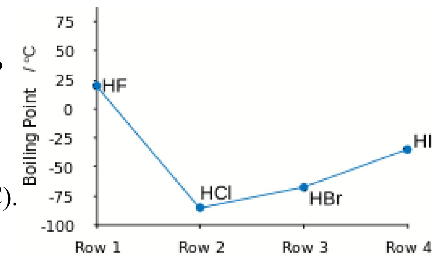
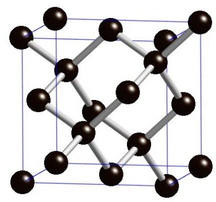
Intermolecular Forces of Attraction Questions

1. How are intramolecular and intermolecular forces of attraction different?
2. What impact does non-directional bonding have on aggregate structure?
3. Why do ionic solids continuously grow into larger and larger crystals?
4. How does the number of electrons present in an atom or molecule affect LDFs?
5. How does the size of a molecule affect LDFs?
6. Explain why melting point of elements **INCREASES** moving down a family.
7. How can a non-polar molecule possess a dipole?
8. Explain why CCl_4 has a higher boiling point than $CHCl_3$ (76.8°C versus 61.2°C).
9. Explain why frozen pipes burst.
10. Explain the adjacent graph depicting the boiling points of several molecules.
11. Explain why the boiling point of water substantially higher than the boiling point of HF.





Answers:

1. Intramolecular forces of attraction act to hold a particle together; whereas, intermolecular forces of attraction act to hold one particle to another particle. Intramolecular forces are typically much stronger than intermolecular forces. Intramolecular forces account for how a particle is constructed; whereas, intermolecular forces are largely responsible for the properties we observe. In an ionic compound, it is impossible to distinguish between the two as the forces are the same and so this represent an exception.
2. Non-directional bonding means that bonds holding the aggregate together are of equal strength in every direction which means the lattice is strongly held together.
3. Since ionic compounds have non-directional bonding, they easily and repeatedly attract more and more ions to the lattice.
4. More electrons = more LDFs (not stronger).
5. Greater size = more LDFs (not stronger).
6. More electrons and bigger size = more LDFs (not stronger) which makes it harder to separate them; therefore, higher melting point.
7. Due to the momentary unequal distribution of electrons within the molecule or the induction of momentary unequal distribution of electrons due to a neighbouring dipole.
8. Both molecules have a tetrahedral shape and have polar covalent bonds between carbon and chlorine. $CHCl_3$ is a polar molecule while CCl_4 is not (vectors cancel); therefore, you would expect $CHCl_3$ to have a higher boiling point because permanent dipole-dipole interactions. However, CCl_4 has 16 more electrons than $CHCl_3$ which means it has a greater number of LDFs, which in this case is more significant that the dipole-dipole interactions in $CHCl_3$ which is sufficient in this case to give CCl_4 a higher boiling point.
9. The extensive lattice of hydrogen bonded water molecules slowly compresses as the temperature drops, but at the moment when water freezes, the forces resisting the distortion of the lattice (due to multiple atomic repulsions and bond bending) repel the molecule suddenly and violently away from each other to actually occupy more space than the lattice did as a liquid and this new lattice gets frozen at the exact moment. As a result, the solid water occupies more space than the liquid and the pipes cannot hold the solid.
10. HF is smallest polar molecule with the fewest electrons, but it has hydrogen bonding which means it is extremely difficult to separate from each other. The rest only have typical dipole-dipoles, but as the halogen ion gets larger, there are more LDFs which explains the gradually rising boiling temperature.
11. Hydrogen bonding is greater in H_2O than in HF because each water molecule can has 3 contact points for hydrogen bonding: 1 from the O and 2 from its hydrogens. HF only has 2 contact points: 1 from H and 1 from F. The greater amount of hydrogen bonding in H_2O results in the greatly increased boiling point of water.