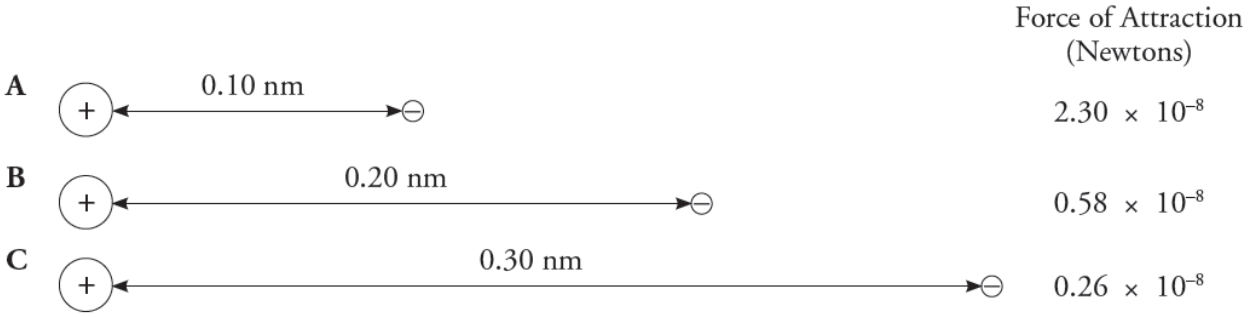
Coulombic Attraction

What variables will affect the force of attraction between charged particles?

Why?

Coulombic attraction is the attraction between oppositely charged particles. For example, the protons in the nucleus of an atom have attraction for the electrons surrounding the nucleus. This is because the protons are positive and the electrons are negative. The attractive force can be weak or strong. In this activity, you will explore the strength of attraction between protons and electrons in various atomic structures.

Model 1 – Distance and Attractive Force



1. What subatomic particles do these symbols represent in Model 1?

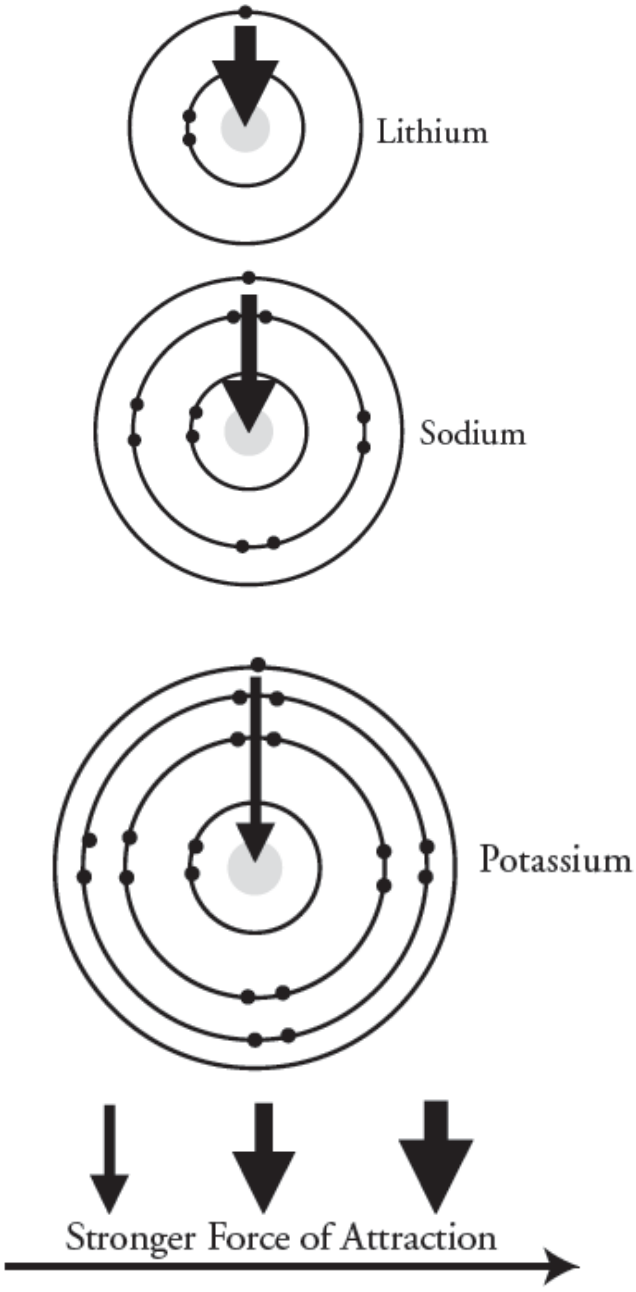
2. Would you expect to observe attraction or repulsion between the subatomic particles in Model 1?

