Intermolecular Forces (IMF)

Intramolecular vs. Intermolecular

Inter-

- Interstate highway – a highway that crosses over more than one state (example: hwy 44)
- Internet – a global computer network

Intra-

- Intrastate highway – a highway that only exists inside the state (example: hwy 51)
- Intranet – a computer network within a school or office

Intramolecular vs. Intermolecular

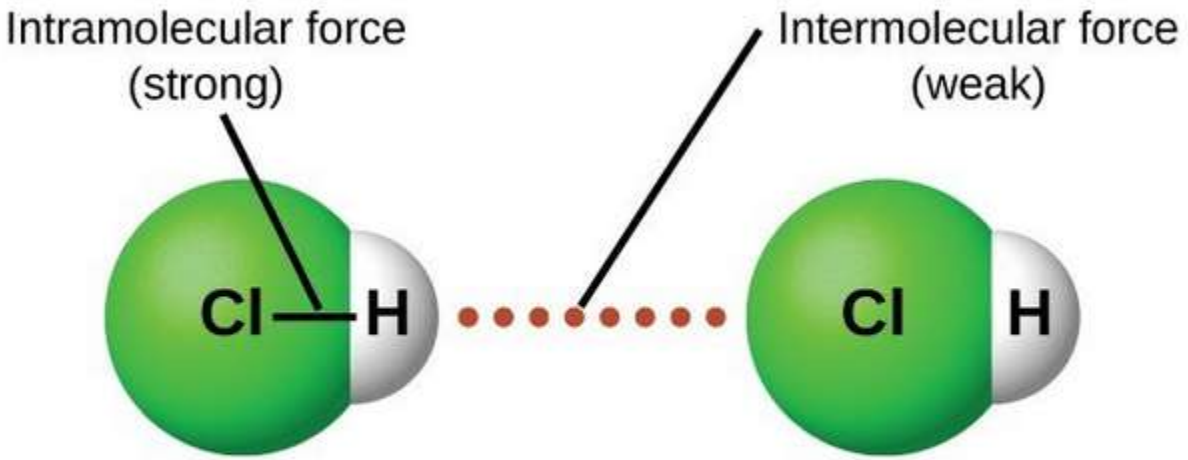


Figure 4. Intramolecular forces keep a molecule intact. Intermolecular forces hold multiple molecules together and determine many of a substance's properties.

Intramolecular Forces:

Forces that bind atoms together to form compounds

- Ionic bonds – chemical bonds between atoms where cations and anions are attracted to each other by giving or taking electrons.
- Covalent bonds – chemical bonds between atoms where electrons are shared

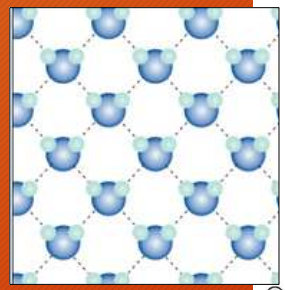
Intermolecular Forces:

