

Questions

- Why do some solids dissolve in water but others do not?
- Why are some substances gases at room temperature, but others are liquid or solid?
- What gives metals the ability to conduct electricity, what makes non-metals brittle?
- The answers have to do with ...

Intermolecular forces

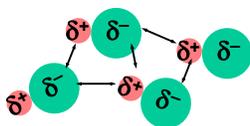
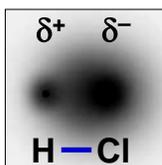
Intermolecular forces

Overview

- There are 2 types of attraction in molecules: intramolecular bonds & intermolecular forces
- We have already looked at intramolecular bonds (ionic, polar, non-polar)
- Intermolecular forces (IMF) have to do with the attraction between molecules (vs. the attraction between atoms in a molecule)
- IMFs come in six flavours: 1) ionic, 2) dipole - dipole, 3) H-bonding, 4) London forces, 5) covalent (network solids), 6) metallic

Ionic, Dipole - Dipole attractions

- We have seen that molecules can have a separation of charge
- This happens in both ionic and polar bonds (the greater the EN, the greater the dipoles)
- Molecules are attracted to each other in a compound by these +ve and -ve forces



H - bonding

- H-bonding is a special type of dipole - dipole attraction that is very strong
- It occurs when N, O, or F are bonded to H
- Q- Calculate the ΔEN for HCl and H₂O
- A-
- The high ΔEN of NH, OH, and HF bonds cause these to be strong forces (about 5x stronger than normal dipole-dipole forces)
- They are given a special name (H-bonding) because compounds containing these bonds are important in biological systems

London forces

- Non-polar molecules do not have dipoles like polar molecules. How, then, can non-polar compounds form solids or liquids?
- London forces are named after Fritz London (also called van der Waal forces)
- London forces are due to small dipoles that exist in non-polar molecules
- Because electrons are moving around in atoms there will be instants when the charge around an atom is not symmetrical
- The resulting tiny dipoles cause attractions between atoms/molecules
- Read 10.3 (pg. 351 - 355) and answer ...

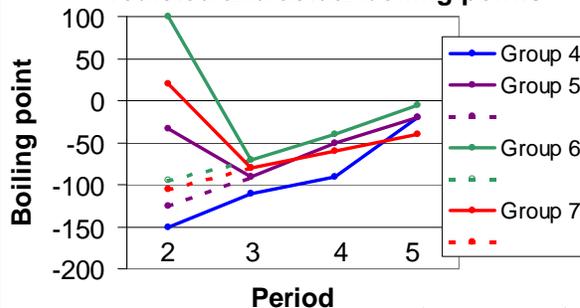
Testing concepts

1. Which attractions are stronger: intermolecular or intramolecular?
2. How many times stronger is a covalent bond compared to a dipole-dipole attraction?
3. What evidence is there that nonpolar molecules attract each other?
4. Which chemical in table 10.1 has the weakest intermolecular forces? Which has the strongest? How can you tell?
5. Suggest some ways that the dipoles in London forces are different from the dipoles in dipole-dipole attractions.
6. A) Which would have a lower boiling point: O₂ or F₂? Explain. B) Which would have a lower boiling point: NO or O₂? Explain.

7. Which would you expect to have the higher melting point (or boiling point): C₈H₁₈ or C₄H₁₀? Explain.
 8. What two factors causes hydrogen bonds to be so much stronger than typical dipole-dipole bonds?
 9. So far we have discussed 4 kinds of intermolecular forces: ionic, dipole-dipole, hydrogen bonding, and London forces. What kind(s) of intermolecular forces are present in the following substances: a) NH₃, b) SF₆, c) PCl₃, d) LiCl, e) HBr, f) CO₂ (hint: consider ΔEN and molecular shape/polarity)
- Challenge: Ethanol (CH₃CH₂OH) and dimethyl ether (CH₃OCH₃) have the same formula (C₂H₆O). Ethanol boils at 78 °C, whereas dimethyl ether boils at -24 °C. Explain why the boiling point of the ether is so much lower than the boiling point of ethanol.
- Challenge: try answering the question on the next slide.

H – bonding and boiling point

Predicted and actual boiling points



- See pg. 369 – Q – why does BP↑ as period ↑, why are some BP high at period 2?