Name: _____

Simulation: Periodic Trends

Background

In this investigation you will examine several periodic trends, including atomic radius, ionization energy and ionic radius. You will be asked to interact with select atoms as you investigate these concepts.

1. Draw a picture to support a written definition of the word "radius."

2. Assuming atoms are shaped like spheres, what subatomic particles would be found in the center? What subatomic particles would be found around the perimeter?

3. Keeping in mind your answers to questions 1 & 2, in your own words describe the meaning of "atomic radius"

4. What is an ion? What is a valence electron? How is an ion formed?

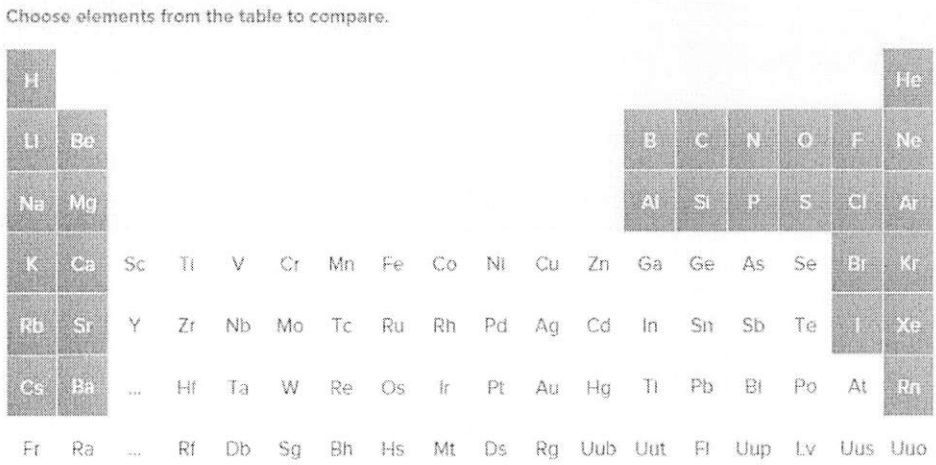
5. What do you think *ionization energy* means? Think about this in relation to your answer to question #4.

6. Keeping in mind all of your answers thus far, attempt to define the term *ionic radius*.

*Check your answers before moving on to the next portion of the activity.

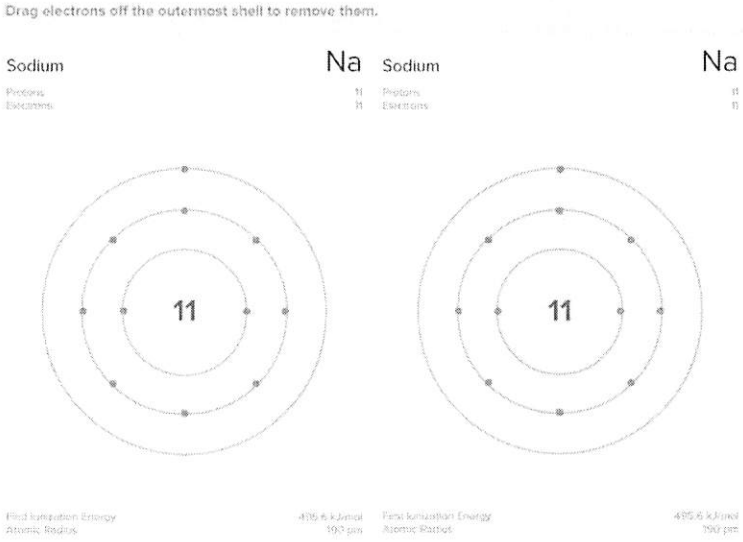
Procedure

Using your computer, tablet or mobile device, navigate to the website: http://www.teachchemistry.org/periodic-trends. You should see the picture below on your screen.



Atomic Radius

1. Choose any element shown in green from ***group 1*** on periodic table clicking the on the element symbol. You should see details about the element that you chose appear at the bottom of the screen. An example is shown below.



   a. Select another element from **group 1** clicking on its symbol. Write the symbols and atomic number for each of the elements that you chose below:

   b. Which element appears larger in the side-by-side comparison?

c. What is the value in picometers (pm) for the radius of each atom? Do these values support your answer for part b?

 ***Reset the selected data using the reset symbol.***

d. Next, choose an element from a **different group** by clicking on its symbol. Again choose a second element to compare from the same group. Write the symbols and atomic number for each of the elements that you chose below:

e. Which element appears larger in the side-by-side comparison?

f. What is the value in picometers (pm) for the radius of each atom? Do these values support your answer for part e?

g. Based on your answers in question 1 parts a-f, what is the general trend in the atomic radius of atoms **within the same group**? Give suggestions for why you think this trend exists based on your interaction with the elements.

2. Choose any element from ***period 2*** on the periodic table by clicking on the element symbol. You should see details about the element that you chose appear at the bottom of the screen.

   a. Select another element from the ***period 2*** by clicking on its symbol. Write the symbols and atomic number for each of the elements that you chose below:

   b. Which element appears larger in the side-by-side comparison?

   c. What is the value in picometers (pm) for the radius of each atom? Do these values support your answer for part b?

d. Do your answers in part b & c surprise you? Explain.