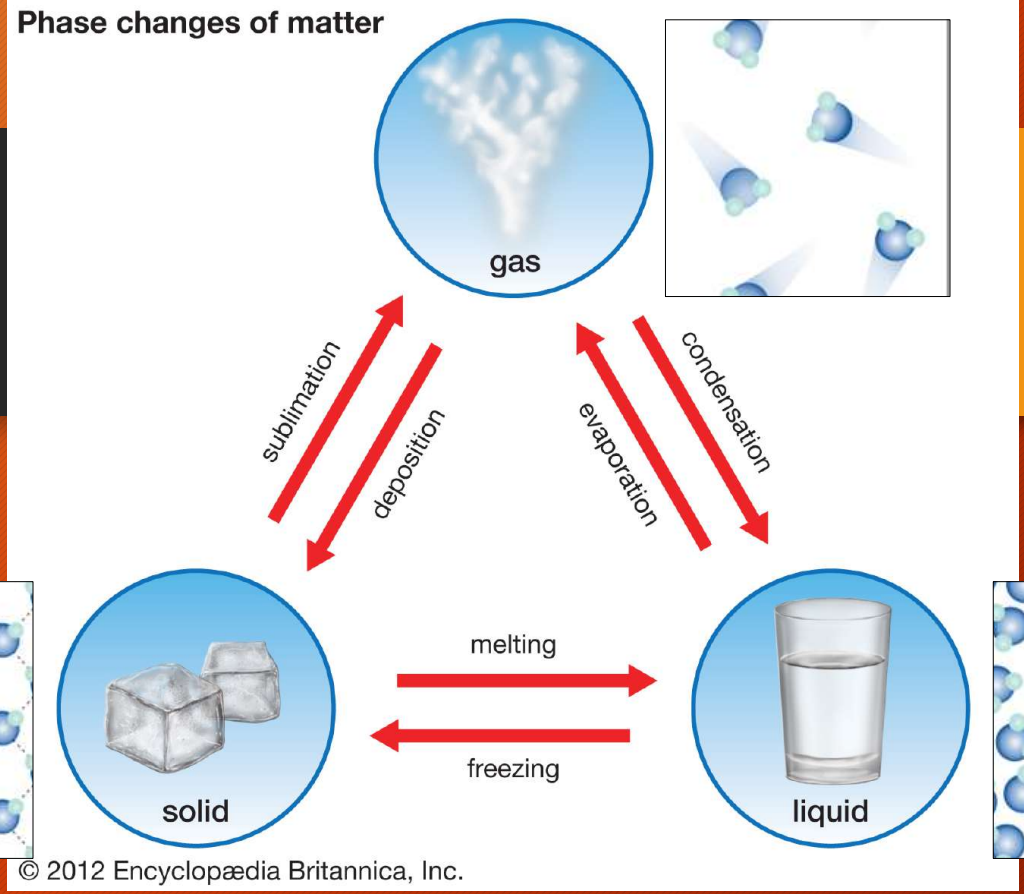
Forces that bind compounds together

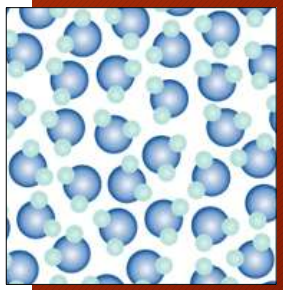
Intermolecular Forces

Intermolecular Forces influences:

1. Phase Changes
   a) Melting point
   b) Evaporation
   c) Freezing point







2. Surface Tension
   a) **T**he property of the **surface** of a liquid that allows it to resist an external force, due to the cohesive nature of the liquid molecules.

Intermolecular Forces

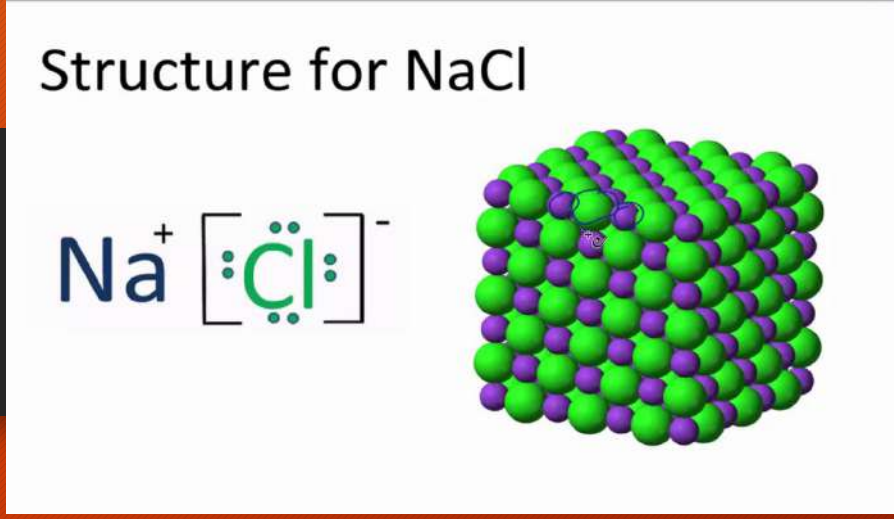
Forces between a compound and another compound

1. Ionic Forces
2. Dipole-Dipole

(polar molecule)

