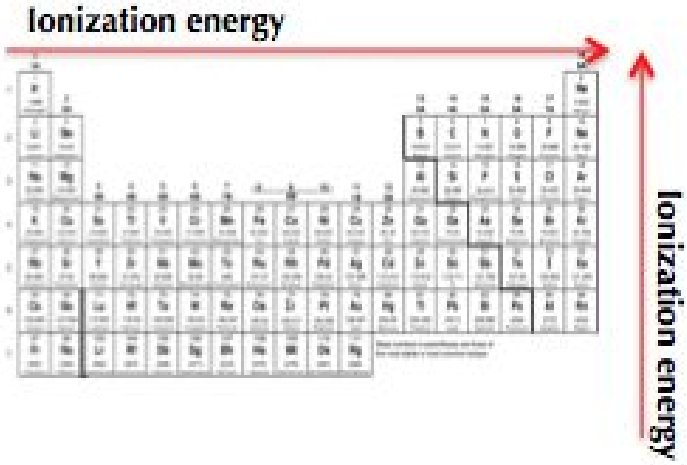
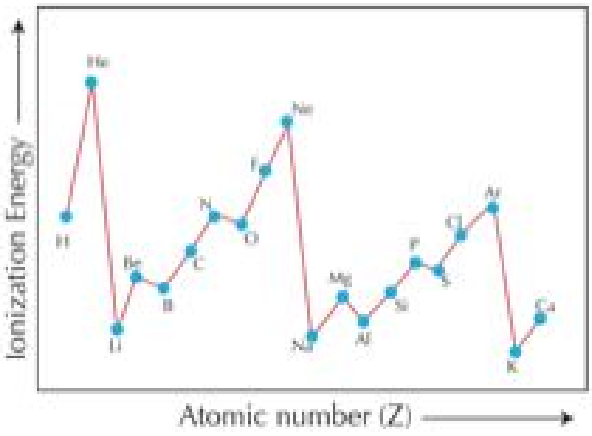
# Reading Science

Name: _____ Date: _____

## Ionization Energy

**Lexile 1080L**




The periodic table is an amazing reference that gives a wealth of information at a glance. You can identify elements based on their chemical symbol, atomic number, and atomic mass. You can also classify elements by the patterns that are found within the table's structure. Periodic trends are patterns that occur across a row (from left to right) or down a column of the periodic table. They can be used to predict certain properties of elements in their atomic or ionic form. These trends are based in large part on the number of protons and electrons found in the atoms. Periodic trends include such properties as atomic radius, electronegativity, and ionization energy.

As you may know, each element has a unique number of protons in the nucleus. The number of protons is the same as the atomic number of each element. Each of these protons has a positive charge, and the more protons that are in the nucleus of an atom, the greater the positive charge. Each neutral atom will have the same number of electrons as protons. Therefore, for neutral atoms, the atomic number will equal the total number of electrons in that atom. However, it is the valence electrons of the atom that become important. Remember, the valence electrons are the electrons found only in the outermost electron shell of an atom. These valence electrons will not only contribute to the possible charge of the atom, but they are also responsible for many of the periodic properties and trends of elements.

Period 1 elements can hold two electrons in their electron orbital, giving those atoms one or two valence electrons. The elements from periods 2 and 3 can hold between one and eight valence electrons. The elements from periods 4 and 5 can have up to 18 outer-shell electrons. The elements from periods 6 and 7 can have up to 32 outer-shell electrons. When an electron shell contains all of the electrons it can hold, it is said to be "full" and is in its most stable state.

# Reading Science

As electrons are removed or gained, the atom will develop a charge based on the number of electrons removed or gained. Ions with a positive or negative charge will be created. As you can imagine, it takes energy to move electrons. Ionization energy is one type of energy required to move electrons. Ionization energy refers to the amount of energy required to remove an electron from a neutral atom. The energy required to remove the first electron is called the first ionization energy. It is represented by the graphs at the beginning of this passage.

Consider the element neon (Ne), a noble gas found in group 8A. It has 10 protons and eight valence electrons. As this element has all of the valence electrons its outermost electron orbital can hold, it is in its most stable state. Neon does not "want" to lose its electrons. All noble gases have very high ionization energies, meaning it is very difficult to remove any of their valence electrons. This is one of the reasons why noble gases are considered nonreactive. On the other hand, sodium (Na) in the next period has 11 protons but only one valence electron. It does not take much energy to remove this electron from this atom. Sodium, therefore, has a very low ionization energy, as do all of the group 1A elements. The element to the right of neon, magnesium (Mg), has 12 protons and two valence electrons. There is more of a positive force pulling on the valence electrons of this atom. This extra pull makes it more difficult to remove an electron from magnesium than sodium. These examples demonstrate that the trend for ionization energy **increases**, moving from left to right across a period.

There is another dimension to this periodic trend. As you move down a column (group) on the periodic table, each element will contain more electron shells. This means that there will be more of a buffer between the positive protons and the negative valence electrons in the reactive outer shell. For example, argon (Ar) is just below neon (Ne) in group 8A. Compared to neon, argon has an additional electron shell between its protons and valence electrons. Therefore, argon has a lower ionization energy than neon. The same goes for the element calcium (Ca). Calcium has an additional electron shell between its protons and valence electrons. This gives calcium a lower ionization energy than magnesium. Therefore, the trend for ionization energy **decreases** as you move down a group on the periodic table.

# Reading Science

**1** The passage discusses some of the properties of the elements that are found on the periodic table. What atomic component contributes to many of the trends of elements?

**A** Protons

**B** Total number of electrons

**C** Valence electrons

**D** Neutrons

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**2** Place the following elements in order of **increasing** ionization energy. Their elemental symbols are listed below.

**Argon (Ar), Magnesium (Mg), Phosphorus (P), and Chlorine (Cl)**

**A** Mg, P, Cl, Ar

**B** Ar, Cl, P, Mg

**C** Cl, P, Ar, Mg

**D** Not enough information is given

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**3** Which of the following is not a trend found on the periodic table?

**A** Atomic radius

**B** Electronegativity

**C** Radioactivity

**D** Ionization energy

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**4** One of the trends, or patterns, that occurs on the periodic table is that of ionization energy. What does ionization energy refer to?

**A** The amount of energy required to add an electron to an atom

**B** The amount of energy required to remove a proton from an atom

**C** The amount of energy required to remove an electron from a neutral atom

**D** All of the above

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**5** As you move from left to right across a period on the periodic table, there is an increase in the positive charge of the nucleus of the atom which contributes to the increase in the first ionization energy of atoms. Why is there a decrease in ionization energy as you move down a column (group) on the periodic table?

**A** The valence electrons are not as negative.

**B** The protons become negative.

**C** There are fewer electron orbitals between the protons and the valence electrons.

**D** There are more electron orbitals between the protons and the valence electrons.

# Reading Science

**6** Place the following elements in order of **decreasing** ionization energy. Their elemental symbols will be listed below.

**Barium (Ba), Neon (Ne), Calcium (Ca), and Bromine (Br)**

**A** Ne, Br, Ca, Ba

**B** Ne, Ca, Br, Ba

**C** Ba, Ca, Br, Ne

**D** Ba, Br, Ca, Ne