Name: **Date:** **Period:**

Scientific Literacy Reading: Why Do Atoms Bond? Atoms vs. Ions

Vocabulary definitions **& Questions to consider as you read:**

Sodium vs. Sodium Chloride:

It's found in Gatorade, taco seasoning, the ocean, and sprinkled on top of french fries. Salt is the common name for the chemical compound sodium chloride, NaCl. Sodium chloride is contained in most foods we eat and is actually essential for proper nerve function in the body as long as it is consumed in appropriate quantities. As you saw earlier this year, the element sodium (Na) is an incredibly dangerous metal that reacts vigorously with water just like the rest of the alkali metals. If a person consumed elemental sodium (Na), it would react explosively as soon as it contacted their saliva, leading to serious injury or possibly death. How is it possible that the same element that ignites in water is also found in sodium chloride (salt), a mineral the body needs to survive?

Q1: *According to the text, what is the difference between the effect of sodium vs. sodium chloride on your body?*

It turns out that most atoms in the universe are unstable by themselves, like elemental sodium. Because of this, when two unstable atoms come into contact, a chemical reaction often takes place that causes both atoms to form a chemical bond and, in the process, become stable. Almost everything a person sees or touches in daily life—the air we breathe (a mixture of O_2, N_2 & other gases), the food we eat, the clothes we wear, and so on—is the result of a chemical bond between two or more atoms. As stated above, the world is generally not composed of isolated atoms; rather, atoms bond to one another to form chemical compounds or molecules. Not all chemical bonds are created equal: some are weak (such as the bonds in a sugar molecule) and some very strong, a difference that depends primarily on the interactions of the electrons between the atoms within the bond.

Stable: not easily changed or disturbed

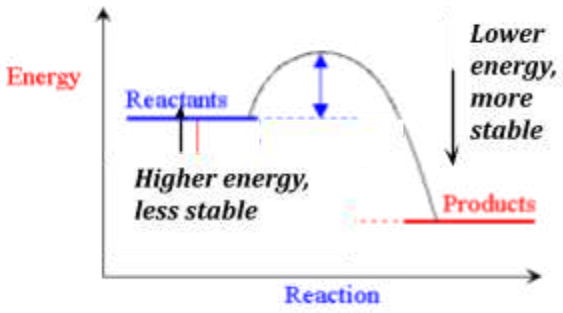
ignite*—to set on fire*

Q2: What does the phrase, *"the world is generally not composed of isolated atoms"* mean?

bond*—to join together*

Q3: According to the text, why do atoms form chemical bonds?

The Octet Rule—Stable Atoms

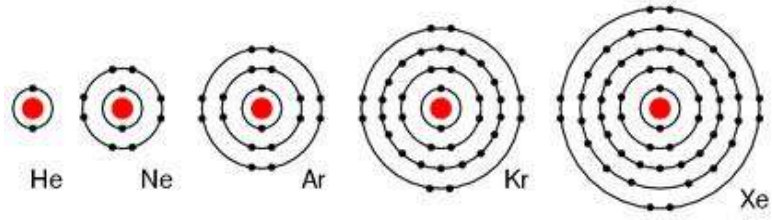


Stability in an atom depends on whether or not it has a full shell of valence electrons. An atom's stability is related to its energy; that is, lower energy states are more stable and higher energy states are not. The noble gases are the only

Q4: What does the word "inert" mean according to the text? How does "inert" describe the noble gases?

Name: **Date:** **Period:**

stable, low energy, **inert** (non-reactive) family of elements since they have a full shell of outer valence electrons. When atoms achieve a full valence shell, like the noble gases, they are said to have a stable **octet** of electrons. Since most of the atoms on the periodic table do not have a full outer shell of electrons, they are unstable and reactive by themselves. The **octet rule** states that atoms will become stable by gaining or losing electrons from other atoms in order to reach a full valence shell (like the noble gases).