3. Hydrogen Bonding
4. London Dispersion Forces

Intermolecular Forces



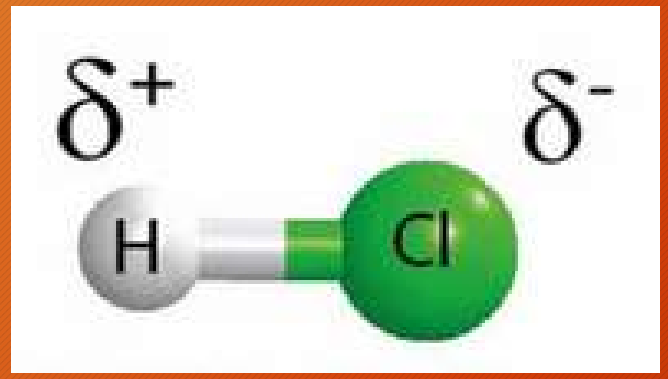
Ionic Forces

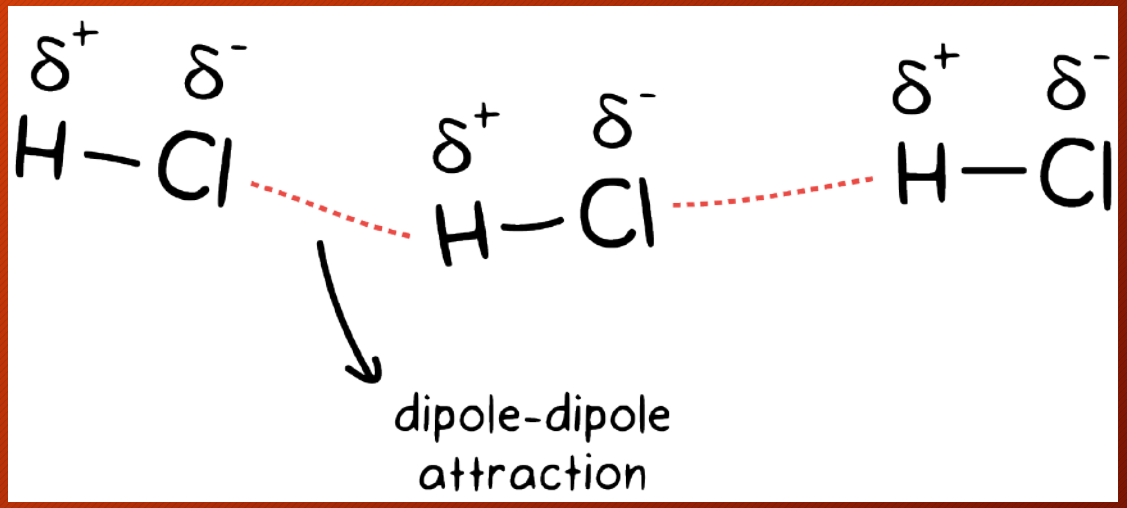
- Ion-Ion : Forces between ionic compounds.
  - Networks of ionic bonds are held together by electrostatic forces between the oppositely charged ions.
  - As the ionic lattice contains such a large number of ions, a lot of energy is needed to overcome this ionic bonding so ionic compounds have high melting and boiling points.
- Ion-Dipole: Forces between ions and dipoles (polar molecules).
  - For example, when NaCl dissolves in water, the sodium cation separates from the chloride anion.
  - Those ions are attracted to the water molecules. That attraction is called an ion-dipole force.

Intermolecular Forces

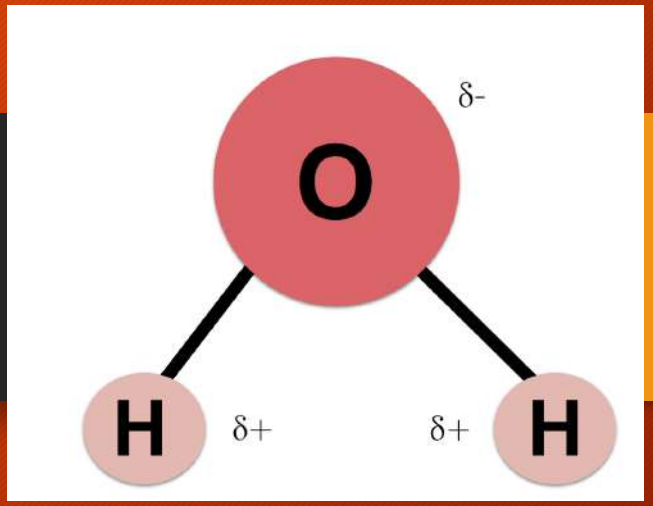
Forces between a compound and another compound

