

Lecture 23
Intermolecular Forces I
Tutorial

- 1) For each pair of compounds listed below, identify the compound that has the highest boiling point, and explain why this is in terms of intermolecular forces.
- a. NH₃ and CH₄

NH₃ has London dispersion forces and hydrogen bonds.
CH₄ only has London dispersion forces, as it is non-polar.
Both species are approximately the same size, so their London dispersion forces are comparable. Hydrogen bonds are much stronger than London dispersion forces. As a greater amount of energy is required to break stronger forces of attraction, the boiling point of ammonia is higher.

- b. He and Ar

Both Helium and Argon have only London Dispersion forces. Since Argon is larger and has more electrons, it is more polarizable than Helium. Thus Argon experiences greater London dispersion forces. As a greater amount of energy is required to break stronger forces of attraction, the boiling point of Argon is higher.

- c. H₂O and H₂S

H₂O has London dispersion forces and hydrogen bonds.
H₂S has London dispersion forces and dipole-dipole forces.
Hydrogen bonds are much stronger than normal dipole-dipole forces. As a greater amount of energy is required to break stronger forces of attraction, the boiling point of H₂O is higher.

- d. CaOH or H₂O

H₂O has London dispersion forces and hydrogen bonds.
CaOH has ionic bonds.
Ionic bonds are much stronger than hydrogen bonds. As a greater amount of energy is required to break stronger forces of attraction, the boiling point of CaOH is higher.

- 2) Explain why Cl₂ is a gas and Br₂ is a liquid at 25°C and 1 atm.

Cl₂ and Br₂ are both non-polar and only have London dispersion forces. Br₂ is larger and has more electrons, making it more polarizable than Cl₂. Thus, Br₂ experiences greater London dispersion forces. Because of the stronger forces of attraction, Br₂ exists as a liquid at 25°C and 1 atm, while Cl₂ exists as a gas.

- 3) Explain why ethane C_2H_6 melts at $-183^\circ C$ and nonane C_9H_{20} melts at $-54^\circ C$.

C_2H_6 and C_9H_{20} are both non-polar and only have London dispersion forces. C_9H_{20} is larger and has more electrons, making it more polarizable than C_2H_6 . Thus, C_9H_{20} experiences greater London dispersion forces. Because of the stronger forces of attraction, C_9H_{20} requires more energy to melt than does C_2H_6 .

- 4) Explain why oxygen gas, O_2 , is able to dissolve in water.

Oxygen gas is a non-polar molecule, and water is a polar molecule. When oxygen gas dissolves in water, the polar water molecule induces a dipole in the non-polar oxygen molecule. The dipole-induced dipole forces of attraction are able to hold a small concentration of oxygen molecules in the water.