***AP Chemistry***

Intermolecular Attractions

The purpose of this activity is to compare and contrast the different types of intermolecular attractions. Students will work in expert groups to learn about one type of intermolecular attraction, and then teach about that intermolecular attraction to the other students in their base groups. At the end of class, you should be able to determine the types of intermolecular attractions that are possible for a particular compound and use this information to compare physical properties such as boiling points or melting points for a set of substances.

Base Group: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Intermolecular forces** are the attractions between molecules. They hold stable molecules or compounds to each other. Unlike chemical bonds, you can overcome them by adding energy to the system without changing the chemical nature of the substance. Ice, liquid water and steam are all chemically H20. The differences in their states of matter are possible because of energy's effect on the intermolecular forces that attract individual water molecules to each other. Watch a [quick video recap](http://www.youtube.com/watch?v=GnswLP4t6d0&feature=related)

Split up into expert groups:

Expert Group: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

As a group, use the available resources to prepare a description of the intermolecular attraction, an illustration of the attraction, and answers to the key questions. It isn’t necessary to use all of the available resources; however, you may find additional resources if needed! When you are done, return to your base groups. Base group members will take turns teaching about each of the intermolecular attractions. Then, group members will work together to complete the application questions.

**Expert Group 1: Dipole-Dipole Attractions**

**Resources:**

[**http://www.chem.purdue.edu/gchelp/liquids/disperse2.html**](http://www.chem.purdue.edu/gchelp/liquids/disperse2.html)

<http://www.cengage.com/chemistry/discipline_content/dvd/Power_Lectures/General_Chemistry/dswmedia/hmswf/flv/act081_media1.html> <https://chem.libretexts.org/Core/Physical_and_Theoretical_Chemistry/Physical_Properties_of_Matter/Atomic_and_Molecular_Properties/Intermolecular_Forces/Specific_Interactions/Dipole-Dipole_Interactions>

<http://butane.chem.uiuc.edu/pshapley/Enlist/Labs/LiquidSol/LiquidSol.html> <http://chemistry.elmhurst.edu/vchembook/163boilingpt.html>

1. Illustration:
2. What type of attraction is the basis for your IMF?
3. Is your IMF weak, strong or somewhere in between? WHY?

1. What types of common substances are held together by your IMF? (Common, real world example, please!)
2. How does your IMF directly affect and/or explain a substance’s physical properties?

**Expert Group 2: Hydrogen Bonding**

**Resources:**

[**http://www.chemguide.co.uk/atoms/bonding/hbond.html**](http://www.chemguide.co.uk/atoms/bonding/hbond.html)

[**http://www.chem.purdue.edu/gchelp/liquids/hbond2.html**](http://www.chem.purdue.edu/gchelp/liquids/hbond2.html)

<http://www.cengage.com/chemistry/discipline_content/dvd/Power_Lectures/General_Chemistry/dswmedia/hmswf/flv/act082_media1.html>

<http://www.chem.ucla.edu/~harding/IGOC/H/hydrogen_bond_acceptor.html> <http://chemistry.elmhurst.edu/vchembook/163boilingpt.html>

1. Illustration:
2. What type of attraction is the basis for your IMF?
3. Is your IMF weak, strong or somewhere in between? WHY?
4. What types of common substances are held together by your IMF? (Common, real world example, please!)
5. How does your IMF directly affect and/or explain a substance’s physical properties?

**Expert Group 3: Dipole-Induced Dipole Attractions**

**Resources:**

[**http://www.chem.purdue.edu/gchelp/liquids/inddip.html**](http://www.chem.purdue.edu/gchelp/liquids/inddip.html)

[**http://abetterchemtext.com/Condensed/dip\_induc.htm**](http://abetterchemtext.com/Condensed/dip_induc.htm)

<http://employees.oneonta.edu/viningwj/modules/CI_dipoleinduced_dipole_forces_13_5a.html>

1. Illustration:
2. What type of attraction is the basis for your IMF?
3. Is your IMF weak, strong or somewhere in between? WHY?
4. What types of common substances are held together by your IMF? (Common, real world example, please!)
5. How does your IMF directly affect and/or explain a substance’s physical properties?