Dipole-Dipole : An attraction between oppositely charge regions of a polar molecule





Intermolecular Forces

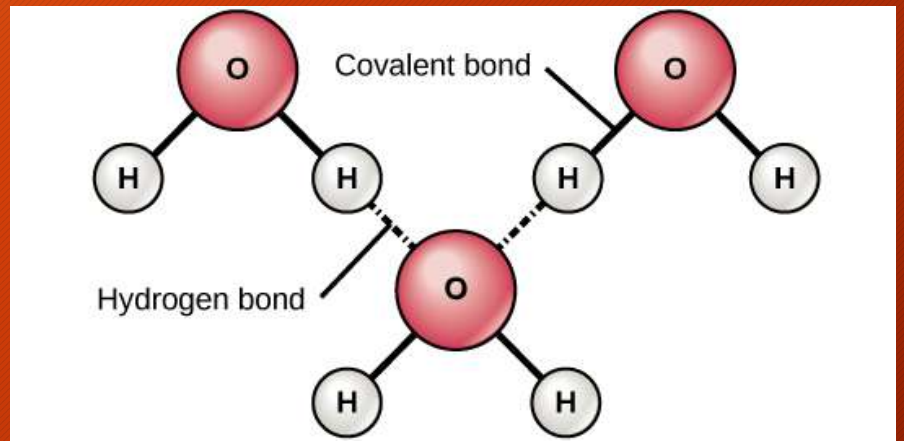


Forces between a compound and another compound

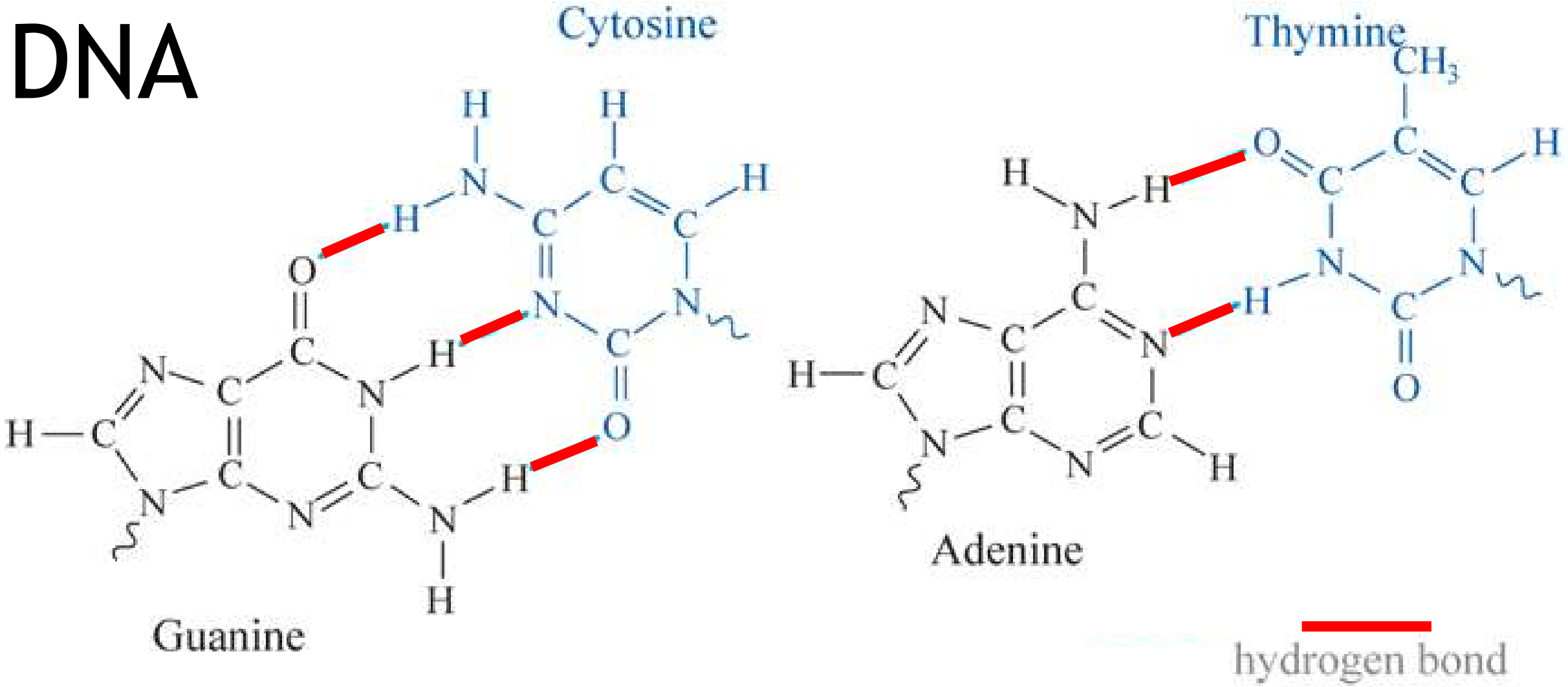
Hydrogen bond : when a hydrogen atom of 1 molecule is attracted to the highly electronegative atom of either fluorine, oxygen, or nitrogen (F, O, N) on another molecule

