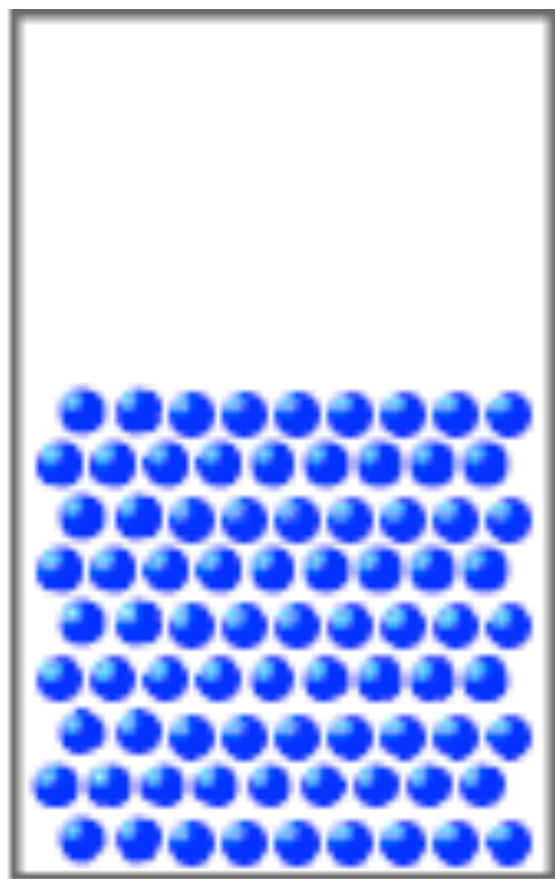
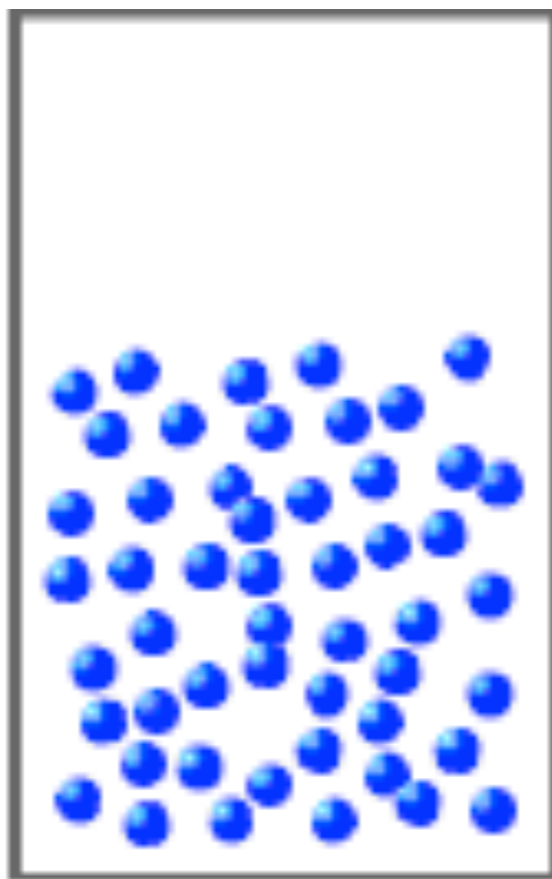


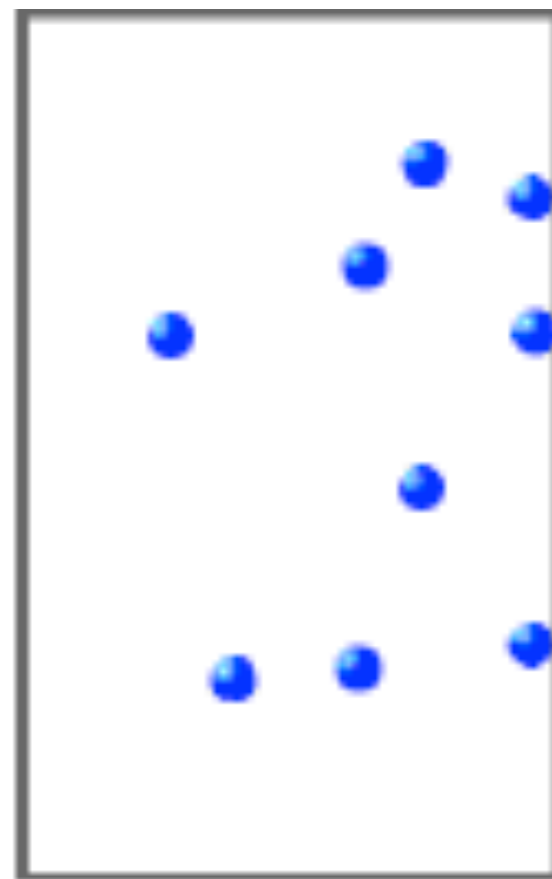
What determines whether a substance will be a solid, liquid, or gas?