3. **Consider the data in Model 1. Write a complete sentence that describes the relationship between distance of the particles and the force of attraction.**

4. **If the distance between a proton and electron is 0.50 nm, would you expect the force of attraction to be greater than or less than 0.26 x 10^{-8} N?**

5. If two protons are 0.10 nm away from one electron, would you expect the force of attraction to be greater than or less than 2.30 x 10^{-8} N?

Model 2 – The Alkali Metals



6. Consider the diagrams in Model 2.
    a. What do the arrows represent?

    b. How does the thickness of the arrows relate to the property given in part a?

7. Using a periodic table, locate the elements whose atoms are diagrammed in Model 2. Are the elements in the same column or the same row?

8. Circle the outermost (valence) electron in each of the diagrams in Model 2.

a. As you move from the smallest atom to the largest atom in Model 2, how does the distance between the outermost electron and the nucleus change?

b. As you move from the smallest atom to the largest atom in Model 2, how does attractive force between the outermost electron and the nucleus change?

c. Are your answers in parts a and b consistent with the information in Model 1? Explain.

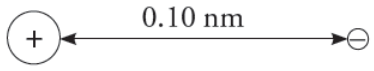
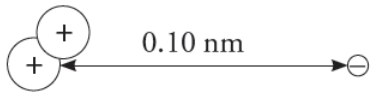
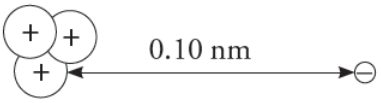
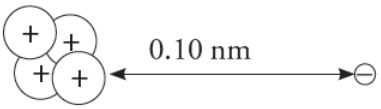
d. Complete the statement below to correctly describe the relationship between the number of energy levels in an atom and the distance between the nucleus and valence electrons.

As the number of energy levels increases, the distance between the nucleus and valence electrons _____.

e. Describe the relationship between the number of energy levels in an atom and the attractive force between the nucleus and valence electrons.

f. Describe the relationship between the number of energy levels in an atom and the size of the atom.

Model 3 – Number of Protons and Attractive Force

		Force of Attraction (Newtons)
A		2.30×10^{-8}
D		4.60×10^{-8}
E		6.90×10^{-8}
F		9.20×10^{-8}

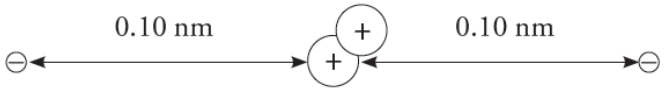
9. Consider the data in Model 3. Write a complete sentence that describes the relationship between the number of protons and the attractive force on the electron.

10. What would be the attractive force on a single electron if five protons were in the nucleus of an atom? Show mathematical work to support your answer.

11. Imagine that a second electron were placed to the left of a nucleus containing two protons (Model 3, set D). Predict the force of attraction on both the original electron and the second electron. Explain your prediction with a complete sentence.

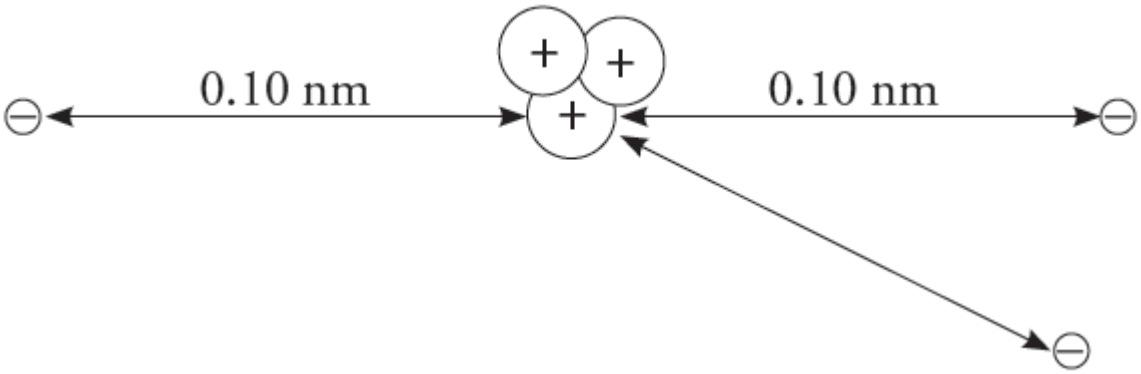
Read This!

