Solids, Liquids, and Intermolecular Forces **Name**_____

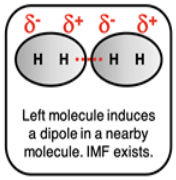
Intermolecular Forces

Read from **Lesson 1: Intermolecular Forces** in the **Chemistry Tutorial Section, Chapter 11** of **The Physics Classroom**: Part a: What are Intermolecular Forces? Part b: Types of Intermolecular Forces

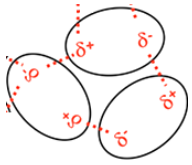
Intermolecular Forces (IMFs)
Intermolecular forces are the attractions between particles that determine the physical properties of substances like boiling point, melting point, and solubility.

There are three main types:

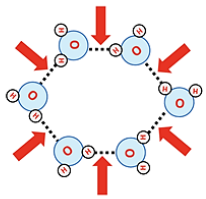
1. **London Dispersion Forces**
   - ↔ Definition: Weak attractions arising from temporary fluctuations in the electron cloud of atoms or molecules.
   - ↔ Applicable to: All atoms and molecules, particularly nonpolar ones. *This is the only intermolecular force that a nonpolar molecule will experience.*
   - ↔ Example: The weak attraction between N_2 molecules in the air.
   - ↔ Strength: Weakest IMF



2. **Dipole-Dipole Interactions**
   - ↔ Definition: Attractions between the positive end of one polar molecule and the negative end of another polar molecule.
   - ↔ Applicable to: Only polar molecules.
   - ↔ Example: Interactions between hydrogen chloride (HCl) molecules.
   - ↔ Strength: "Middlest" IMF



3. **Hydrogen Bonding**
   - ↔ Definition: A specific, stronger type of dipole-dipole attraction that occurs when hydrogen is bonded to nitrogen (N), oxygen (O), or fluorine (F).
   - ↔ Applicable to: Molecules containing **H–N**, **H–O**, or **H–F** bonds.
   - ↔ Example: Water (H_2O) molecules forming hydrogen bonds with one another.
   - ↔ Strength: Strongest IMF



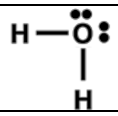
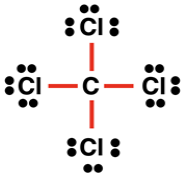
IMF Questions:

1. Explain the difference between a chemical bond and an intermolecular force. (*Use drawing and/or sentences to help with your answer.*)

2. Draw the Lewis structure for carbon dioxide and water. Explain why both molecules have polar bonds but only one molecule has dipole-dipole interactions. Which one? What IMFs do each molecule experience?

Solids, Liquids, and Intermolecular Forces

3. For each of the following compounds, 1) draw the Lewis structure. 2) determine the polarity of the bonds and the polarity of the molecules, and finally 3) determine the types of IMFs the compound would experience.

Compound	Lewis Structure	Polar Bonds (yes/no)	Polar Molecule (yes/no)	London Dispersion Forces Present	Dipole-Dipole Interactions Present	Hydrogen Bonding Present
H_2O		Yes	Yes	✓	✓	✓
CCl_4		Yes	No	✓		
NH_3						
HCN						
CO						
PCl_3						
C_2H_6						
SO_2						
OCl_2						

Solids, Liquids, and Intermolecular Forces

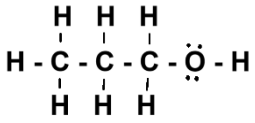
Compound	Lewis Structure	Polar Bonds (yes/no)	Polar Molecule (yes/no)	London Dispersion Forces Present	Dipole-Dipole Interactions Present	Hydrogen Bonding Present
CH_3OH						
$CHCl_3$						
C_2H_5F						

4. Identify the types of intermolecular forces for the compounds shown in each question. Then, list the compounds in order of increasing strength of intermolecular forces.
   a. 1-Chlorobutane $CH_3CH_2CH_2CH_2Cl$ Chloroethane CH_3CH_2Cl Carbon tetrachloride CCl_4

   b. Ammonia NH_3 Boron Trifluoride BF_3 Methane CH_4

5. Aaron Agin and Angel Alkane are discussing the structures of two isomers of C_3H_8O, 1-propanol and methyl ethyl ether. Aaron says that both 1-propanol and ether have London dispersion forces and dipole-dipole interactions. This is due to the fact that they have the same formula and have polar bonds. Angel agrees but states that 1-propanol also has hydrogen bonding present, but not ether. Who is correct and why? Explain your reasoning.

1-Propanol



Methyl Ethyl Ether