Name _____ Date _____ Class _____

Assess Your Understanding

Atoms, Bonding, and the Periodic Table

What Determines an Element's Chemistry?

1a. DEFINE What are valence electrons? _____

_____

b. EXPLAIN Why do the properties of elements change in a regular way across a period? _____

_____

_____

c. RELATE CAUSE AND EFFECT Explain the reactivity of the noble gases in terms of valence electrons. _____

_____

_____

_____

got it?

○ **I get it!** Now I know that the chemical properties of an element are determined by _____

_____

○ **I need extra help with** _____

_____

Name _____ Date _____ Class _____

Key Concept Summary

Atoms, Bonding, and the Periodic Table

What Determines an Element's Chemistry?

An atom's electrons are found in different energy levels. **Valence electrons** have the highest energy. Each element has a specific number of valence electrons, from 1 to 8. **The number of valence electrons in the atoms of an element determines that element's chemical properties.**

An **electron dot diagram** includes the symbol for an element surrounded by dots. Each dot represents one valence electron. Atoms with 8 valence electrons tend to be more stable, so in forming compounds, atoms tend to obtain 8 valence electrons. Valence electrons may be transferred or shared. A **chemical bond** is the force of attraction that holds 2 atoms together as a result of the arrangement of electrons between them.

The periodic table includes rows, called periods, and columns, called groups. The atomic number increases from left to right across each period, as does the number of valence electrons. The first element in each period has 1 valence electron. The last element (except Period 1) has 8 valence electrons. Because elements within a group (except Period 1) have the same number of valence electrons, they have similar properties.

Except for helium, each of the Group 18 elements, the noble gases, has 8 valence electrons. They are stable, unlikely to gain, lose, or share electrons, and do not react easily with other elements. Metal atoms react by losing their valence electrons. A metal's reactivity depends on how easily it loses valence electrons. In general, reactivity decreases from left to right across the periodic table. Nonmetals become stable when their atoms gain or share enough electrons to have 8 valence electrons. Nonmetals usually combine with metals by gaining electrons, but can also combine with other nonmetals and metalloids by sharing. The metalloids, which lie between metals and nonmetals in the periodic table, can either lose or share electrons. They have some properties of both metals and nonmetals.

Hydrogen is placed in Group 1 because it has one valence electron, but it is considered a nonmetal. Its properties differ greatly from those of the other elements in Group 1. When it combines with other nonmetals, hydrogen shares its electron and forms a stable arrangement of 2 electrons.

On a separate sheet of paper, use the periodic table to create electron dot diagrams for barium (Ba), carbon (C), cesium (Cs), iodine (I), krypton (Kr), phosphorus (P), and strontium (Sr).

Place the outside corner, the corner away from the dotted line, in the corner of your copy machine to copy onto letter-size paper.

Name _____ Date _____ Class _____

Lesson Quiz

Atoms, Bonding, and the Periodic Table

If the statement is true, write *true*. If the statement is false, change the underlined word or words to make the statement true.

1. _____ An atom's valence electrons are those electrons that have the highest energy.

2. _____ Atoms tend to be stable and nonreactive if they have six valence electrons.

3. _____ In the periodic table, the number of valence electrons in each element decreases from left to right across each period.

4. _____ The reactivity of a metal depends on how easily it loses its valence electrons.

5. _____ Within each period in the periodic table, elements have similar properties because they have the same number of valence electrons.

Fill in the blank to complete each statement.

6. The number of _____ in the atom of an element determines its chemical properties.

7. The columns in the periodic table are called _____.

8. A(n) _____ shows the number of valence electrons in an atom in pictorial fashion.

9. The attractive force that holds two atoms together is called a(n) _____.

10. Because it can either lose or share electrons when it combines with other elements, each _____ has some of the properties of metals and some of the properties of nonmetals.

Name _____ Date _____ Class _____

Assess Your Understanding

Ionic Bonds

How Do Ions Form?

1a. REVIEW An atom that loses a valence electron becomes a (positive/negative) ion. An atom that gains a valence electron becomes a (positive/negative) ion.

b. APPLY CONCEPTS Write the symbols for the ions that form when potassium and iodine react to form the ionic compound potassium iodide. _____

c. RELATE CAUSE AND EFFECT Why is potassium iodide electrically neutral? _____

_____

got it?