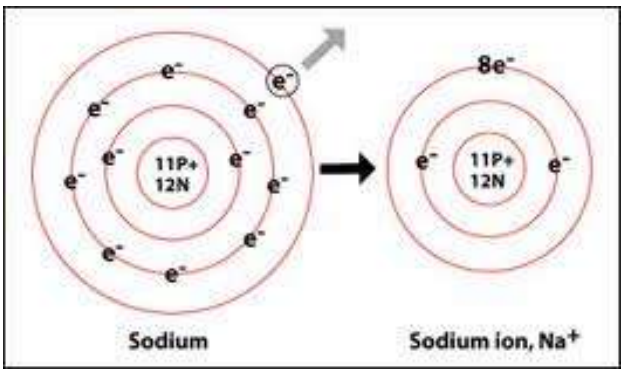


octet—*a group of eight*

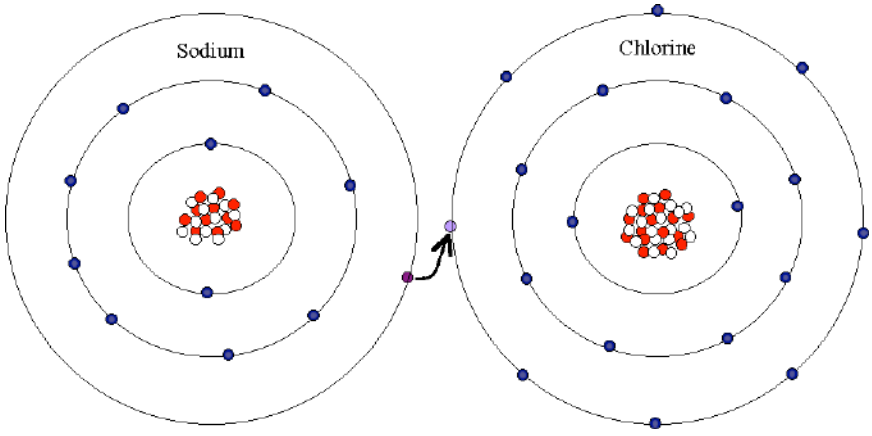
Q5: What is the octet rule in your own words? How do the noble gases exemplify the octet rule?

For instance, Group 1 elements (sometimes called alkali metals), such as sodium (Na), only have one valence electron and are therefore very unstable and reactive by themselves as can be observed in their explosive reactions with water. Since sodium (Na) has a very low ionization energy, in order to become stable, it tends to give its valence electron away in a reaction to a highly electronegative atom such as chlorine (Cl). When Na loses its outer electron in a reaction, it goes back to its last full stable valence shell (as seen in the picture above) thereby becoming stable. When the chlorine (Cl) atom takes sodium's (Na) electron, it also becomes stable (see picture below) since it also gains a full valence shell.

Q6: In your own words, explain what is happening to the unstable sodium atom when it becomes a sodium ion in the image & text to the left.



Q7: *How do unstable sodium and chlorine atoms work together to both become stable?*



Q8: How does the image to the left show evidence of the octet rule taking place?

Name: **Date:** **Period:**

Test Your Understanding:

To become stable, elements need a _____ valence shell and they will _____ or _____ electrons from other atoms to do so.

Practice: Fill in the charge information in the chart for the period 2 atoms below. Assume the atoms have neither gained or lost electrons.

Li	**Be**		**B**	**C**	**N**	**O**	**F**	**Ne**
								
p+ = +3 **e- = -3** **Charge =-3+3= 0**	**p+ =____** **e- =** **_____** **Charge =** **_____**		**p+ =____** **e- =** **_____** **Charge =** **_____**	**p+ =____** **e- =** **_____** **Charge =** **_____**	**p+ =____** **e- =** **_____** **Charge =** **_____**	**p+ =____** **e- =** **_____** **Charge =** **_____**	**p+ =____** **e- =** **_____** **Charge =** **_____**	**p+ =____** **e- =** **_____** **Charge =** **_____**

