**Inter & Intra Molecular Forces Notes Outline**

**\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Forces are intermolecular forces; that is, they are attractions \_\_\_\_\_\_\_\_\_\_\_\_\_ neutral molecules**. They hold molecules \_\_\_\_\_\_\_\_\_\_\_\_\_\_ to make liquids or solids. They are the forces we break when we \_\_\_\_\_\_\_\_\_\_ or \_\_\_\_\_\_\_\_\_\_\_a substance. All van der Waals forces are \_\_\_\_\_\_\_\_\_\_\_compared to ionic bonds, covalent bonds, and metallic bonds.However, there is a wide range of strength in van der Waals forces depending upon the type of molecules they are holding together. **There are \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ interactions and \_\_\_\_\_\_\_\_\_\_\_\_\_\_bonds, which hold \_\_\_\_\_\_\_\_\_\_\_molecules to other polar molecules and are the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of the van der Waals forces. There are \_\_\_\_\_\_\_\_\_\_\_forces, which hold \_\_\_\_\_\_\_\_\_\_\_molecules to other nonpolar molecules and are the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ type of van der Waals forces.**

**\_\_\_\_\_\_\_\_\_\_\_\_\_ molecules (or dipoles) are molecules that do NOT have an even \_\_\_\_\_\_\_\_\_\_\_\_\_\_ of electrical charge.** One end of the molecule is partially \_\_\_\_\_\_\_\_\_\_\_, the other end partially \_\_\_\_\_\_\_\_\_\_\_. The partially positive end of one molecule is \_\_\_\_\_\_\_\_\_\_\_\_to the partially negative end of another molecule. **These attractions between polar molecules are called \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ interactions.**

**\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ bonds are a special kind of dipole-dipole interaction where the partially positive end of a molecule contains a \_\_\_\_\_\_\_\_\_\_\_\_ atom. Dipole-dipole interactions and hydrogen-bonds are the \_\_\_\_\_\_\_\_\_\_\_\_\_types of van der Waals forces.** Water is a compound that is considered the classic example of a substance containing hydrogen bonding. It is those hydrogen bonds that we are breaking when we melt or boil water.

There are \_\_\_\_\_\_\_\_ attractions that exist between nonpolar molecules; we know this because many substances that are made of nonpolar molecules are liquids or \_\_\_\_\_\_\_ melting point solids. If there were no attractions between the molecules they would \_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_ and the substance would be a gas. **The weak attractions between nonpolar molecules are called \_\_\_\_\_\_\_\_\_\_\_\_\_\_ forces and they are the weakest of the van der Waals forces.** They are extremely weak so nonpolar covalent substances are frequently gases as room temperature.

We believe that London forces (aka \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ forces) are the result of the weak, momentary attractions called instantaneous \_\_\_\_\_\_\_\_\_\_\_\_. **An instantaneous dipole is formed when \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_moving in a molecule get “off balance” for an instant so for that instant one end of the molecule is \_\_\_\_\_\_\_\_\_\_ and the other end is \_\_\_\_\_\_\_\_\_\_\_\_. This will cause charges in the neighboring molecules and set up a whole chain reaction of short-lived attractions.** As the electrons continue to move the charges even out again but the whole process happens many times per second in a sample of matter containing billions of molecules.

1. What are van der Waals forces?

1. What is a dipole?

1. What is a dipole-dipole force/interaction?

1. What is a hydrogen bond?

1. What are London forces?

1. Explain instantaneous dipoles.

Now that we know about intermolecular forces, we can expand the table from the previous worksheet:

|  |  |  |  |
| --- | --- | --- | --- |
| **Difference in electronegativity**  **(BIG – small)** | **Intramolecular Forces**  **(within ONE molecule)** | **Intermolecular Forces**  **(between MULTIPLE molecules)** | **Examples** |
| 0 - 0.49 | Nonpolar Covalent  (electrons are SHARED EQUALLY) | London Forces | O2 |
| 0.5 – 1.69 | Polar Covalent  (electrons are SHARED UNEQUALLY) | 1. Hydrogen Bonding (any polar molecules WITH HYDROGEN)    2. Dipole-Dipole (any polar molecule WITHOUT HYDROGEN) | H2O |
| 1.7 or greater | Ionic  (electrons are TRANSFERRED) | Ionic  (positive ions are attracted to negative ions) | NaCl |

Use your electronegatvity table and the chart above to answer the following questions:

1. Determine the INTRAmolecular force for the following compounds: (nonpolar covalent, polar covalent, ionic)

CH4=

CF4=

HI=

CO=

NH3=

NaCl=

2. How did you determine the intramolecular force for these compounds?

3. Determine the INTERmolecular force for the compounds above: (London forces, dipole-dipole, H bonding, ionic)

CH4=

CF4=

HI =

CO2=

NH3=

NaCl=

4. How did you determine the intermolecular force for these compounds?

**Inter & Intra Molecular Forces Notes Outline**

**- KEY**

**Van der Waals Forces are intermolecular forces; that is, they are attractions between neutral molecules**. They hold molecules together to make liquids or solids. They are the forces we break when we melt or boil a substance. All van der Waals forces are weak compared to ionic bonds, covalent bonds, and metallic bonds.However, there is a wide range of strength in van der Waals forces depending upon the type of molecules they are holding together. **There are dipole-dipole interactions and hydrogen bonds, which hold polar molecules to other polar molecules and are the strongest of the van der Waals forces. There are London forces, which hold nonpolar molecules to other nonpolar molecules and are the weaker type of van der Waals forces.**