 ***Reset the selected data using the reset symbol.***

e. Choose an element from a different **period** by clicking on its symbol. Again choose a second element to compare from the same period. Write the symbols and atomic number for each of the elements that you chose below:

f. Which element appears larger in the side-by-side comparison?

g. What is the value in picometers (pm) for the radius of each atom? Do these values support your answer for part e?

h. Based on your answers in question 2 parts a-g, what is the general trend in the atomic radius of atoms *within the same period*?

i. Think about the possible *contributing factors to* the atomic radius trend within a period, specifically considering the protons in the nucleus, the electrons and the electron shells. List them below:

 ***Reset the selected data using the reset symbol.***

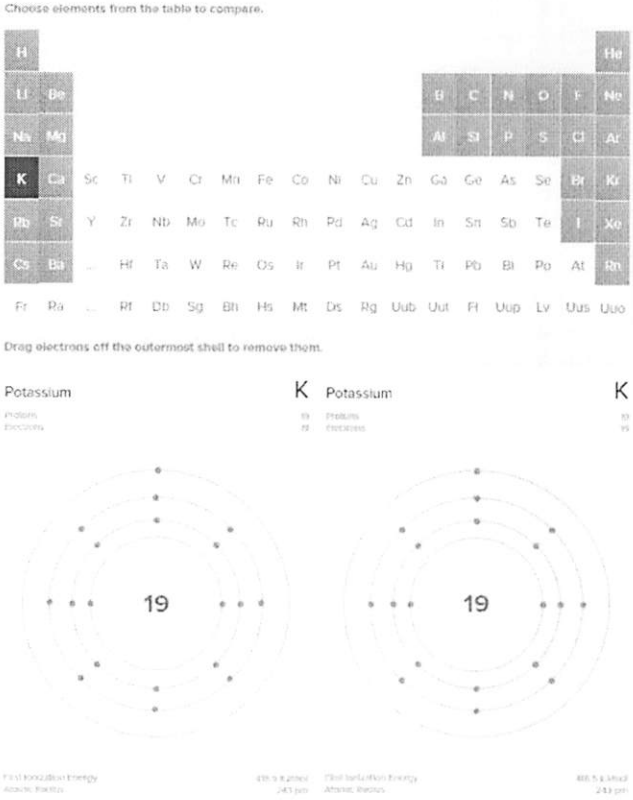
3. Based on what you have learned, and without the assistance of the periodic trends simulation, predict which element is larger in the following pairs of atoms:

a. Be *or* Sr	c. Rb *or* S	e. Br *or* Ca
b. P *or* Ar	d. F *or* He	f. Xe *or* Ba

Using the simulation, check your predicted answers to see if you are correct!

Ionization energy

4. Choose an element from the ***Alkali Metal family*** (group 1) by clicking on the element symbol. You should see details about the element that you chose appear at the bottom of the screen. An example is shown below.



a. Using your cursor attempt to ionize the atom that you chose by pulling a valence electron from the electron shell. Describe what happened. (Were you successful? Was it "easy" to remove the electron? Did the atom seem to have a strong hold on the electron?)

b. What was the ionization energy value for the atom that you chose?

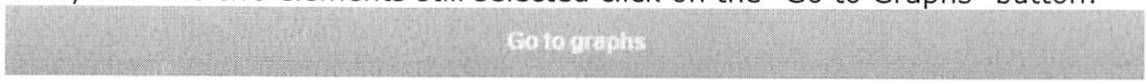
c. Did any other information about the atom change after your attempt to ionize the atom?

d. Now choose the Noble Gas element that is in the same period as the Alkali metal chosen in part a. Attempt to ionize this atom by pulling a valence electron from the electron shell. Describe what happened. (Were you successful? Was it "easy" to remove the electron? Did the atom seem to have a strong hold on the electron?)

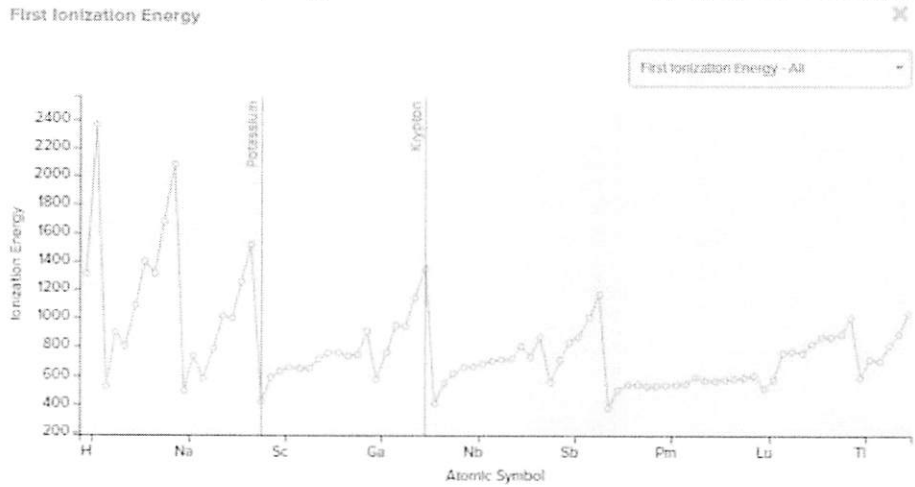
e. What was the ionization energy value for the noble gas atom that you chose?

