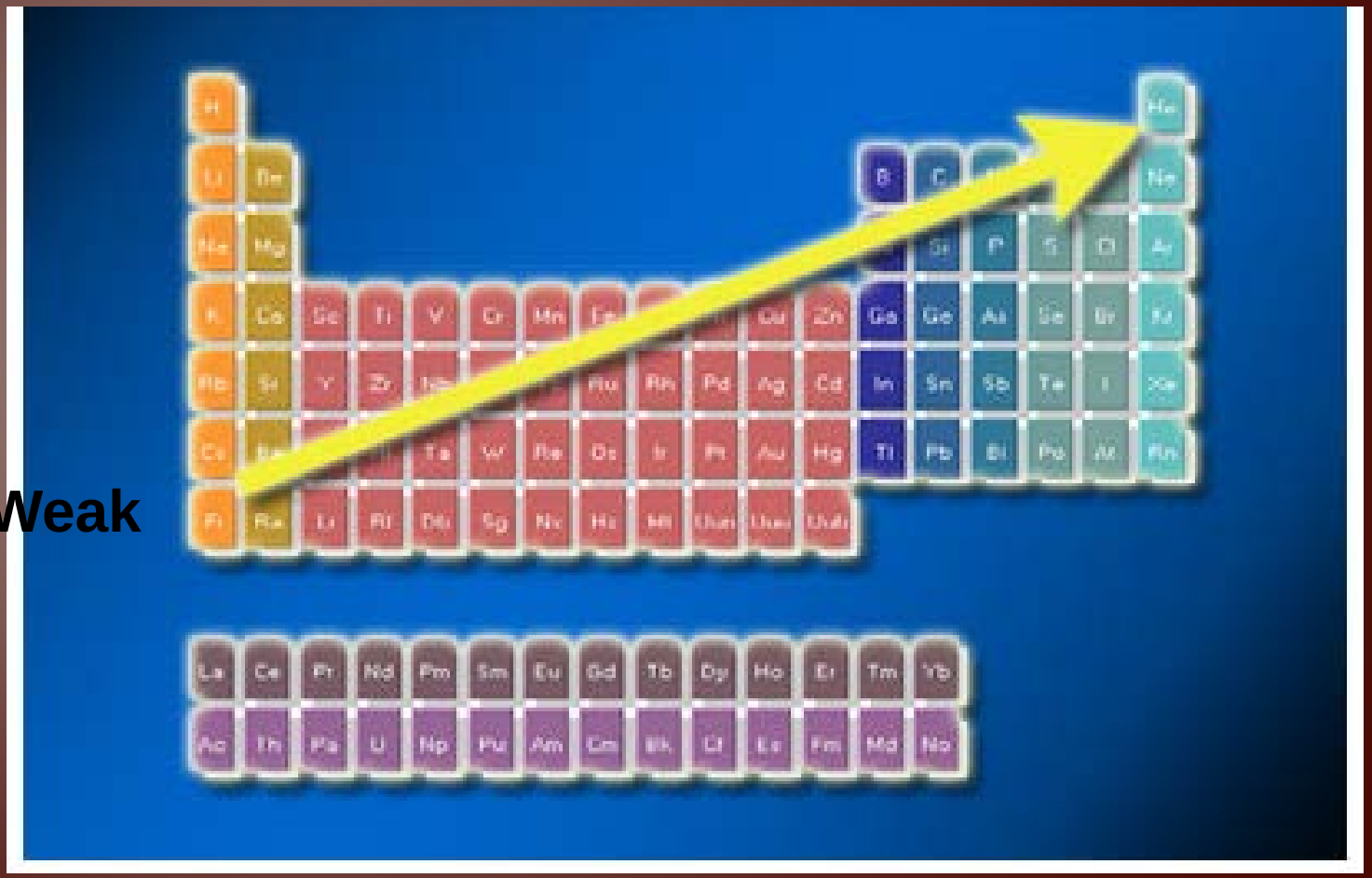
Trends

Atomic Radius
Electronegativity
Ionization Energy



Overall Trends..

Small & Strong



Big & Weak