○ **I get it!** Now I know ions form when _____

_____

○ **I need extra help with** _____

_____

How Are the Formulas and Names of Ionic Compounds Written?

2a. EXPLAIN The formula for sodium sulfide is Na_2S. Explain what this formula means. _____

_____

b. APPLY CONCEPTS Write the formula for calcium chloride. Explain how you determined this formula. _____

_____

_____

got it?

○ **I get it!** Now I know that to write the formula for an ionic compound, _____

_____

_____

○ **I need extra help with** _____

_____

Place the outside corner, the corner away from the dotted line, in the corner of your copy machine to copy onto letter-size paper.

Name _____ Date _____ Class _____

Assess Your Understanding

Ionic Bonds

What Are Properties of Ionic Compounds?

3a. REVIEW Ionic bonds are strong enough to cause all ionic compounds to be _____ at room temperature.

b. RELATE CAUSE AND EFFECT Solid table salt does not conduct electric current. How does dissolving salt in water allow electric current to flow? _____

got it?

○ **I get it!** Now I know that properties of ionic compounds include _____

○ **I need extra help with** _____

Name _____ Date _____ Class _____

Ionic Bonds

How Do Ions Form?

When an atom loses a valence electron, it loses a negative charge and becomes a positive ion. When an atom gains an electron, it gains a negative charge and becomes a negative ion. An **ion** is an atom or group of atoms that has an electric charge; it does not have the same number of protons and electrons. Positive and negative ions attract each other because oppositely charged particles attract. The attraction between two oppositely charged ions is called an **ionic bond,** and the substance formed is called an **ionic compound.** Ions that are made of more than one atom are called **polyatomic ions.** Ions are usually formed by the elements on the edges of the periodic table, those in Groups 1, 2, 16, and 17. Remember that Group 18 elements have eight valence electrons and are stable.

How Are the Formulas and Names of Ionic Compounds Written?

A **chemical formula** is not unlike a formula in mathematics; it is a combination of symbols that shows the ratio of elements in a compound. For example, the formula for sodium chloride is NaCl. **To write the formula for an ionic compound write the symbol of the positive ion and then the symbol of the negative ion. Add the subscripts that are needed to balance the charges. For an ionic compound, the name of the positive ion comes first, followed by the name of the negative ion.**

What Are Properties of Ionic Compounds?

In general, ionic compounds form hard, brittle crystals that have high melting points. When dissolved in water or melted, they conduct electric current. The attraction between ions is very strong, so it takes a lot of energy to break the bond—in other words, ionic compounds generally have high melting points. When ionic compounds dissolve in water, they become ions again. The charged particles carry electric current where the neutral ionic crystals do not.

A fluorine (F) ion has a charge of 1–. An aluminum (Al) ion has a charge of 3+. On a separate sheet of paper, explain how fluorine and aluminum would exchange valence electrons to form an ionic compound. Then write the compound's chemical formula and name the compound.

Name _____ Date _____ Class _____

Lesson Quiz

Ionic Bonds

Write the letter of the correct answer on the line at the left.

1. ___ Ionic bonds form between two ions that have
   A ionic compounds
   B negative charges
   C positive charges
   D opposite charges

2. ___ Ions that are made of more than one atom are called
   A ionic compounds
   B crystals
   C polyatomic atoms
   D ionic bonds

3. ___ Which is most likely to form a negative ion?
   A an element from Group 17
   B a metal
   C an element from Group 1
   D an element with atoms that have eight valence electrons

4. ___ Which of the following is the correct name for $MgCl_2$?
   A magnesium chlorine
   B magnesium dichlorine
   C magnesium chloride
   D magnesium dichloride

Fill in the blank to complete each statement.

5. A(n) _____ is an atom or group of atoms that has an electric charge.

6. The attraction between oppositely charged ions is called a(n) _____ _____.

7. When an atom loses a valence electron, it becomes a(n) _____ ion.

8. In order to have a stable arrangement of 8 valence electrons, metal atoms are likely to _____ electrons.

9. In an ionic compound, the total positive charge of all the positive ions _____ the total negative charge of all the negative ions.

10. Because the force of attraction between the positive and negative ions is so strong, ionic compounds have _____ melting points.

