

Intramolecular Forces (between atoms)

Covalent

- Sharing of electrons between 2 nonmetallic atoms
- Occurs in molecular substances
- **Network Covalent** is the strongest type of bonding

Ionic

- Ions are formed when electron(s) are transferred from one atom to another
- Metal atoms lose electrons to form cations (positive)
- Nonmetal atoms gain electrons to form anions (negative)
- Ionic bonds the force of attraction between oppositely-charged ions
- The second strongest type of bonding

Metallic

- Positive ions attract valence electrons which are free to move from one empty valence orbital to another
- The third strongest type of bonding

Intermolecular Forces (between molecules)

London Dispersion Forces

- occurs in ALL molecular substances
- the attraction of positive nuclei of one molecule to the electrons of another molecule (& vice-versa)
- strength of these forces depends on the number of electrons in a molecule and the shape of the molecule

Dipole-dipole Forces

- only occurs among polar molecules
- the δ^+ end of one polar molecule is attracted to the δ^- end of another polar molecule (& vice-versa)

Hydrogen Bonding

- a special type of dipole-dipole force (about 10 times stronger)
- only occurs among molecules that contain a H atom which is directly bonded to a highly electronegative atom (F, O, N)
 - ie. the molecule contains at least one H-F, H-O, or H-N bond
- the H-bond is between the H of one molecule and the N, O, or F of another molecule

Criteria to Determine Which Substance has the Highest Boiling Point (bp) or Melting Point (mp)

1. Any network covalent solid (eg. C_n , SiC or SiO_2) will have the highest bp
2. Any ionic substance that is present with a network covalent solid will have the second highest b.p.
eg. SiC will have a higher bp than NaCl
3. Any metallic substance that is present with a network covalent solid and an ionic compound will have the third highest bp
eg. Na will have a lower bp than SiC and NaCl
4. Any molecular substances that are not network covalent solids will have the lowest bp.
To determine the substance with the highest bp with molecular substances, identify the types and relative strengths of the intermolecular forces (IMF) present:
 - ▶ London Dispersion forces
 - present in all molecules
 - count the number of electrons
 - if no other IMF are present, the substance with the greatest number of electrons will have the highest bp.
 - determine if other IMF are present for substances with the same # of electrons (isoelectronic)
 - ▶ Dipole-dipole forces
 - present in polar substances, in addition to London forces, thus this substance has the higher b.p.
 - if both substances are polar, then determine if Hydrogen bonds are present
 - ▶ Hydrogen bonding
 - present if molecules contain a H-F, H-O or H-N bond
 - this substance will have the higher bp, since it contains all 3 types of IMF

Note: For substances that are isoelectronic and polar but do not contain Hydrogen bonds, the substance with the higher bp will be the one that is most polar
ie. has the greatest difference in electronegativities between its' atoms.