Solid



Liquid



Gas

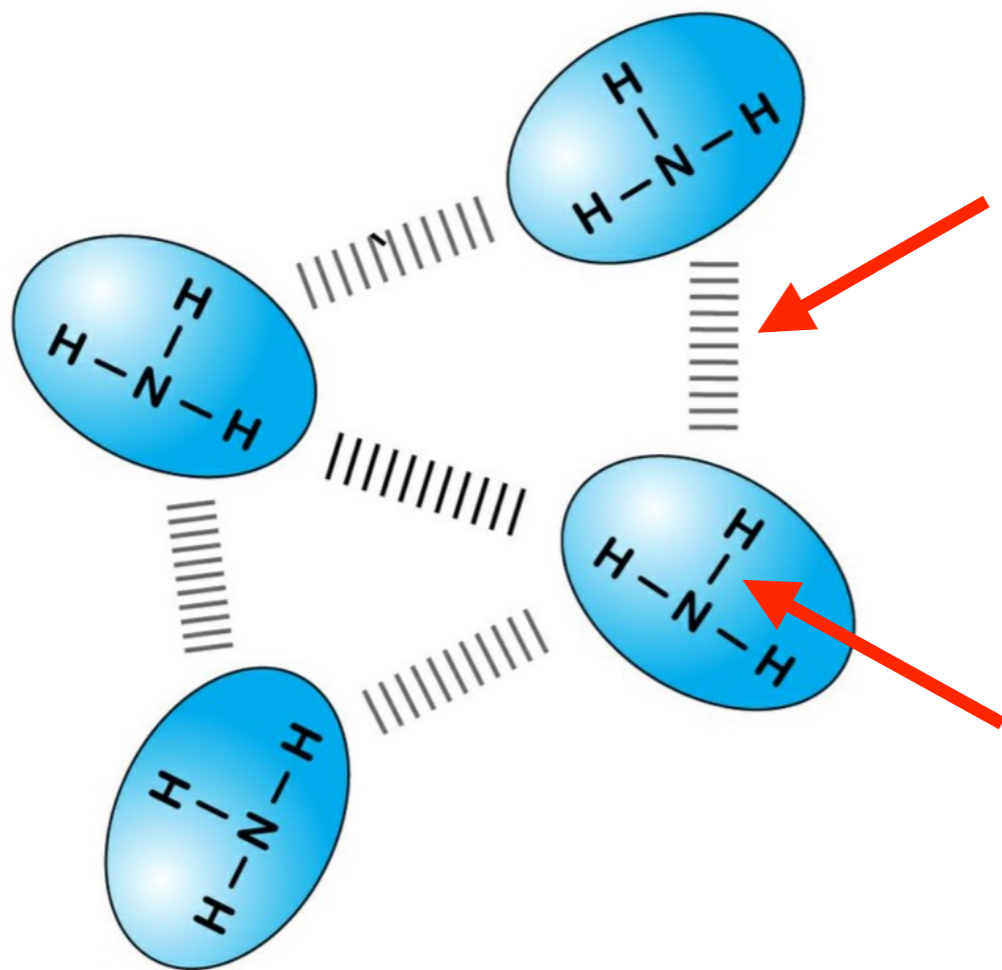
The attractive forces between its particles

For covalent compounds these forces are called...

Intermolecular Forces

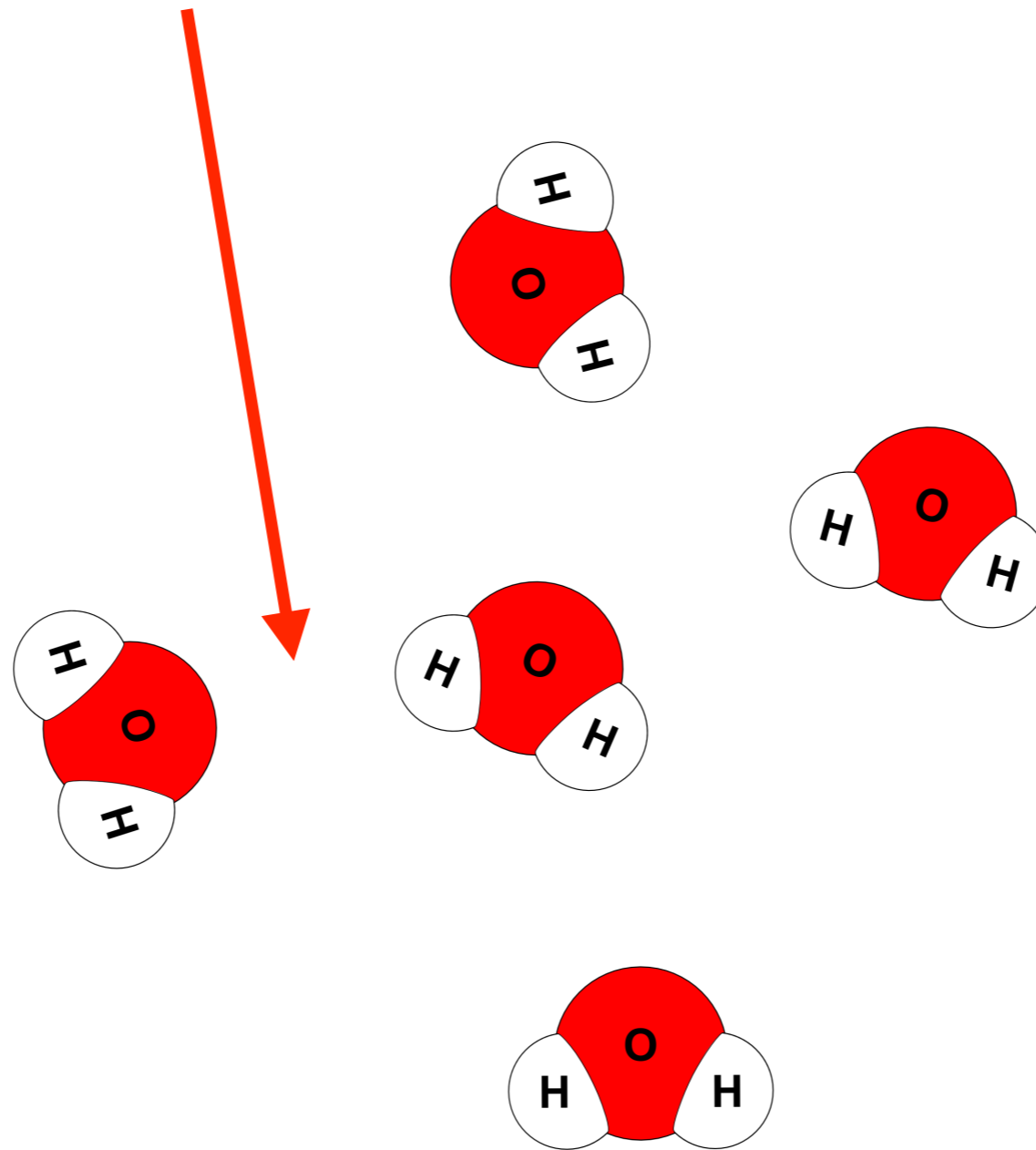
Intermolecular Forces: The attractive forces that exist *between molecules*. (weak)

