Score ____ / 100 pts.

Name _____
Class _____ Date _____

Atoms form bonds with other atoms by transferring or sharing electrons. The arrangement of electrons in an atom, particularly the valence electrons, determines how an atom can interact with other atoms.

The types of chemical bonds holding them together determine many of the physical properties of compounds. The formation of compounds results in a great diversity of matter from a limited number of elements.

STANDARD III: Students will understand chemical bonding and the relationship of the type of bonding to the chemical and physical properties of substances

1. Define the following:
    a. compound: combination of more than one element
    b. valence electrons: electrons found in the outermost energy level.
    c. ionic: bonding that involves the transfer of electrons to form ions, which are then attracted by electrostatic charge.
    d. covalent: bonding that involves two elements sharing electrons by overlapping orbitals.
    e. malleability: ability to shape or form a solid without breaking
    f. conductivity: ability to allow the flow of heat or electricity through a substance
    g. solubility: ability to dissolve into a substance
    h. polarity: where a molecule has an imbalance of charge resulting in one positive pole and a negative pole.
    i. matter: Stuff that has mass and takes up space
    j. law of conservation of mass/energy: energy and mass is conserved and cannot be created from nothing
    k. entropy: measure of how many ways energy can be distributed in a system. High entropy leads to high disorder, chaos, and results from high levels of freedom.
    l. chemical equation: a symbolic representation of a chemical reaction.
    m. endothermic: a process that draws energy in from its surroundings.
    n. exothermic: a process that releases energy out to the surroundings.

Objective 1 Analyze the relationship between the valence (outermost) electrons of an atom and the type of bond formed between atoms.

2. What is the difference between a physical property and a chemical property? Physical properties describe a substance without changing its make-up or composition. Chemical properties describe a substances characteristics that involve changes in make-up or composition.

3. What is a chemical bond? Name the three types of chemical bonds and describe them. Which bonds are the strongest? Chemical bonds are the electrostatic attractions between particles. Ionic bonds form as one particle loses electrons to become a positive ion, and bonds to another particle that has gained electrons to become a negative ion. Covalent bonding involves overlapping electron orbitals to share electrons between two particles. Metallic bonding involves delocalizing electrons throughout

a lattice to create a sea of electrons that contain metallic cations. Bond strength increase as the charge and attractive forces involved increase. The strongest bonds have the strongest attractive forces.

4. Which electrons are involved in bonding? What do we call these electrons? What is a quick way to find out how many of these electrons an atom has? Outer level electrons are involved in bonding. We call these electrons, valence electrons. Valence electrons can be determined by the group number of the element on the periodic table.

5. What is a "family" on the periodic table? What else do we call it? Why are these elements so similar to each other? Families are the groups or columns on the periodic table. Each member of a group has the same number of valence electrons and tend to have very similar bonding processes.

6. Which atoms form positive ions? (are happy to get rid of electrons) Why? How can you predict the charge the ion will have? Metallic atoms readily release electrons to form positive ions. The effective strength of the nucleus is weaker than other elements in the same period. The charge of an ion is determined by how many electrons are lost or gained in order to have the outer electron shell filled.

7. Which atoms form negative ions? (are happy to gain extra electrons) Why? How can you predict the charge the ion will have? Nonmetallic atoms form negative electrons. The effective strength of the nucleus is sufficient to attract the electrons needed to fill the outer electron shell. The charge is determined by how many electrons are needed to fill the outer shell.

8. What combinations of atoms tend to form ionic bonds? Where are they on the periodic table? Nonmetals form ionic bonds with metals. Nonmetals are above the staircase, metals below.

9. What combinations of atoms tend to form covalent bonds? Where are they on the periodic table? Nonmetals form covalent bonds with nonmetals. Nonmetals are found above the staircase.

10. What combinations of atoms tend to form metallic bonds? Where are they on the periodic table? Metallic bonds are formed between metals. Metals are found below the staircase.

Objective 2 Explain that the properties of a compound may be different from those of the elements or compounds from which it is formed.