The attractive and repulsive forces in an atom are rather complex. An electron is attracted to the protons in the nucleus, but it is also repelled by the other electrons in the atom. It is important to note however that the attractive force of the nucleus is NOT divided up among the electrons in the atom. Each electron gets approximately the full attractive force of the nucleus (minus the repulsive effects of other electrons). Compare the diagram below to set D in Model 3. Notice the similarity in attractive force.

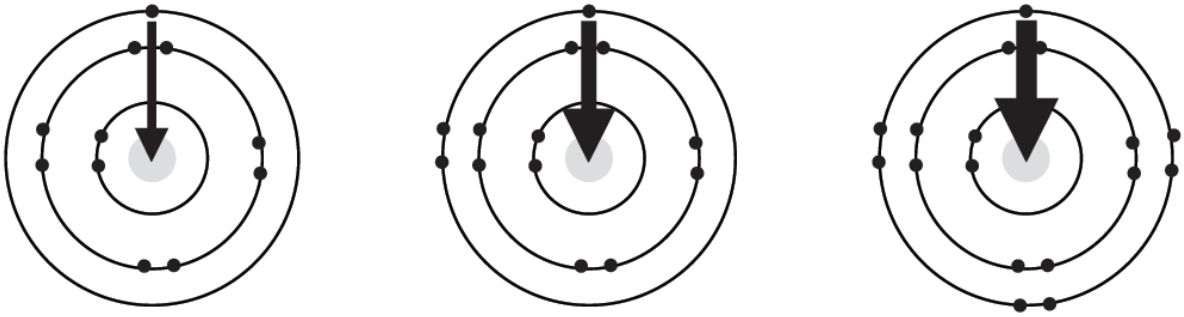


approx. 4.60×10^{-8} (on each electron)

12. What is the approximate attractive force on each electron below?



Model 4 – Period 3 Elements



Sodium Aluminum Chlorine

13. Using the periodic table, locate the elements whose atoms are diagrammed in Model 4. Are the elements in the same column or the same row?

14. Circle the outermost (valence) electron(s) in each of the atoms in Model 4.

15. Which of the three atoms diagrammed in Model 4 has the strongest attraction for its valence electron(s)?

16. Consider the information in Model 4.
    a. As you move from the smallest atom to the largest atom, does the distance between the outermost electron(s) and the nucleus change significantly?

    b. Can the differences in the attractive force shown by the arrows be explained by a change in the distance between the electron(s) and the nucleus? Explain.

    c. On the diagram in Model 4, write the number of protons located in the nucleus of each atom.

    d. Can the difference in attractive forces shown by the arrows in Model 4 be explained by a change in the number of protons in the nucleus? If yes, explain the relationship in Model 4.

17. For each of the elements below, circle the element whose atoms will have a stronger attractive force between their valence electron(s) and the nucleus.
    a. Ba and Ca b. Cr and Cu c. Ar and Xe

18. For each of the elements below, circle the element whose atoms will have a smaller atomic size.
    a. Ba and Ca b. Cr and Cu c. Ar and Xe

Summary

19. Atoms of elements in the same period have the same number of _____ _____, therefore the difference in size of the atoms is determined by the number of _____. As the number of _____ increases, the attractive force between the nucleus and valence electrons _____, resulting in a smaller _____ between the nucleus and valence electrons, thus causing a _____ atomic size.

20. Atoms of elements in the same group have different number of _____ _____, therefore the difference in size of the atoms is determined by the number of _____ _____. As the number of _____ _____ increases, the distance between the nucleus and valence electrons _____, resulting in _____ attractive force between the nucleus and valence electrons, thus causing a _____ atomic size.

21. Based on your summary, identify and label the element on the periodic table below that would have the smallest atoms and the element that would have the largest atoms.