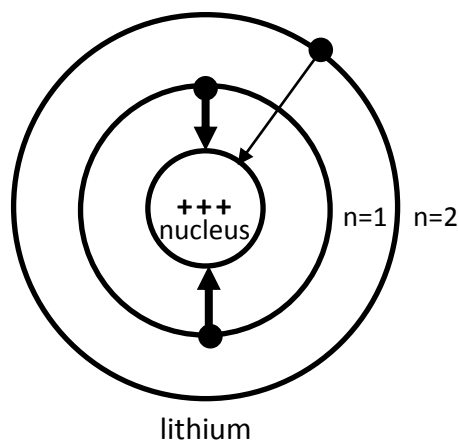


## Electrostatic Attraction (aka Coulombic Attraction) Guided Inquiry

The positive charge of the proton and the negative charge of an electron create an electrostatic force of attraction between the atom's nucleus and its electrons. This force of attraction is also known as coulombic attraction. Two variables affect the strength of this attraction:

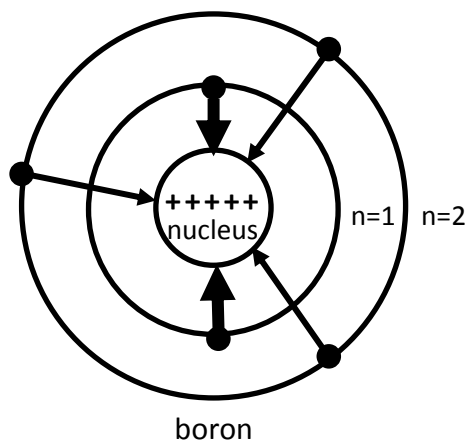
**The distance between the charged particles** – The force of attraction has an *indirect* relationship with the square of the distance. This means that as the distance between the nucleus and the electron increases the electrostatic attraction *decreases*. Because the relationship is with the square of distance the force *decreases* rapidly as the distance increases. For example, doubling the distance between the nucleus and electron *decreases* the force of attraction by a factor of 4. Tripling the distance between the nucleus and electron *decreases* the force of attraction by a factor of 9.

The lithium atom is shown on the right. The force of attraction between the nucleus and the 2 electrons in the n=1 energy level is stronger than the force of attraction between the nucleus and the electron in the n=2 energy level, because the electrons in the n=1 energy level are closer to the nucleus than the electron in the n=2 energy level.



**The strength of the charged particles** – The force of attraction has a *direct* relationship with the strength of the charged particles. An electron can only have a 1- charge; however, the strength of the nucleus's charge is equal to the number of protons in the nucleus. So as the number of protons in the nucleus increases the strength of the electrostatic attraction between the nucleus and the electron *increases*. If the number of protons in the nucleus doubles, then the force of attraction *increases* by a factor of 2. If the number of protons in the nucleus triples, then the force of attraction *increases* by a factor of 3.

The boron atom is shown on the right. The force of attraction between boron's nucleus and its 3 electrons in the n=2 energy level is stronger than the force of attraction between lithium's nucleus and its electron in the n=2 energy level, because boron's nucleus has 5 protons compared to only 3 protons for lithium's nucleus.



### What is the effect when both variables change?

The general relationship between the force of attraction,  $F$ , the distance between the electron and the nucleus,  $d$ , and the number of protons in the nucleus,  $Z$ , is  $F \propto \frac{Z}{d^2}$ . Changing distance has a *bigger effect* on the attractive force than changing the number of protons. So, if both the distance between the nucleus and electron, and the number of protons in the nucleus doubled, the attractive force would *decrease by a factor of 2*. If the distance between the nucleus and electron, and the number of protons in the nucleus tripled, the attractive force would *decrease by a factor of 3*.

Use this information about the force of attraction between electrons and the nucleus and the periodic table to solve the problems on the other side.

Complete each table below by writing down the number of protons each element has and the highest main energy level of its electron cloud in the ground state. Then rank the strength of the electrostatic attraction between their nucleus and the out most electron(s).

Element	# of Protons	Highest Main Energy Level	Relative Strength of Coulombic Attraction
chlorine			
magnesium			
argon			
silicon			
sodium			
sulfur			
phosphorus			
aluminum			

Element	# of Protons	Highest Main Energy Level	Relative Strength of Coulombic Attraction
strontium			
barium			
magnesium			
radium			
beryllium			
calcium			

Element	# of Protons	Highest Main Energy Level	Relative Strength of Coulombic Attraction
cesium			
fluorine			
zirconium			
iron			
silicon			