Two Requirements for Hydrogen Bonding:

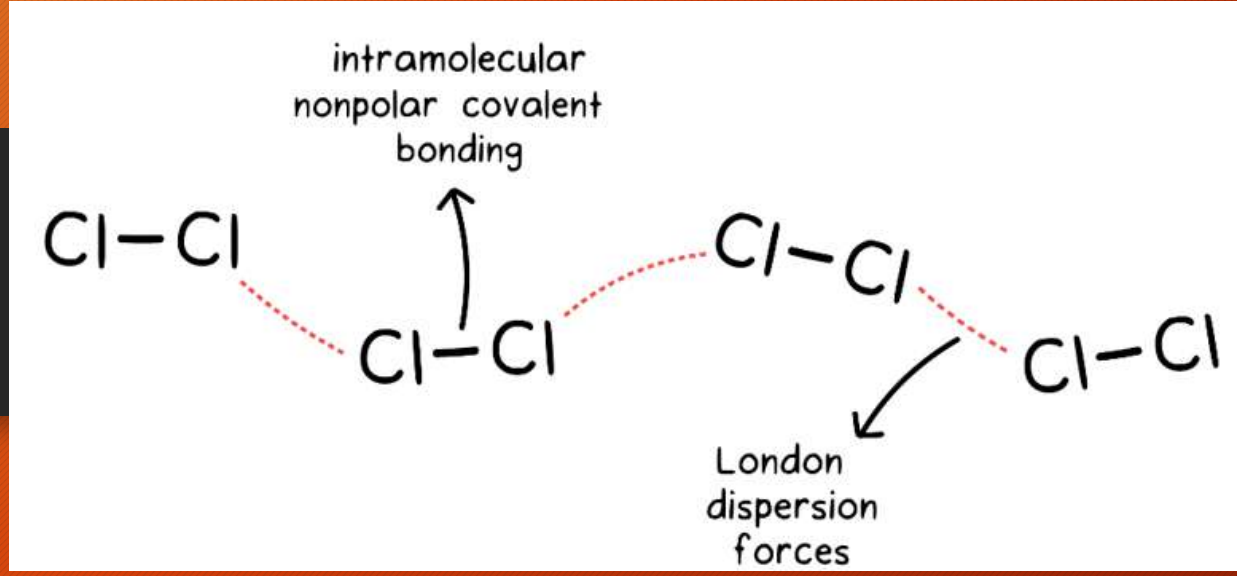
1. First molecule has hydrogen covalently bonded to a highly electronegative atom (must be F, O, N).
2. Second molecule has a lone pair of electrons on a highly electronegative atom (must be F, O, N).



DNA



Intermolecular Forces



Forces between a compound and another compound

London Dispersion Forces :

- Because the electrons of an atom or molecule are in constant motion, at any moment in time, an atom or molecule can develop a temporary, **instantaneous dipole** if its electrons are distributed asymmetrically.
- The presence of this dipole can, in turn, distort the electrons of a neighboring atom or molecule, producing an **induced dipole**.
- These two rapidly fluctuating, temporary dipoles thus result in a relatively weak electrostatic attraction between the molecules.

