Periodic trends: Ionization energy answers.

Name _____

1. What is the atomic number?

   The number of protons found in an element.

2. What is the ionization energy of an element?

   It is the minimal energy needed to remove an electron from the outer shell of a neutral atom in a gaseous state.

3. Make a prediction about the following trends you expect to see in ionization energy:

   a. As you move across a period? Why?

      It will increase because of the increased positive charge of the nucleus pulling on the electrons

   b. As you move down a group? Why?

      It will decrease because the outer electrons are farther away from the positively charged nucleus and the inner electrons shield the outer electrons, decreasing the attraction.

Go to the Periodic Table Live! at *www.chemeddl.org/resources/ptl*. Click on the "Graph/Table" button in the upper right corner. Use this graphing feature to answer the questions below.

Start by clicking the "Deselect All" button above the miniature periodic table. You want to be able to choose which *elements, groups,* and *periods* will be graphed to answer this worksheet.

Select any main-group elements *period* (excluding 6 and 7). On the graph to the right of your screen go to the drop-down menus below *x* and *y* (this is where you can choose the value for your *x*- and *y*-axis). You should graph atomic number (under atomic properties) and first ionization energy (also under atomic properties).

4. On which axis did you place atomic number? Explain why you placed it there.

   The ionization energy is dependent on the number of protons found in an element. The atomic number is the independent variable, which is placed on the x-axis by convention.

5. What factors influence the ease of removing an electron from an element?

    - *the effective charge of a nucleus on the specific electron*
    - *the electron configuration*
    - *the size of the element*

6. Do you notice a *general trend* (don't worry about a few outliers—look for the overall trend) in the ionization energy across the period you chose? Try a couple of other periods. Is the trend consistent? Describe the trend.

    It's pretty consistent with a few outliers. There is a general upward trend. More energy is needed to remove an electron as you move across the periodic table.

7. Can you explain why you see this trend as you move across a period?

    A larger positive charge within the nucleus results from the increase in protons; there is a larger pull on the electrons in that outer shell, so it is harder and harder to pull them away—requiring more energy to achieve it.

8. Next, deselect all and choose any one group in the periodic table, with the same *x*- and *y*-axes that you used above. Look at a few more groups (look at groups outside of the transition metals). Do you see a trend in the ionization energy down a group? Is it consistent between groups?

    It decreases down a group.

9. Can you explain why you see this trend?

    Atomic size increases down a group. The outer electrons get farther and farther away from the positive charge of the nucleus, and the inner electrons shield the outer electron. This makes it easier to remove an electron because the attractive force holding the outer electron(s) is less.

10. Make a prediction about the relative strength of the second ionization energy compared to the first ionization energy.

    It should be higher because now the atom will be charged and the attractive force for the electron will be higher. It should be more difficult to pull a second electron away.

11. Test your hypothesis using the chart and sort feature of the PTL! Go into the graph you already made and choose the *y* drop down menu. Click on the "multiple fields" choice. Here, you can choose up to two more fields to add to your graph. Add the second ionization energy. Does the result support your hypothesis? If it doesn't, explain the trend you see.

Yes, the energy is higher. More energy is required to separate the electron from the atom.

For a more thorough exploration of ionization energy, download the following article:

Matsumoto, P.S. 2005. Trends in ionization energy of transition-metal elements. *Journal of Chemical Education* 82 (11): 1660–1661.