Lesson plan: Intermolecular Forces Review
FOR THE TEACHER

Summary
In this lesson plan, students will review concepts of intermolecular forces.

Grade Level
High school

AP Chemistry Curriculum Framework
- **Big Idea 2:** Chemical and physical properties of materials can be explained by the structure and the arrangement of atoms, ions, or molecules and the forces between them.
  - **2.1** Students can predict properties of substances based on their chemical formulas and provide explanations of their properties based on particle views.
  - **2.3** The student is able to use aspects of particulate models (i.e., particle spacing, motion, and forces of attraction) to reason about observed differences between solid and liquid phases and among solid and liquid materials.
  - **2.11** The student is able to explain the trends in properties and/or predict properties of samples consisting of particles with no permanent dipole on the basis of London dispersion forces.
  - **2.13** The student is able to describe the relationships between the structural features of polar molecules and the forces of attraction between the particles.
  - **2.23** The student can create a representation of an ionic solid that shows essential characteristics of the structure and interactions present in the substance.
  - **2.24** The student is able to explain a representation that connects properties of an ionic solid to its structural attributes and to the interactions present at the atomic level.
  - **2.30** The student is able to explain a representation that connects properties of a covalent solid to its structural attributes and to the interactions present at the atomic level.
  - **2.31** The student can create a representation of a molecular solid that shows essential characteristics of the structure and interactions present in the substance.
  - **2.32** The student is able to explain a representation that connects properties of a molecular solid to its structural attributes and to the interactions present at the atomic level.

- **Big Idea 5:** The laws of thermodynamics describe the essential role of energy and explain and predict the direction of changes in matter.
  - **5.9** The student is able to make claims and/or predictions regarding relative magnitudes of the forces acting within collections of interacting molecules based on the distribution of electrons within the molecules and the types of intermolecular forces through which the molecules interact.
  - **5.10** The student can support the claim about whether a process is a chemical or physical change (or may be classified as both) based on whether the process involves changes in intramolecular versus intermolecular interactions.
  - **5.11** The student is able to identify the noncovalent interactions within and between large molecules, and/or connect the shape and function of the large molecule to the presence and magnitude of these interactions.

Objectives
By the end of this lesson, students should be able to
- List the five types of intermolecular forces.
- Explain London dispersion forces.
- Explain dipole-induced dipoles.

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Thanks to:
Flinn Scientific
• Explain dipole forces, hydrogen bonding, and ionic bonding.
• Distinguish between all of the above types of intermolecular forces.

Chemistry Topics
This lesson supports students’ understanding of
• Intermolecular forces
• Hydrogen bonding

Time
Teacher Preparation: 5 minutes
Lesson: 45 minutes

Safety
• There are no special safety considerations for this activity.

Teacher Notes
• This lesson is intended as a review of intermolecular forces.
• Go through the PowerPoint presentation as students fill in the correct answers on their student sheets.
• You may also have students research the answers on their own, and then check their answers with the PowerPoint presentation.

FOR THE STUDENT
Lesson

Student Activity Sheet: Intermolecular Forces

1. Intermolecular forces are interactions __________ two or more molecules or atoms.
   • IMF is based upon polarity and Coulomb's Law
   • The 5 intermolecular forces, in order of increasing strength (weakest to strongest) are:
   • The stronger the IMF, the greater the interaction between two particles, resulting in a higher melting point and boiling point since it would require more energy (in the form of heat or compression) to disrupt the intermolecular forces present between them and permit a phase change.

2. London dispersion forces
   • London dispersion forces are present between ALL substances (polar/ non-polar).
   • The only IMF that ____________ particles exhibit are LDF
   • As two particles get closer together, LDF interactions ___________ in strength
   • This is because as you decrease the distance of separation (r) between two particles, Coulombic repulsion of the two particles' electron cloud will force electron density to redistribute, inducing a temporary (or instantaneous) dipole in order to maximize attraction and minimize repulsion.
   • As you increase in molecular size (MW), the strength of LDF ______________
This is because as you increase in molecular weight, the molecule becomes larger. The larger the molecule, the larger the electron cloud, and therefore the greater the dispersion forces.

3. Dipole-induced dipole
   - Recall that non-polar substances do _____ have a dipole moment
   - When a polar particle approaches a non-polar particle, the polar substance ______ a temporary dipole on the non-polar particle that wasn’t there originally
   - This temporary dipole occurs in order to ________ Coulombic attraction and _________ Coulombic repulsion

4. Dipole forces
   - Recall that polar substances ______ dipole moments
   - Dipole forces are present between ____ polar substances
   - The _________ dipole on a polar molecule is Coulombically attracted to a positive dipole on another polar molecule
   - The _________ dipole on a polar molecule is Coulombically attracted to a negative dipole on another polar molecule

5. Hydrogen bonding
   - Hydrogen bonding is present when a polar substance has a H that is bonded to a highly __________ atom (i.e. N, O, or F)
   - H-bonding is extremely strong; so strong that it can stably maintain the structure of large macromolecules, such as proteins and nucleic acids

6. Ionic bonding
   - Recall, ions are ______ because they have a permanent dipole
   - Ionic bonds occur between a ______ and a __________ due to the TRANSFER of electrons, resulting in an ionic compound between two ions
   - Ionic bonding is present when there are metal and non-metal ions in solution
   - Ionic bonding is the ________ IMF, and nearly as strong as covalent bonding (the only intramolecular bond)