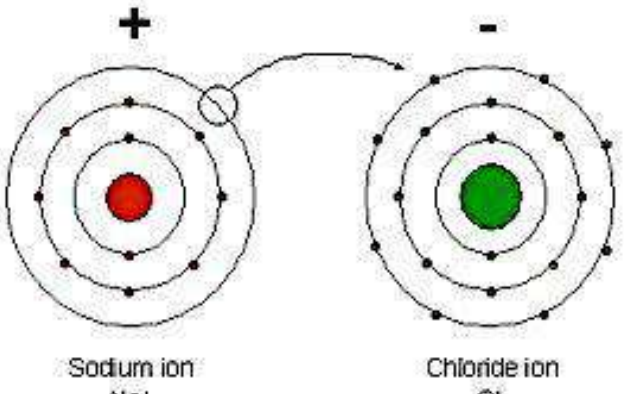
Reading cont…

***Vocabulary definitions* & Questions to consider as you read:**

Ions vs. Atoms

A neutral atom has the same number of electrons outside of its nucleus as it has protons inside. Because of this, the negative electron charge cancels the positive proton charge, making individual atoms neutral as you observed in the practice chart above (ie: sodium has 11p+ and 11e- so it's overall charge is zero). However, when an atom *loses or gains* one or more of its valence electrons to acquire a full, stable octet like the noble gases, the charges of the electrons and protons no longer cancel out. When this happens, the atom becomes a charged (+ or -) particle called an **ion.**

Q9: Why do atoms form ions? Why don't they just stay neutral atoms according to the text?



For example, the weakly electronegative atom sodium (Na), which in its neutral form contains 11 protons and 11 electrons, often *loses* its one valence electron to form the ion Na^{+1}. The sodium ion still contains 11 protons (p+ never

Q: How does Na become Na^{+1}?

Name: **Date:** **Period:**

change) but only 10 electrons, resulting in a +1 charge. Positively charged ions such as Na^{+1} are called **cations**. *Cations are smaller* than their original atom because they have lost the electrons from their outer electron shell causing them to shrink slightly. On the other hand, an electronegative atom such as Chlorine (Cl) will *gain* extra electrons to complete its valence shell (it already has 7 v.e-). The extra electron results in 17 protons and 18 electrons in fluorine (+17 -18 = -1), so it becomes a negatively charged ion, Cl^{-1}. Negatively charged ions, like Cl^{-1}, are called **anions**. An *anion is slightly larger* than its original atom due to the fact that it has added an electron to its outer shell.

Q: Compare **cations** with **anions**. How are they similar? Different?

Practice: Fill in the charge information in the chart for the period 2 atoms below. Make sure the outermost electron shell is full.

These atoms lose electrons to get a full valence shell. Fill in only the first shell.				**Skip Carbon**	**These atoms gain electrons to get a full valence shell. Fill in the first and second shell.**			
Li  **p+ = +3 e- = -2 Charge =-2+3= +1**	**Be**  **p+ =____ e- = _____ Charge = _____**		**B**  **p+ =____ e- = _____ Charge = _____**	**Carbon will not form ions.**	**N**  **p+ =____ e- = _____ Charge = _____**	**O**  **p+ =____ e- = _____ Charge = _____**	**F**  **p+ =____ e- = _____ Charge = _____**	**Ne**  **p+ =____ e- = _____ Charge = _____**

Test Your Understanding:

An Ion is an atom that _____ or _____ valence electrons to get a full **octet**.

Cations _____ (loses/gains) electrons and become _____(positive/negative) charged ions, which are _____(larger/smaller) than their original atom.

Anions _____ (loses/gains) electrons and become _____(positive/negative) charged ions, which are _____(larger/smaller) than their original atom.

Name: **Date:** **Period:**

Cations & Anions

Element	Number of Protons	Number of Electrons	Metal or Nonmetal?	High or Low E.N?	# of Valence e-	Gain or Lo se e-?	What is the ion formed?	Cation or Anion?
Ex. Sodium	*11+*	*11-*	*Metal*	*High*	*1*	*Lose*	*Na^{+1}*	*Cation*
Magnesium								
Iodine								
Nitrogen								
Potassium								
Fluorine								
Francium								
Radium								
Indium								
Thallium								
Tellurium								
Arsenic								
Phosphorus								
*Argon								
Sulfur								