Covalent Bonds: Sharing of electrons that exist *between atoms*. (strong)



Boiling and Melting Points

When a molecular compound melts or boils, *intermolecular forces* are being broken.



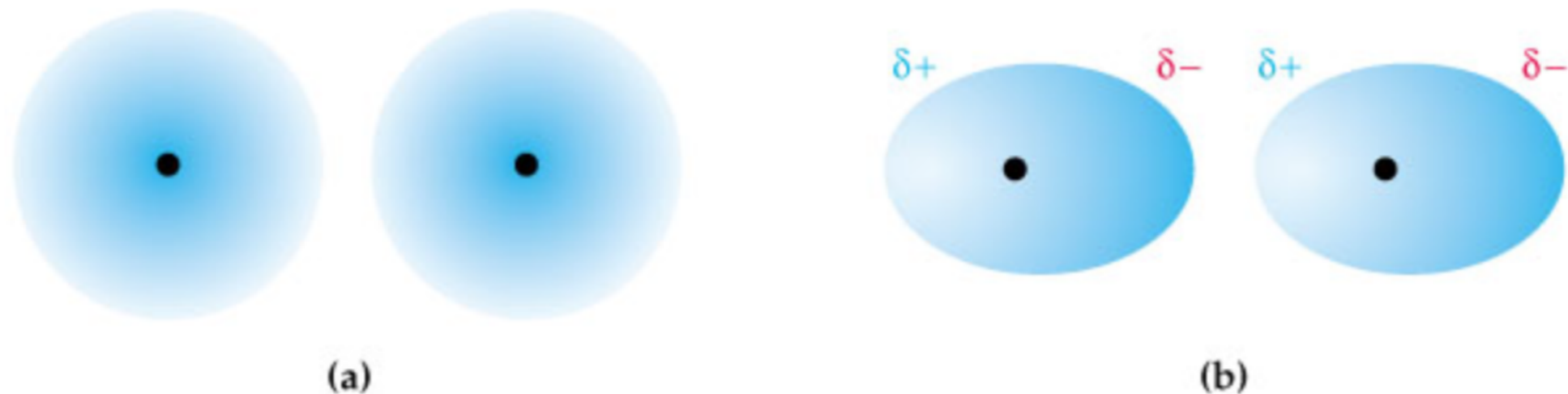
Types of Intermolecular Forces (in order of increasing strength)

1. Dispersion Forces
2. Dipole-Dipole Forces
3. Hydrogen Bonds

1. Dispersion Forces (London Dispersion Forces)

Attraction between *nonpolar* molecules

Weakest intermolecular force resulting from momentary shifting of e^- from one side of a molecule to another (temporary/induced dipole)