Name _____ Date _____ Class _____

Assess Your Understanding

Covalent Bonds

How Are Atoms Held Together in a Covalent Bond?

got it?

○ **I get it!** Now I know that the atoms in a covalent bond are held together by _____

_____

_____

○ **I need extra help with** _____

_____

What Are Properties of Molecular Compounds?

got it?

○ **I get it!** Now I know that properties of molecular compounds include _____

_____

_____

○ **I need extra help with** _____

_____

Name _____ Date _____ Class _____

Assess Your Understanding

Covalent Bonds

How Do Bonded Atoms Become Partially Charged?

1a. REVIEW What type of bonds are formed when atoms share electrons unequally? _____

_____

b. PREDICT Would carbon dioxide or water have a higher boiling point? Explain. _____

_____

_____

_____

c. ANSWER How can bonding determine the properties of a substance? _____

_____

_____

_____

_____

_____

got it?

○ **I get it!** Now I know that some atoms in covalent bonds become slightly negative or slightly positive when _____

_____

○ **I need extra help with** _____

_____

Place the outside corner, the corner away from the dotted line, in the corner of your copy machine to copy onto letter-size paper.

Name _____ Date _____ Class _____

Key Concept Summaries

Covalent Bonds

How Are Atoms Held Together in a Covalent Bond?

When two atoms share electrons (instead of gaining and losing them), the chemical bond is called a **covalent bond. The attraction between the shared electrons and the protons in each atom's nucleus hold the atoms together in a covalent bond.** The substance formed by a covalent bond is called a **molecule.** If two atoms share *two* pairs of electrons, the bond is called a **double bond.** If the two atoms share *three* pairs of electrons, the bond is called a **triple bond.** A molecule can include more than two atoms and therefore a number of different bonds.

What Are Properties of Molecular Compounds?

A **molecular compound** is a compound that is composed of molecules. Water, plastic, and rubber are all molecular compounds. Molecular compounds usually form from elements that are more in the middle of the periodic table, instead of on the edges. **Unlike ionic compounds, molecular compounds usually do not conduct electric current when melted or dissolved in water. Also, compared to ionic compounds, molecular compounds generally have lower melting points and boiling points.** There are no charged particles available to move in molecular compounds, so they don't carry current well. In molecular solids, forces hold the molecules close to one another. But the forces between molecules are much weaker than the forc between ions. That's why the melting points of molecular solids are generally much lower than thc of ionic solids.

How Do Bonded Atoms Become Partially Charged?

Unequal sharing of electrons causes covalently bonded atoms to have slight electric charges. These charges are not as strong as the charges on ions. A covalent bond in which atoms are shared equally, such as H_2, is a **nonpolar bond.** A covalent bond in which one atom pulls harder on the electrons than the other atom, such as HF, is a **polar bond.** Polar bonds can create polar molecules—molecules that have positively charged ends and negatively charged ends. These polar molecules have stronger intermolecular forces (forces *between* molecules) than nonpolar molecules.

On a separate sheet of paper, compare and contrast carbon dioxide and water. Be sure to fully describe the types of bonds involved, and compare and contrast the properties of the compounds.

Place the outside corner, the corner away from the dotted line, in the corner of your copy machine to copy onto letter-size paper.

Name _____ Date _____ Class _____

Lesson Quiz

Covalent Bonds

Write the letter of the correct answer on the line at the left.

1. ___ In an electron dot diagram, two pairs of shared electrons represents a
   - A single bond
   - B double bond
   - C triple bond
   - D quadruple bond

2. ___ A nitrogen molecule (N_2) has one triple bond. How many electrons do the nitrogen atoms share?
   - A 1
   - B 3
   - C 4
   - D 6

3. ___ Compared to ionic compounds, molecular compounds generally have
   - A good conductivity
   - B greater densities
   - C more chemical bonds
   - D a low boiling point

4. ___ Compared to ionic compounds, molecular compounds generally have
   - A stronger chemical bonds
   - B poor conductivity
   - C a high melting point
   - D lower densities

If the statement is true, write *true*. If the statement is false, change the underlined word or words to make the statement true.

5. _____ The chemical bond formed when two atoms share electrons is called a(n) ionic bond.

6. _____ Covalent bonds usually form when a nonmetal combines with a(n) metal.