Exploring Intermolecular Forces

Purpose

In this experiment the evaporation and surface tension of three liquids (water, isopropyl alcohol, and acetone) will be compared in order to assess the strength of their intermolecular forces.

Exploring Intermolecular Forces

Pre-Lab Questions

The four major types of intermolecular forces in order of their strength (strongest to weakest) are:

1. _____: ion-ion (forces between ionic compounds); ion-dipole (forces between ions and polar molecules)

2._____: when a hydrogen atom of 1 molecule is bonded to the highly electronegative atom of either fluorine, oxygen, or nitrogen (F, O, N) and then attracted to the F, O, or N atom of another molecule.

3. _____: an attraction between oppositely charge regions of a polar molecule.

4._____: a temporary attractive force that results from a temporary dipole caused by the constant random motion of electrons in an atom.

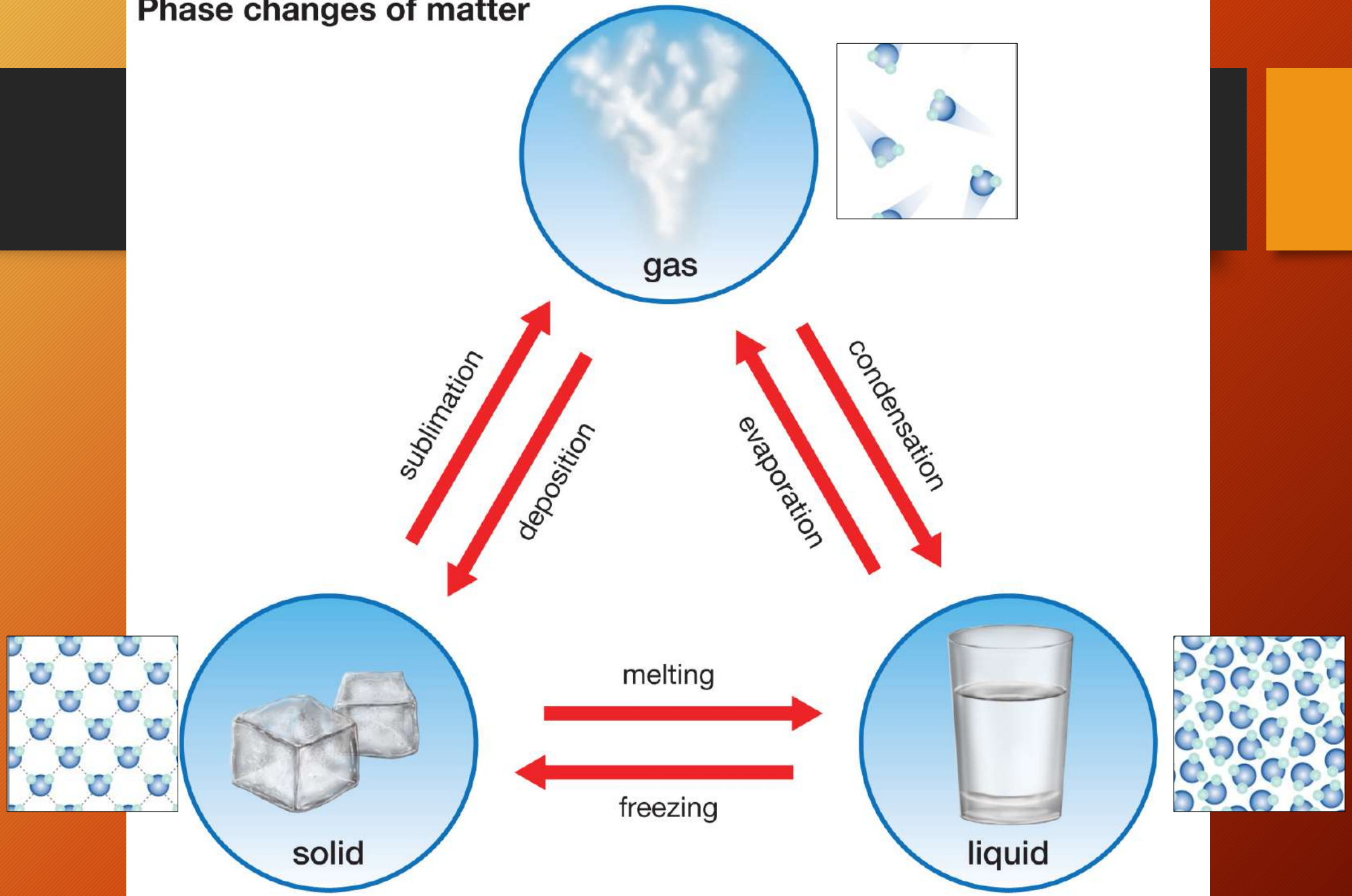
Exploring Intermolecular Forces

Pre-Lab Questions