1. Dispersion Forces

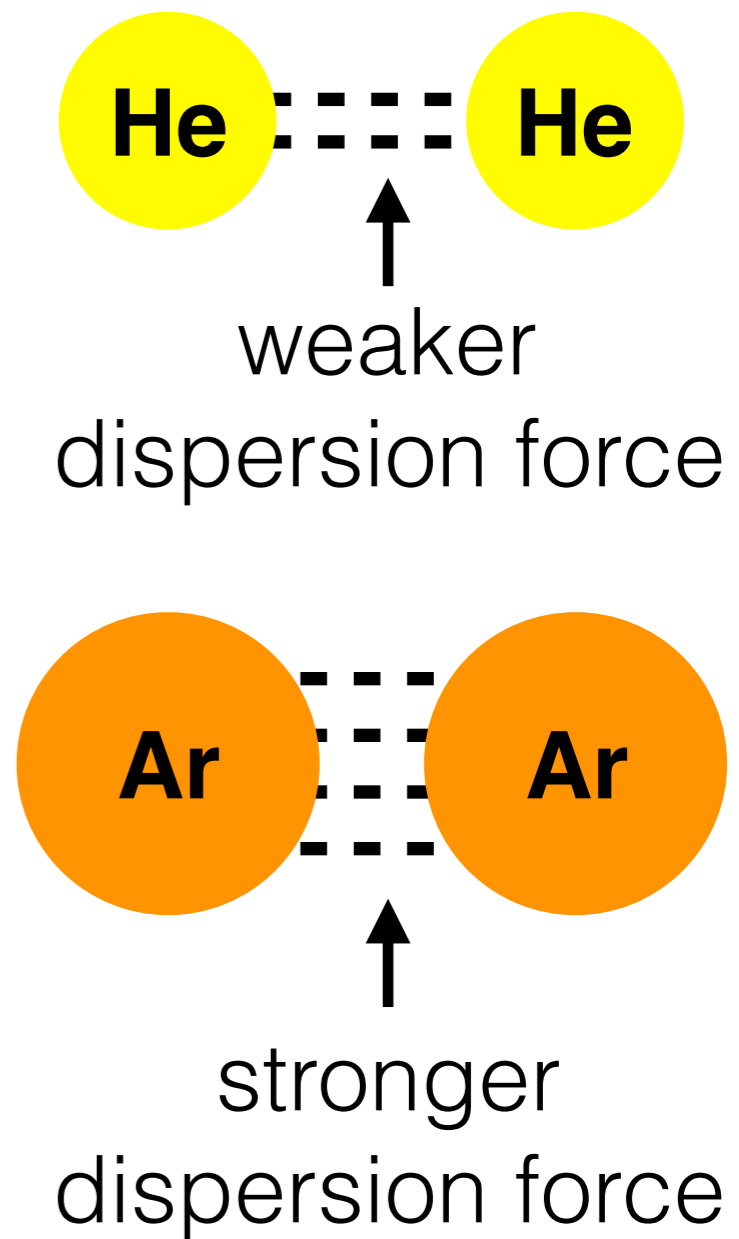
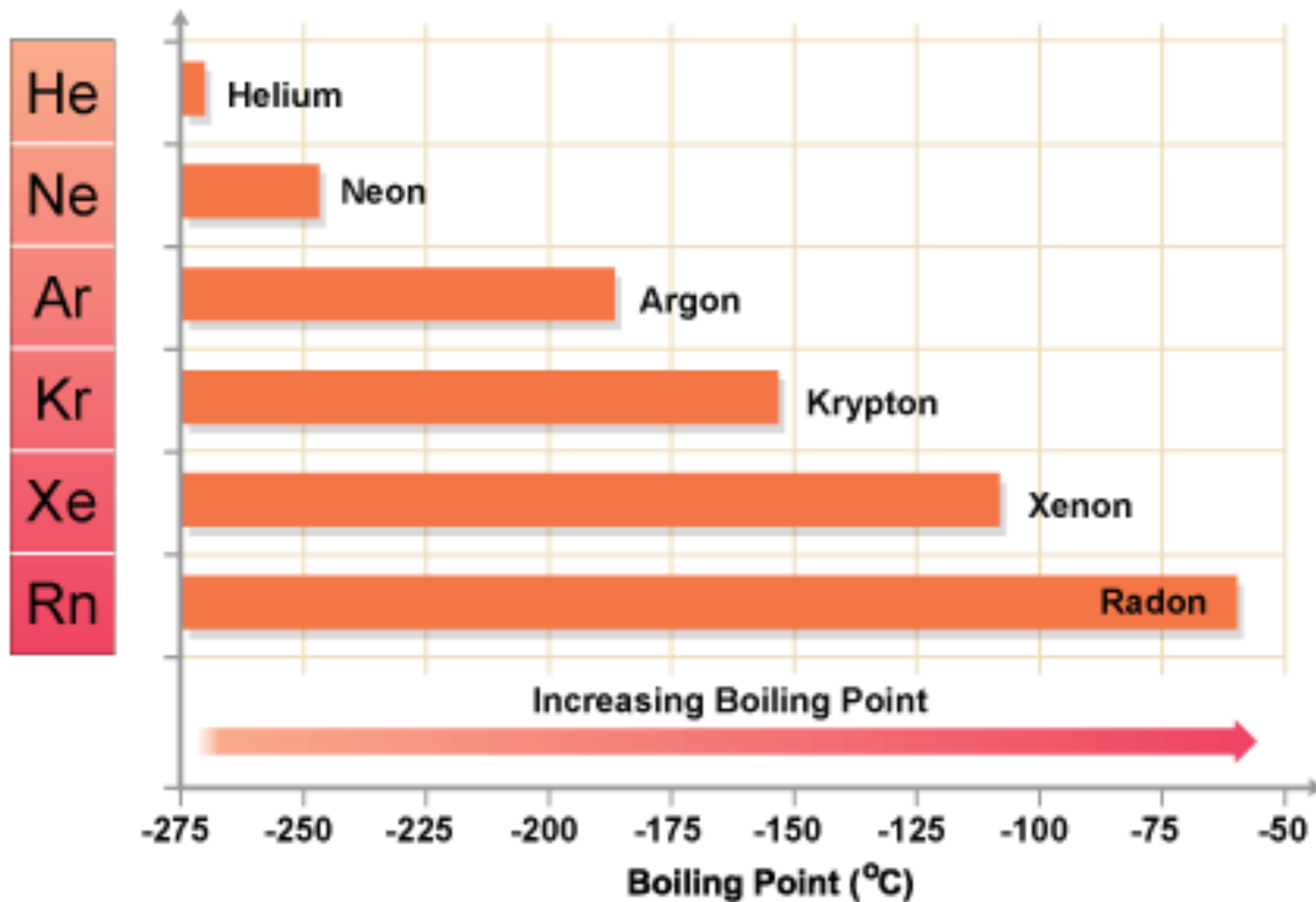
Ex: I_2