11. In the chemical formula: $5\ Ca(OH)_2$
    a. What does the number 5 tell us? There are 5 total units of $Ca(OH)_2$
    b. What does the number 2 tell us? There are two hydroxide ions attached to the calcium
    c. What do the parenthesis tell us? There are multiple OH ions
    d. How many oxygen atoms do I have total? two from each unit for a total of 10.
    e. What is the molar mass of this substance? 73.088 g per mole
    f. What is the name of this substance? Calcium hydroxide

12. Name these compounds: a. CaO — Calcium hydroxide; b. $MgCl_2$ — Magnesium Chloride; c. Fe_2O_3 — Iron (iii) oxide

13. Write these formulas: a. Sodium Oxide — Na_2O; b. Potassium Bromide — KBr; c. Copper (II) Oxide — CuO

14. Name these compounds: a. CO_2 — Carbon dioxide; b. SO_3 — Sulfur trioxide; c. PCl_5 — phosphorus pentachloride

15. Write these compounds: a. Carbon Tetrachloride CCl_4 b. Nitrogen Trioxide NO_3
16. There are only about 100 known elements in the universe, yet there are BILLIONS of different substances. How is this possible? Every combination of substances is unique. For example, if we only use H and O, we could make many, many combinations: one H with one O, or two H with one O, etc.
17. H_2O (water) and H_2O_2 (hydrogen peroxide) are both made of hydrogen and oxygen. Do they behave the same? No, their bonding is different, composition is different, and properties are very different. Just because two compounds are made of similar atoms does that mean they will behave the same? No, behavior is determined by electron configurations, combinations and many other factors. Water and hydrogen peroxide have very different bonding, element combinations and other factors.(For example: H_2O and H_2O_2)
18. Water is made up of oxygen (a clear gas that loves to react) and hydrogen (a clear gas that loves to explode). Does water share these properties? No water puts out fire, hinders explosions. Does a compound have the same properties as the elements that it is made out of? No, as elements combine electron configurations change which results in a change in properties.

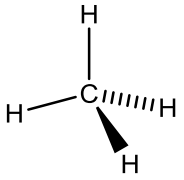
Objective 3 Relate the properties of simple compounds to the type of bonding, shape of molecules, and intermolecular forces.

19. Describe the basic physical properties of each type of solid (covalent, metallic, ionic) and explain WHY the solids behave this way based on their bonds. Covalent solids have low melting points, the attractions holding molecules together are relatively weak, based on partial charges due to polarity of the molecule. Ionic solids have very high melting points; the attractions holding ions together are due to full charges, the attractions are much stronger. Metallic solids have low to high melting points depending on how many electrons are let out in the electron sea; more electrons released result in stronger charges and bonding making melting points higher.

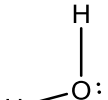
    Covalent solids do not conduct electricity when dissolved because they are not dissociated into ions. Ionic solids do conduct electricity when dissolved because they do dissociate into ions. The ions carry the current of the electricity.

    Metallic solids are malleable due to the give of the electron sea when force is applied. Ionic and covalent solids do not have this room to give and will shatter when force is applied.

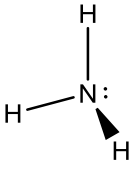
20. Draw Lewis Structures for water, methane, and ammonia. Predict their shapes based on your drawing. Methane, water, and ammonia, in order respectively.



Tetrahedral



Bent



Trigonal Pyramidal

21. What is polarity? State whether each of the above compounds will be polar and why. Polarity occurs when the distribution of charge in a molecule is uneven resulting in a positive pole or side and a negative pole or side. Methane is balanced symmetrically so it will be nonpolar. Water is not balanced, one side has lone pair electrons and the other has hydrogen atoms, it will be polar. The ammonia is the same, one part has a lone pair, and the other side has hydrogen atoms, it will be polar.

22. Water is very unique because it has lots and lots of lone pairs on one molecule attracted to the hydrogen atoms of another molecule forming hydrogen bonds. What is a hydrogen bond? it is where the polarity of molecules with nitrogen, oxygen, and fluorine bonded to hydrogen becomes very strong. This polarity results in the lone pair of one molecule attracting to the hydrogen of another molecule and forming a very strong attraction. How does it compare to REAL bonds? It is not as strong as a true ionic or covalent bond. How does it compare to other Intermolecular Forces? The attractions of hydrogen bonding is stronger than normal dipole attractions or dispersion attractions.

23. List 5 properties that water has BECAUSE of its hydrogen bonds and say why they are important to life on earth.

    Water has a much higher boiling point than other molecules of similar size. Water's strong attractions allow for increased capillary action. Its small size and strong attractions result in a very high specific heat, which results in its ability to retain heat for a long time. Water has a very strong surface tension. It is polar and is able to dissolve just about anything that has a charge. Cellular processes in living things depend greatly on the ability of water to dissolve other ions, and remain in the liquid state.