Note Packet # 11

Intermolecular Force of Attraction

An **intermolecular force of attraction** is the force of attraction that exists between **molecules**. Remember! Molecules are groups of atoms that are covalently bonded. The strength of the force of attraction between molecules depends on the polarity of the molecule. Remember! Polarity describes something with different ends.The greater the polarity of the molecules the greater the force of attraction between them.This is an electrostatic force. The concept of electrostatic force is; **opposite electric charges attract and like electric charges repel**.

Intermolecular forces determine a substance's:

a) **Melting point**
b) **Boiling point**
c) **Vapor pressure**

Substances with **strong intermolecular forces** have **low vapor pressures** and **high melting** and **boiling points.**

Why? Because a strong force of attraction holds molecules together tightly. A lot of kinetic energy (high temperature) is required to melt, boil, or create vapor pressure for a substance with a strong intermolecular force of attraction.

Substances with **weak intermolecular forces** have **high vapor pressures** and **low melting boiling points.**

Why? Because a weak force of attraction holds molecules together loosely. A small amount of kinetic energy (low temperature) is required to melt, boil, or create vapor pressure for a substance with a weak intermolecular force of attraction.

Don't forget!
You must know how intermolecular forces affect vapor pressure **"Table H".**

Important! An intermolecular force of attraction **is** a force of attraction between molecules!

Important! An intermolecular force of attraction **is not** a chemical bond between atoms!

The intermolecular forces we will study are:

a) **Dipole force of attraction**

b) **Hydrogen bonding**

c) **Molecule-Ion force of attraction**

d) **Van Der Waals Force of Attraction**

Important! The diagrams used to represent intermolecular bonding are 2-dimensional. The real world is 3-dimensional.

Notepacket # 11

Dipole Force of Attraction

Dipole Force of Attraction refers to the force of attraction between polar molecules. Polar molecules have ends with opposite electric charges. Opposite electric charges attract. The result is polar molecules aligning themselves with opposite ends facing each other. Because of this attraction, molecules of polar substances hold together tightly resulting in high melting and boiling points and low vapor pressures.

This shape represents the dipole force of attraction between the + and - ends of the molecules.

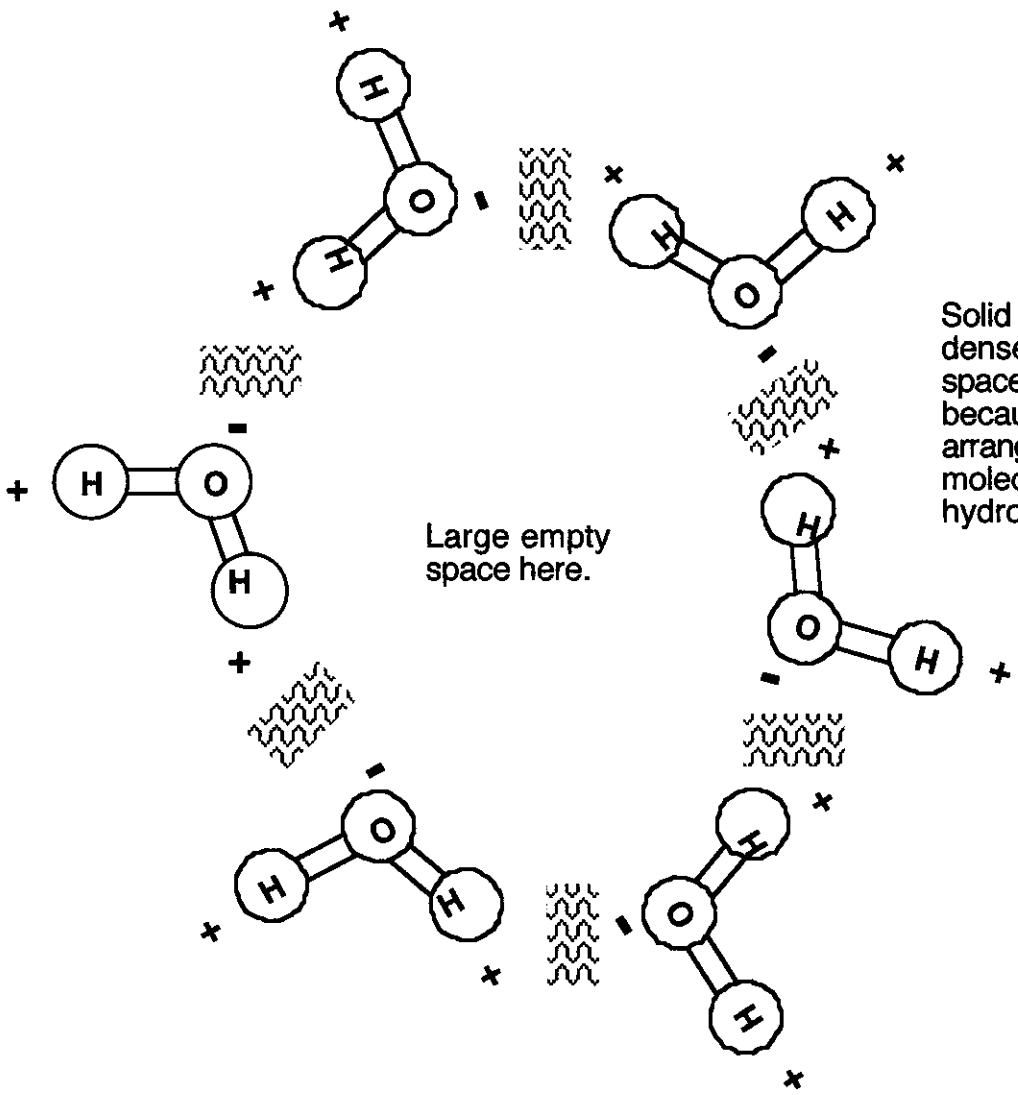
Important! An intermolecular force of attraction **is** a force of attraction between molecules!