No Dipole



No Dipole



Larger Atoms or Molecules (more e⁻) =
 Greater Dispersion Force =
 Higher Boiling and Melting Points

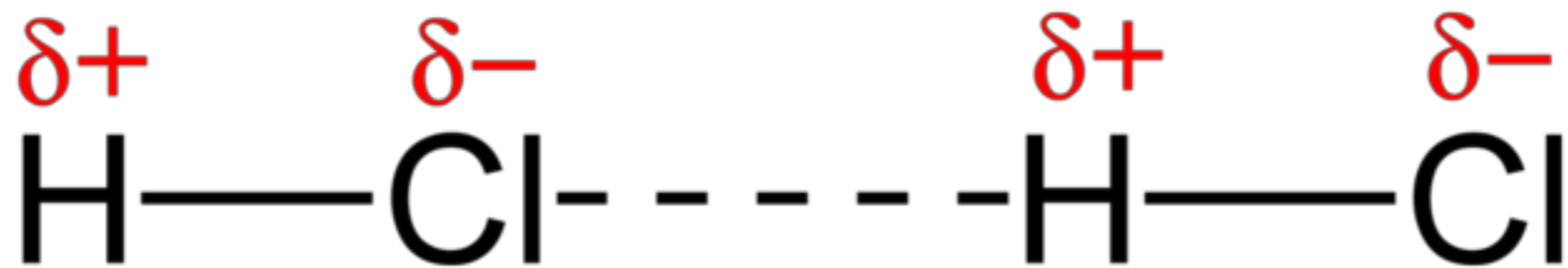
2. Dipole-Dipole Forces

Attraction between *polar* molecules



2. Dipole-Dipole Forces

Ex: HCl



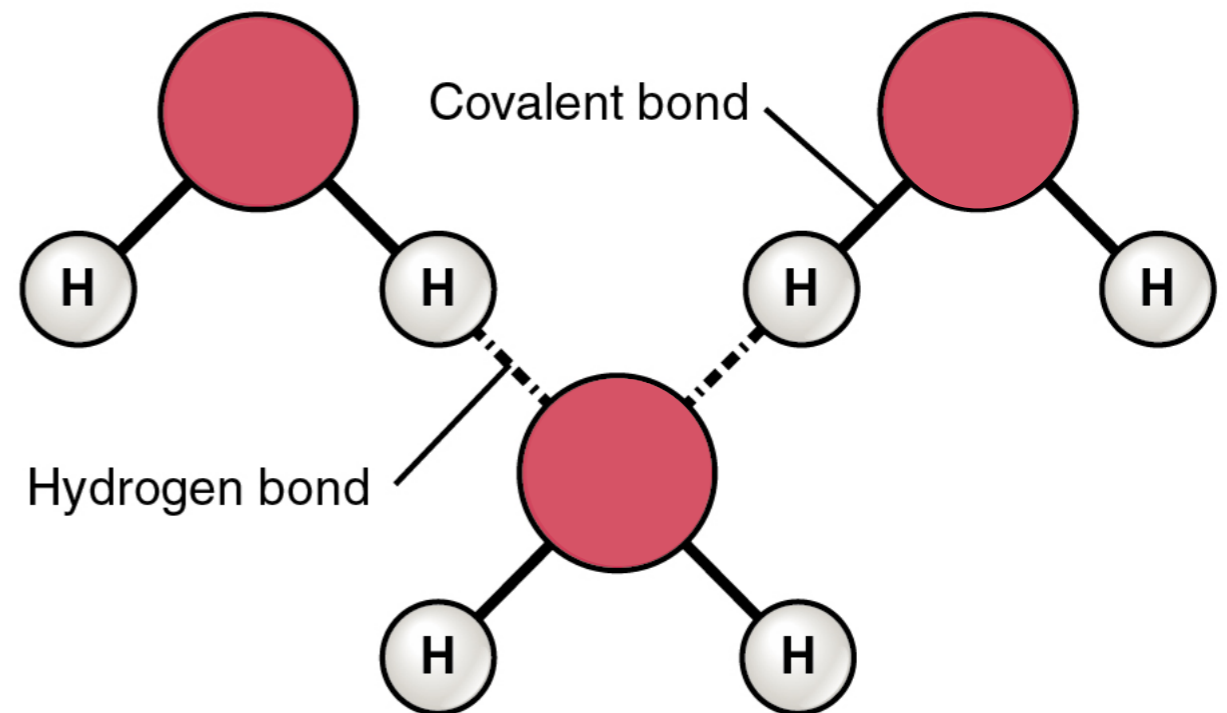
3. Hydrogen Bonds

Strongest dipole-dipole attraction

Occurs between molecules that have H bonded to very electronegative atoms:

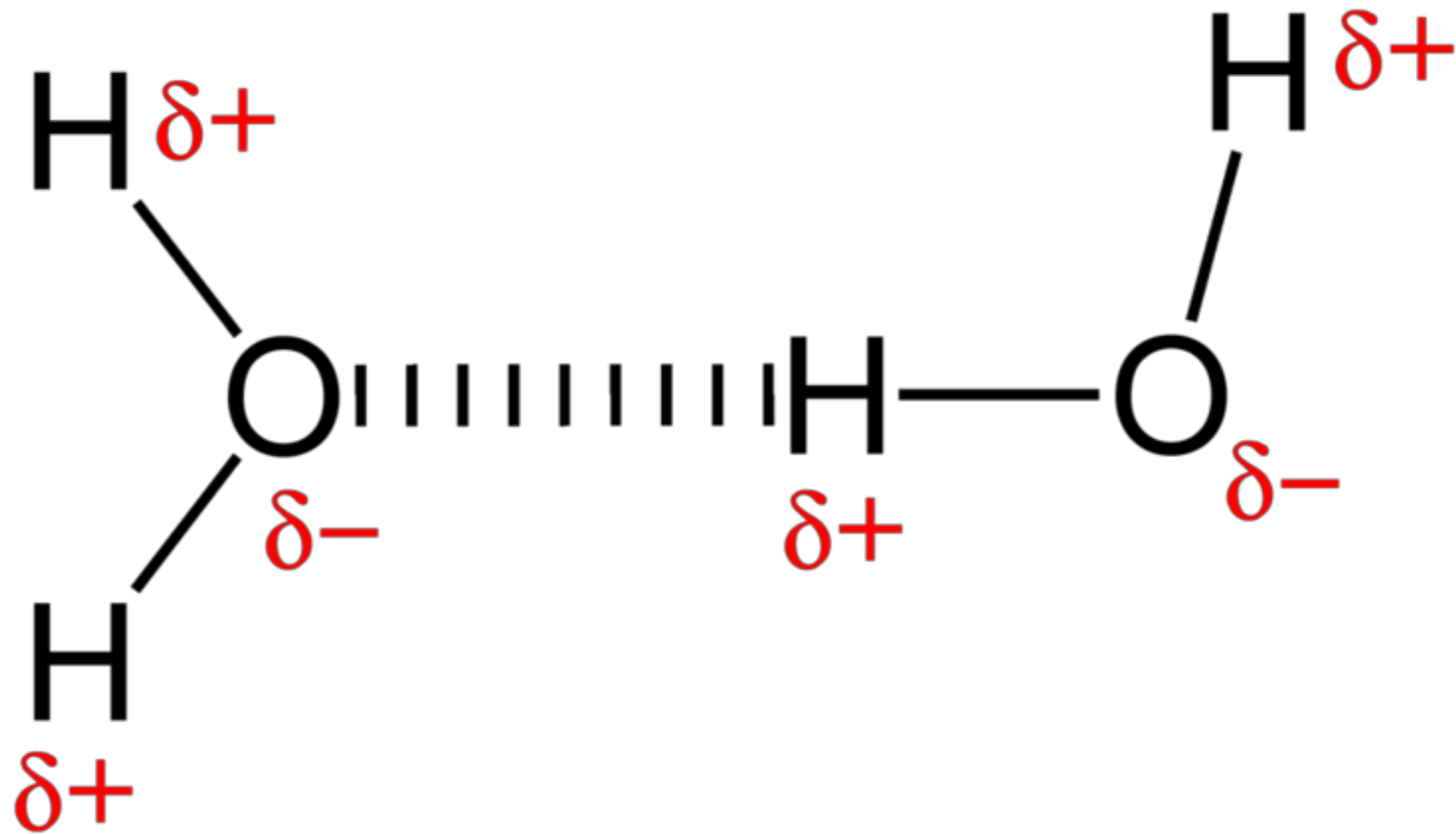


**H is on
the
FON**