Tell which intermolecular forces would exist between molecules of the following substances:

H_2S (polar)	
O_2	
NH_3	
HCl (polar)	
CO_2 (nonpolar)	

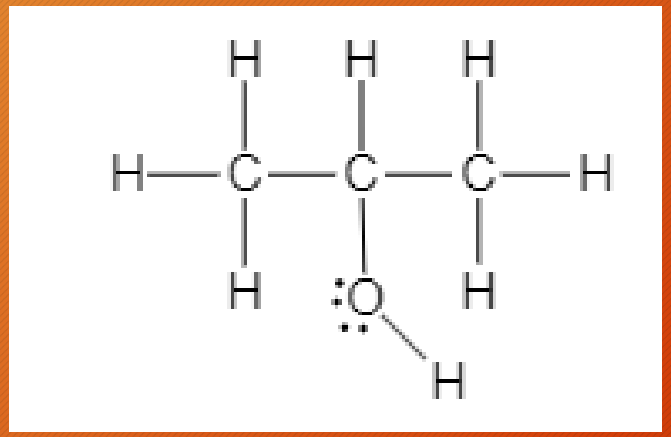
Phase changes of matter



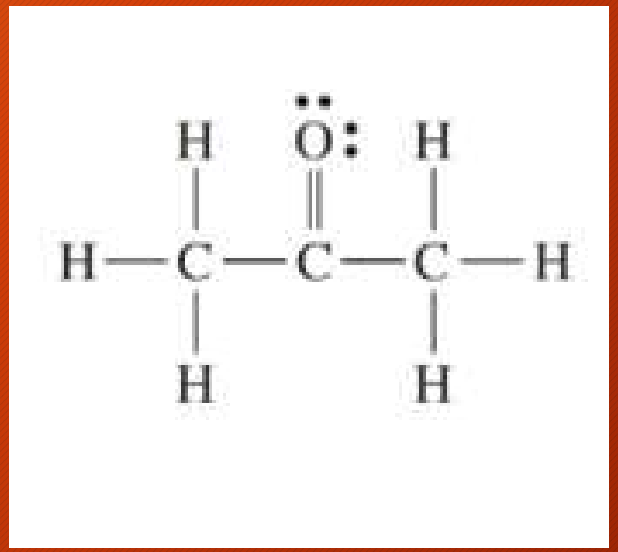
Exploring Intermolecular Forces

Look at the molecular models and compound names/formulas of the substances you will be comparing for your lab. Your instructor will provide these for you.

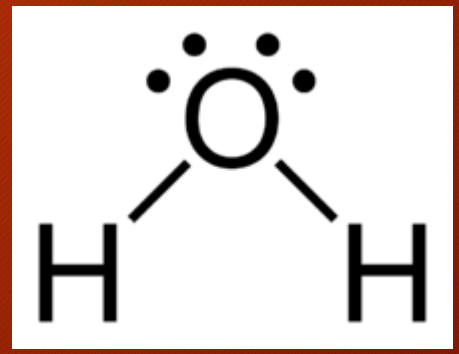
Label each model with the correct compound names/formulas.



isopropyl alcohol



acetone



water

Exploring Intermolecular Forces

- Tell which intermolecular forces would exist between molecules of the substances in this lab:

Name	Formula	Intermolecular Forces
Isopropyl Alcohol	C_3H_8O	
Acetone	C_3H_6O	
Water	H_2O	

Exploring Intermolecular Forces

Hypothesis:

_____will have the strongest intermolecular forces.

_____will have the next strongest intermolecular forces.

_____ will have the weakest intermolecular forces.