**Polar molecules (or dipoles) are molecules that do not have an even distribution of electrical charge.** One end of the molecule is partially positive, the other end partially negative. The partially positive end of one molecule is attracted to the partially negative end of another molecule. **These attractions between polar molecules are called dipole-dipole interactions. Hydrogen bonds are a special kind of dipole-dipole interaction where the partially positive end of a molecule contains a hydrogen atom. Dipole-dipole interactions and hydrogen-bonds are the strongest types of van der Waals forces.** Water is a compound that is considered the classic example of a substance containing hydrogen bonding. It is those hydrogen bonds that we are breaking when we melt or boil water.

There are weak attractions that exist between nonpolar molecules; we know this because many substances that are made of nonpolar molecules are liquids or low melting point solids. If there were no attractions between the molecules they would fly apart and the substance would be a gas. **The weak attractions between nonpolar molecules are called London forces and they are the weakest of the van der Waals forces.** They are extremely weak so nonpolar covalent substances are frequently gases as room temperature. We believe that London forces (aka dispersion forces) are the result of the weak, momentary attractions called instantaneous dipoles. **An instantaneous dipole is formed when electrons moving in a molecule get “off balance” for an instant so for that instant one end of the molecule is positive and the other end is negative. This will cause charges in the neighboring molecules and set up a whole chain reaction of short-lived attractions.** As the electrons continue to move the charges even out again but the whole process happens many times per second in a sample of matter containing billions of molecules.

1. What are van der Waals forces?

**intermolecular forces that are attractions between neutral molecules**

1. What is a dipole?

**molecules that do not have an even distribution of electrical charge**

1. What is a dipole-dipole force/interaction?

**When the partially positive end of one molecule is attracted to the partially negative end of another molecule**

1. What is a hydrogen bond?

**a special kind of dipole-dipole interaction where the partially positive end of a molecule contains a hydrogen atom**

1. What are London forces?

**The weak attractions between nonpolar molecules**

1. Explain instantaneous dipoles.

**Instantaneous dipoles are formed when electrons moving in a molecule get “off balance” for an instant so for that instant one end of the molecule is positive and the other end is negative**

Now that we know about intermolecular forces, we can expand the table from the previous worksheet:

|  |  |  |  |
| --- | --- | --- | --- |
| **Difference in electronegativity**  **(BIG – small)** | **Intramolecular Forces**  **(within ONE molecule)** | **Intermolecular Forces**  **(between MULTIPLE molecules)** | **Examples** |
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| 0.5 – 1.69 | Polar Covalent  (electrons are SHARED UNEQUALLY) | 1. Hydrogen Bonding (any polar molecules WITH HYDROGEN)    2. Dipole-Dipole (any polar molecule WITHOUT HYDROGEN) | H2O |
| 1.7 or greater | Ionic  (electrons are TRANSFERRED) | Ionic  (positive ions are attracted to negative ions) | NaCl |

Use your electronegatvity table and the chart above to answer the following questions:

1. Determine the INTRAmolecular force for the following compounds: (nonpolar covalent, polar covalent, ionic)

CH4=

**C – 2.5 2.5 – 2.1 = 0.4**

**H – 2.1 Nonpolar Covalent**

CF4=

**C – 2.5 4.0 – 2.5 = 1.5**

**F – 4.0 Polar Covalent**

HI=

**H – 2.1 2.7 – 2.1 = 0.6**

**I – 2.7 Polar Covalent**

CO=

**C – 2.5 3.5 – 2.5 = 1.0**

**O – 3.5 Polar Covalent**

NH3=

**N – 3.0 3.0 – 2.1 = 0.9**

**H – 2.1 Polar Covalent**

NaCl=

**Na – 0.9 3.0 – 0.9 = 2.1**

**Cl – 3.0 Ionic**

2. How did you determine the intramolecular force for these compounds?

**By looking at the difference in their electronegativity and comparing it to the table above**

3. Determine the INTERmolecular force for the compounds above: (London forces, dipole-dipole, H bonding, ionic)

CH4=

**C – 2.5 2.5 – 2.1 = 0.4**

**H – 2.1 London Forces**

CF4=

**C – 2.5 4.0 – 2.5 = 1.5**

**F – 4.0 Dipole-Dipole**

HI=

**H – 2.1 2.7 – 2.1 = 0.6**

**I – 2.7 Hydrogen Bonding**

CO=

**C – 2.5 3.5 – 2.5 = 1.0**

**O – 3.5 Dipole-Dipole**

NH3=

**N – 3.0 3.0 – 2.1 = 0.9**

**H – 2.1 Hydrogen Bonding**

NaCl=

**Na – 0.9 3.0 – 0.9 = 2.1**

**Cl – 3.0 Ionic**

4. How did you determine the intermolecular force for these compounds?

**By looking at the difference in their electronegativity and comparing it to the table above**