**Expert Group 4 London forces (induced dipole-induced dipole)**

**Resources**

<https://www.chem.wisc.edu/deptfiles/genchem/netorial/rottosen/tutorial/modules/intermolecular_forces/02imf/imf4.htm>

[**http://www.chem.purdue.edu/gchelp/liquids/disperse.html**](http://www.chem.purdue.edu/gchelp/liquids/disperse.html)

<http://www.cengage.com/chemistry/discipline_content/dvd/Power_Lectures/General_Chemistry/dswmedia/QuickTime_Movies/flv/13m05an3.html> [**http://chemsite.lsrhs.net/bonding/LondonDispersion.html**](http://chemsite.lsrhs.net/bonding/LondonDispersion.html)

[**http://www.chemhelper.com/molatt.html**](http://www.chemhelper.com/molatt.html)

1. llustration:
2. What type of attraction is the basis for your IMF?
3. Is your IMF weak, strong or somewhere in between? WHY?
4. Key term: What is polarizability, and how does it relate to London forces?
5. What types of common substances are held together by your IMF? (Common, real world example, please!)
6. How does your IMF directly affect and/or explain a substance’s physical properties?

Need more information?

<http://chemistry.elmhurst.edu/vchembook/160Aintermolec.html>

<http://chemistry.bd.psu.edu/jircitano/IMforces.html>

<http://www.docbrown.info/page07/equilibria8a.htm>

<https://www.chem.fsu.edu/chemlab/chm1046course/interforces.html>

<https://opentextbc.ca/chemistry/chapter/10-1-intermolecular-forces/>

Application Questions

1. Skim the following article. Why is this so exciting to chemists?

<http://www.rsc.org/chemistryworld/2013/09/first-pictures-hydrogen-bonds-unveiled-afm>

1. Consider the following six choices below:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| A. | ionic bond | D. | dispersion (London) forces | G. metallic bond |
| B. | polar covalent bond | E. | dipole-dipole forces | H. ion-dipole forces |
| C. | nonpolar covalent bond | F. | hydrogen bond |  |

Give the letter(s) for the type of bond or intermolecular force described for each of the following. A choice may be used once, more than once, or not at all.

1. \_\_\_\_\_\_ What holds two I2 molecules together in a sample of I2*(s)*?
2. \_\_\_\_\_\_ What holds atoms together in HF?
3. \_\_\_\_\_\_ What holds atoms together in a hydrogen molecule?
4. \_\_\_\_\_\_ What holds atoms together in AgCl?
5. \_\_\_\_\_\_ What holds two fluorine molecules together in a sample of liquid fluorine?
6. \_\_\_\_\_\_ What holds two ammonia molecules together in a sample of liquid NH3?
7. \_\_\_\_\_\_ What must be overcome to boil water?
8. \_\_\_\_\_\_ What must be broken to melt Al2O3*(s)*?
9. \_\_\_\_\_\_ Dry ice is CO2*(s)*. Because dry ice does not exist as a liquid under normal

conditions, it sublimes when heated. What must be overcome when dry ice sublimes?

1. Circle the ***all*** of the intermolecular forces that exist between molecules for the following samples. (Hint—draw Lewis structures!)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| i. | water: | London forces | dipole-dipole forces | hydrogen bonds |
| ii. | methane: | London forces | dipole-dipole forces | hydrogen bonds |
| iii.iv. v.  e. | CH2O: SF4:  CH2F2: | London forces  London forces  London forces | dipole-dipole forces dipole-dipole forces  dipole-dipole forces | hydrogen bonds hydrogen bonds  hydrogen bonds |

1. Rank the following substances in terms of increasing boiling point:

**water, CH2O, methane, CO2**

**< < <**

lowest b.p. highest b.p.