f. Make a comparison statement about the two elements that you interacted with in terms of why they require different amounts of ionization energy.

g. Next, with the two elements still selected click on the "Go to Graphs" button:



A graph should appear, you will need to ensure the "First Ionization Energy" filter is selected in the top right hand location of the graph, for example:



What trend in ionization energy do you observe for elements in the same period based on the data in the graph?

h. While still analyzing the graph, make a prediction about the trend in ionization energy between atoms in the same **group** on the periodic table. For example, do atoms with larger atomic numbers have greater ionization energy than atoms with small atomic numbers in the **same group**?

Navigate back to the main page, and reset the data using the reset symbol.

i. Now choose two elements that are in the same group. How do their ionization energy values compare? Does this data support your prediction from part h?

5. Based on what you have learned, and without the assistance of the periodic trends simulation, organize the following lists of atoms *from lowest ionization energy to highest ionization energy:*

   a. S, Na, Al, Ar

   b. I, F, Br, Cl

   c. Rb, O, Si, Mg, He

Using the simulation, check your predicted answers to see if you are correct!

6. Reflecting on what you have learned about both atomic radius and ionization energy at this point, which of the following statements best describe these trends?

   - Atoms that have large atomic radii also have large values of ionization energy.

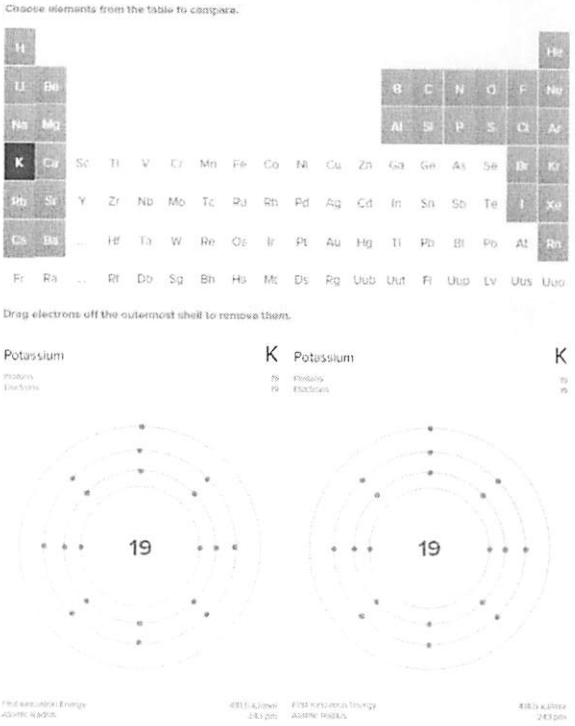
   - Atoms that have small atomic radii will have large values of ionization energy.

   Explain your choice referencing ***both*** the atomic model and subatomic particles:

Reset the selected data using the reset symbol.

Ionic Radius

7. Choose an element from the *Alkali Metal family* (group 1) by clicking on the element symbol. You should see details about the element that you chose appear at the bottom of the screen. An example is shown below.



a. What is the atomic radius value for this element?

b. Using your cursor ionize the atom that you chose by pulling a valence electron from the electron shell until it is fully removed. What happened to the electron shell where this valence electron was located? How is the change in subatomic particles related to the size of the ion?

c. Since this atom is now *ionized*, you should see a value for the ionic radius. What is the value? Is this value larger or smaller than the value for the atomic radius in part a?

Reset the selected data using the reset symbol.

8. Next, choose an element from the *Alkaline Earth Metal family* (group 2) by clicking on the element symbol. You should see details about the element that you chose appear at the bottom of the screen.

    a. What is the atomic radius value for this element?

    b. Based on the atomic structure of the atom you chose, how many electrons will need to be removed in order for it to become a stable ion?

    c. Remove the necessary valence electrons from this atom, and record the value for ionic radius below:

9. Both of the atoms selected in question #7 and #8 are metals, that form *cations* (positively charged ions) when they are ionized.

    a. Based on your answers to these questions, is the atomic radius of the neutral atom bigger or smaller than the radius of its cation?

    b. Why does this trend occur?

10. Choose an element from the *Halogen family* (group 17) by clicking on the element symbol. You should see details about the element that you chose appear at the bottom of the screen.

    a. How many valence electrons are present in the atom that you chose?

    b. Using your cursor attempt to ionize the atom that you chose by pulling a valence electron from the electron shell. Describe what happened. (Were you successful? Was it "easy" to remove the electron? Did the atom seem to have a strong hold on the electron?)

    c. In order to make the halogen atom stable, by having a complete outer shell of electrons, what would be an easier solution compared to removing all of the valence electrons?

    d. Based on your answer to part c, do you think the ionic radius will be larger or smaller than the atomic radius for this atom? Justify your prediction with scientific reasoning.