Types of Bonds Summary Sheet

A **bond** is when two or more atoms come together to share or transfer \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, allowing the atoms to gain full \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and become \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. The type of bond depends on the **electronegativity (EN)** of the atoms involved, which is the strength of the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ the atom’s nucleus has on \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

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| **Bond Type:** Ionic | **Bond Type:** Covalent | **Bond Type:** Metallic |
| **What happens:** A metal transfers one or more valence electrons to a non-metal, making two ions  **Why it happens:** The non-metal has a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ EN, which allows it to pull the electron away from the metal, which has a \_\_\_\_\_\_\_\_\_\_\_\_\_ EN. This gives the metal an \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ valence shell and the non-metal a \_\_\_\_\_\_\_\_\_\_\_\_ valence shell, making them both stable. The charged atoms then stick together due to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ attraction.  **Diagram:**  **Average EN:** Medium **EN Difference:** High | **What happens:** Two or more non-metals \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ valence electrons, completing their valence shells.  **Why it happens:** Both atoms have a very \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ EN, so they both pull on the electrons \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. The electron ends up \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ the two atoms, drawing the atoms together in to a bond.  **Diagram:**  **Average EN:** High **EN Difference:** Low | **What happens:** Two or more \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ donate their electrons to a “sea” of a electrons that floats freely around the metal nuclei.  **Why it happens:** Both atoms have a \_\_\_\_\_\_\_\_\_\_\_\_ EN, so \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of the atoms can pull electrons toward themselves. Instead, the electrons freely float around them, weakly attracted to the positively charged nuclei.  **Diagram:**  **Average EN:** Low **EN Difference:** Low |
| **Properties:**   * Powdery or crystalline solids at room temperature * Very high melting points (in the hundreds) and boiling points (in the thousands) * Brittle, crumble easily when hit * Most can dissolve in water * Electrolyte: Conduct electricity when they are dissolved in water, or when they are melted as a liquid, but do not conduct as a solid   + This is because they must be separated into ions to conduct electricity—this only happens as a liquid or when dissolved in water | **Properties:**   * Typically liquids or gases at room temperature (though some are solids) * Usually have low melting and boiling points (often below zero) * As a solid, some are brittle and crumble easily (like sulfur) while others are extremely hard and crystalline (like diamond) * Some dissolve in water, some do not * Do not conduct electricity in any form (except acids) | **Properties:**   * Almost always solids at room temperature * Tend to have high melting and boiling point (from hundreds to thousands of degrees) * Malleable & Ductile—they are easily molded into new shapes (or made into wires) without breaking * Do not dissolve in water * Conduct electricity as solids or liquids   + This is because the electrons are free to move around * Alloys: Mixture of metals end up with properties half way between the metals they are mixed with   + Example: Brass (Cu & Zn) or Steel (Fe & C) |

Practice Questions

For each of the following properties, identify the type(s) of bonds that have that property. (Covalent, metallic, ionic)

1. \_\_\_\_\_\_\_\_\_\_\_\_ conductor as a solid
2. \_\_\_\_\_\_\_\_\_\_\_\_ conduct electricity in water
3. \_\_\_\_\_\_\_\_\_\_\_\_ water soluble
4. \_\_\_\_\_\_\_\_\_\_\_\_ very high melting/boiling points
5. \_\_\_\_\_\_\_\_\_\_\_\_ often gases or liquids at room temperature
6. \_\_\_\_\_\_\_\_\_\_\_\_ usually solids at room temperature
7. \_\_\_\_\_\_\_\_\_\_\_\_ will not conduct electricity

Based on the elements in the following bonds (metals or non-metals or both), classify each of the following compounds as covalent, ionic, or metallic.

1. \_\_\_\_\_\_\_\_\_\_\_\_ CCl4
2. \_\_\_\_\_\_\_\_\_\_\_\_ Li2O
3. \_\_\_\_\_\_\_\_\_\_\_\_ NF3
4. \_\_\_\_\_\_\_\_\_\_\_\_ CaSO4
5. \_\_\_\_\_\_\_\_\_\_\_\_ SO2
6. \_\_\_\_\_\_\_\_\_\_\_\_ Al & Zn

Based on the average electronegativity and electronegativity difference, determine whether each of these bonds is non-polar covalent, polar covalent, or ionic. (Use the EN in the POGIL to help you!)

1. \_\_\_\_\_\_\_\_\_\_\_\_ H2
2. \_\_\_\_\_\_\_\_\_\_\_\_ PCl3
3. \_\_\_\_\_\_\_\_\_\_\_\_ F2
4. \_\_\_\_\_\_\_\_\_\_\_\_ NaBr
5. \_\_\_\_\_\_\_\_\_\_\_\_ NF3
6. \_\_\_\_\_\_\_\_\_\_\_\_ MgO

**Understanding Bond Types:**

1. If water does not conduct electricity, why do they make you get out of the pool when there is lightning?
2. Acetic acid has the formula HC2H3O2.
   1. Based on the elements it’s made of, what type of bond should it have? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
   2. Based on the average EN and difference in EN between oxygen and hydrogen, what kind of bond should it be? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
   3. Acetic acid is considered covalent, but it has some properties of ionic compounds. In water is breaks into ions and conducts electricity. Use EN to explain why this happens.
3. Metallic solids are good conductors of electricity, while covalent elements are not. Use structure of the bonds to explain this.