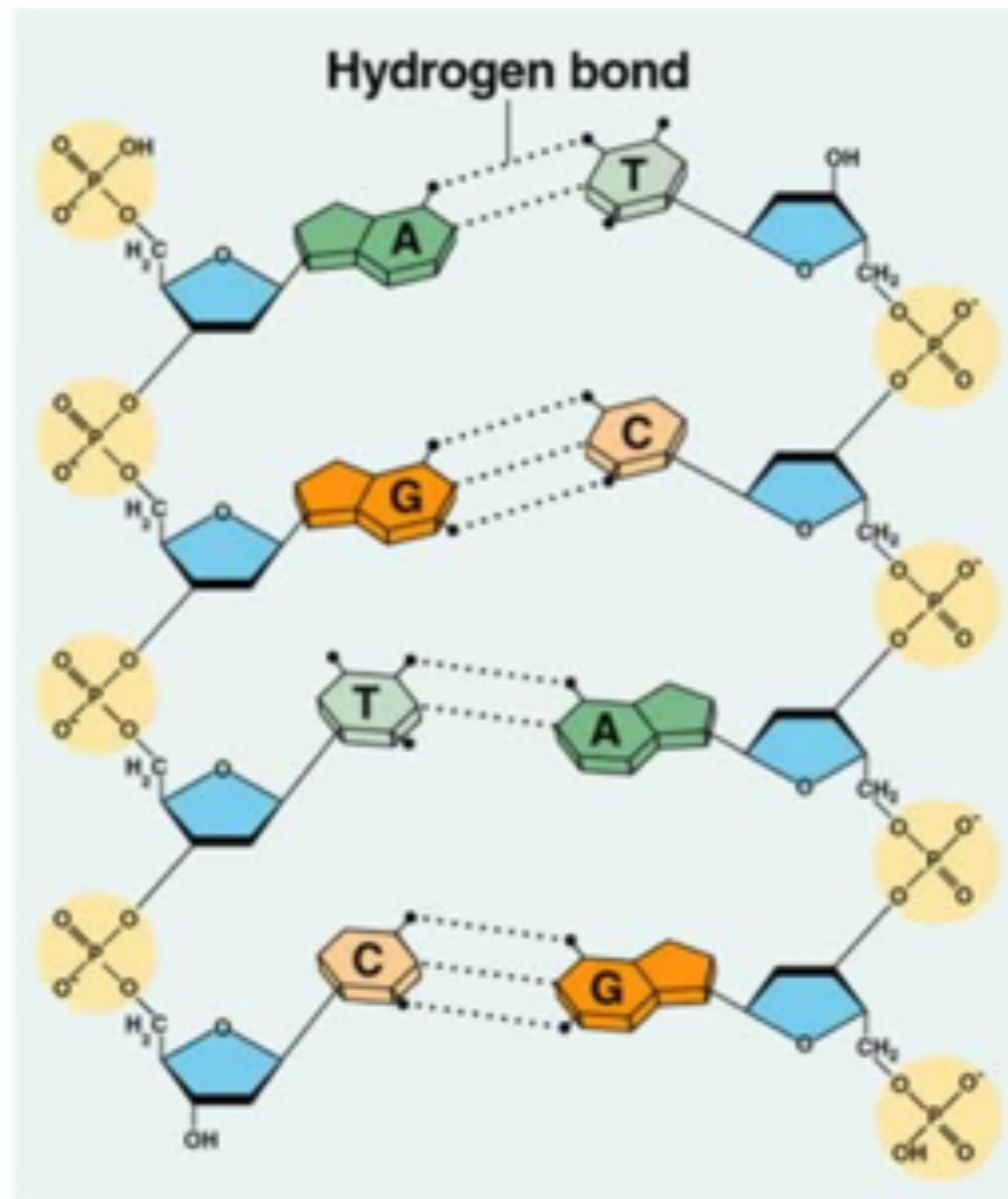
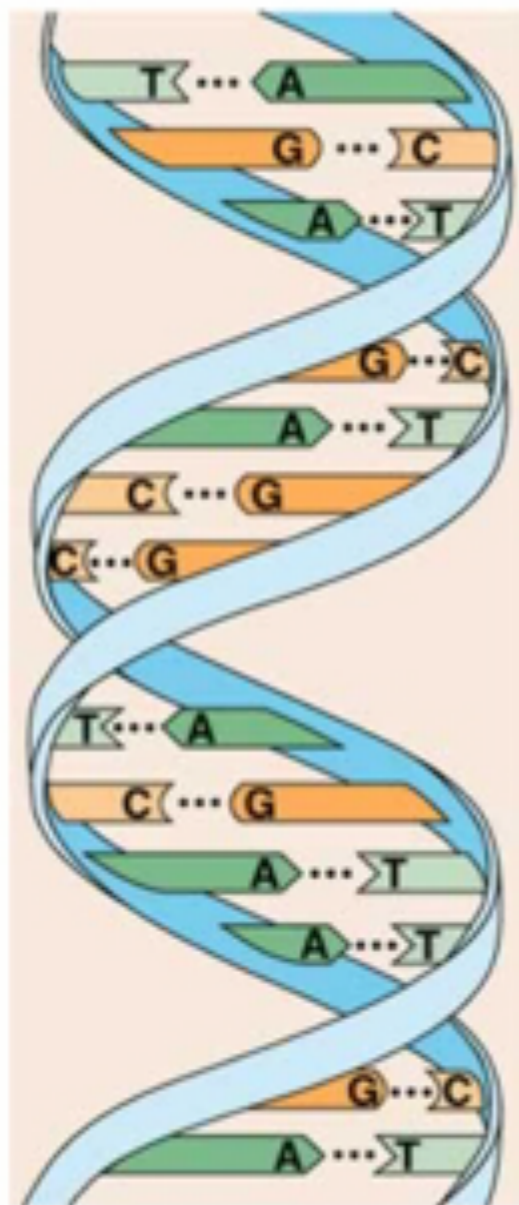