7. _____ A(n) ion is a neutral group of atoms joined by covalent bonds.

8. _____ If a molecule contains polar bonds, the molecule may or may not be polar overall.

9. _____ In a(n) polar bond, one atom pulls on the shared electrons more than the other atom.

10. _____ The forces between molecules are much stronger than the forces between ions.

Place the outside corner, the corner away from the dotted line, in the corner of your copy machine to copy onto letter-size paper.

Name _____ Date _____ Class _____

Assess Your Understanding

Bonding in Metals

What Is the Structure of a Metal Crystal?

got it?

○ **I get it!** Now I know that a metal crystal consists of _____

_____

○ **I need extra help with** _____

_____

What Are Properties of Metals?

1a. IDENTIFY What accounts for the properties of metals? _____

_____

b. EXPLAIN Explain why metals are good conductors of electric current. _____

_____

c. APPLY CONCEPTS Why is it safer to use a nonmetal mixing spoon when cooking something on a hot stove? _____

_____

_____

got it?

○ **I get it!** Now I know that properties of metals include _____

_____

○ **I need extra help with** _____

_____

Name _____ Date _____ Class _____

Key Concept Summaries

Bonding in Metals

What Is the Structure of a Metal Crystal?

Metal atoms lose electrons easily because their valence electrons are not strongly held. This results in a type of bonding that is characteristic of metals. Most metals are crystalline solids. **A metal crystal is composed of closely packed, positively charged metal ions. The valence electrons drift among the ions.** Each metal ion is held in place by a **metallic bond**—an attraction between a positive metal ion and the electrons surrounding it.

What Are Properties of Metals?

Metallic binding explains many of the properties of metals. **Properties of metals include luster, malleability, ductility, high electrical conductivity, and high thermal conductivity.** Each of these properties is related to the behavior of valence electrons in metal atoms.

Luster is shine and reflectivity. When light strikes valence electrons in polished metal, they absorb light and then re-emit the light. A material that is ductile can be pulled into thin strands. Something that is malleable can be rolled into thin sheets or beaten into complex shapes. Metals are both ductile and malleable because the positive metal ions are attracted to the loose electrons all around them rather than to other metal ions. Thermal conductivity is the transfer of thermal energy, or heat. Metals conduct heat easily because their valence electrons are free to move, conveying heat from warmer areas to cooler ones. When charged particles are free to move, they can conduct an electric current. Metals convey electric current easily because their valence electrons move freely among the atoms.

An **alloy** is a mixture made of two or more elements, at least one of which is a metal. Alloys are generally stronger and less reactive than the pure metals from which they are made. For example, while pure gold is shiny but soft, the gold alloys used in making jewelry—for example, gold mixed with a harder element such as copper or silver—are shiny and hard.

On a separate sheet of paper, explain how the behavior of valence electrons contributes to the following properties of metals: luster, malleability, ductility, high electrical conductivity, and high thermal conductivity.

Place the outside corner, the corner away from the dotted line, in the corner of your copy machine to copy onto letter-size paper.

Name _____ Date _____ Class _____

Lesson Quiz

Bonding in Metals

Write the letter of the correct answer on the line at the left.

1. ___ Why are alloys generally used to make everyday objects?

A Alloys are often stronger and less reactive than pure metals.

B Alloys have higher melting points than pure metals.

C Alloys are less expensive to produce than pure metals.

D Alloys have ionic bonds instead of metallic bonds.

2. ___ Metallic bonding is

A a type of covalent bond

B a type of ionic bond

C an attraction between positive and negative ions

D an attraction between positive ions and electrons

3. ___ Which of the following is NOT a property of metals?

A ductile

B good electrical conductor

C good thermal insulator

D malleable

4. ___ At room temperature, most metals are

A liquid

B solid

C gas

D an alloy

Fill in the blank to complete each statement.

5. An attraction between a positive metal ion and surrounding electrons is a(n) _____ bond.

6. Metals typically have _____ melting points.

7. The metal fins that cool a motorcycle's engine make use of the high _____ conductivity of metals.

8. Metals are often used to make wire because they are _____.

9. Metals are used in electrical wires because they have high _____ conductivity.

10. Nonmetals are unlikely to form metallic bonds because their _____ _____ are strongly held.