3. Hydrogen Bonds

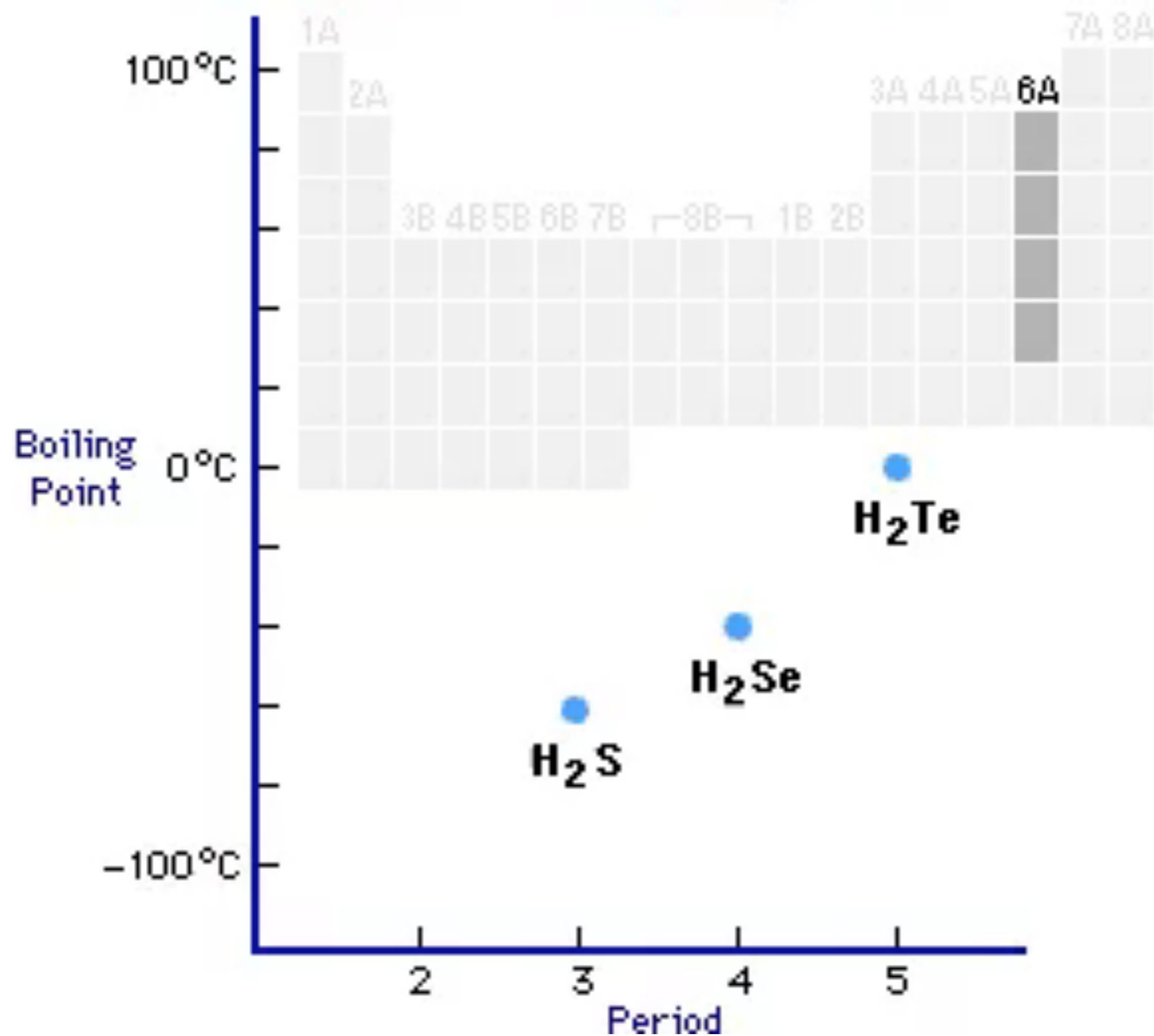
Ex: H₂O



Hydrogen bonds are also what hold the two nucleotide strands together in a DNA molecule.



Boiling Points of Simple Hydrogen-containing Compounds



Is the molecule polar or nonpolar?

nonpolar

polar

**Dispersion
forces**

**Are there any
F—H
O—H
N—H
bonds?**

no

yes

**Dipole-dipole
forces**

Hydrogen bonding

Increasing strength (Higher boiling point)