Important! An intermolecular force of attraction **is not** a chemical bond between atoms!

Notepacket # 11

Hydrogen bonding is a very strong dipole force of attraction. It only occurs between molecules that contain **Hydrogen** and molecules that contain **F**luorine, **O**xygen, or **N**itrogen. Remember! Chemistry is so much **F O N** . Substances with hydrogen bonding have very low vapor pressures and very high melting and boiling points.
Water has a high boiling point compared to other similar molecules due to hydrogen bonding.

The diagram below illustrates how water molecules arrange themselves as a solid "ice" due to hydrogen bonding.



This shape represents the intermolecular force known as hydrogen bonding. Remember! Hydrogen bonding is an intermolecular force between molecules. It is not a chemical bond between atoms.

Important! An intermolecular force of attraction **is** a force of attraction between molecules!

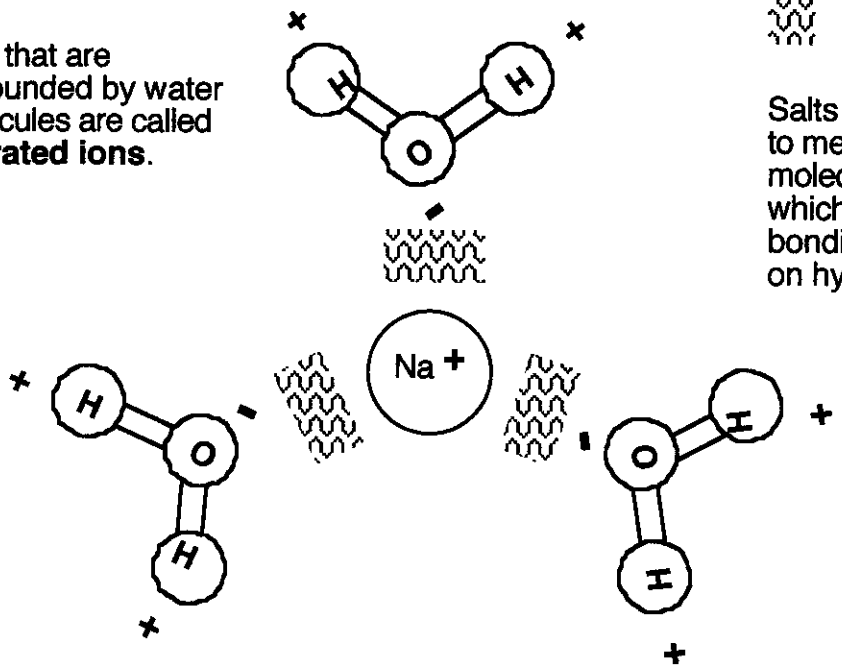
Important! An intermolecular force of attraction **is not** a chemical bond between atoms!

Notepacket # 11

Molecule-Ion Force of Attraction is a force of attraction between polar molecules and ions. Opposite electric charges attract. The negative ends of polar molecules align themselves with + ions. The positive ends of polar molecules align themselves with - ions.
$NaCl_{(aq)}$ describes NaCl dissolved in water. When salt is dissolved in water (aqueous) the water molecules and ions arrange themselves as in the diagram below.

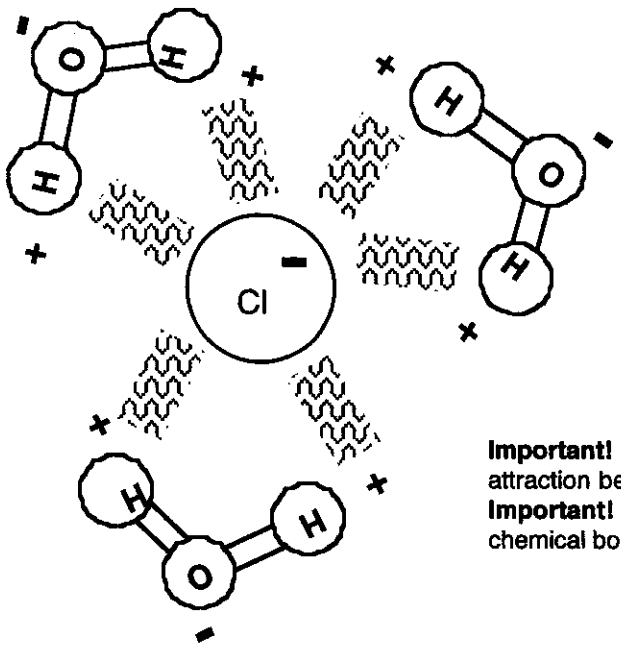
This shape represents the molecule-ion force of attraction.

Ions that are surrounded by water molecules are called **hydrated ions**.



Salts (ionic substances) are used to melt ice since ithey create a molecule-ion force of attraction which disrupts the hydrogen bonding in solid ice. See the page on hydrogen bonding of water.

The term **$NaCl_{(aq)}$** tells us a lot. It tells us that we have a mixture of NaCl (ionic) and water (polar). This mixture will contain a molecule-ion force of attraction.

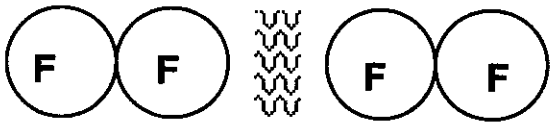


Important! An intermolecular force of attraction **is** a force of attraction between molecules!
Important! An intermolecular force of attraction **is not** a chemical bond between atoms!

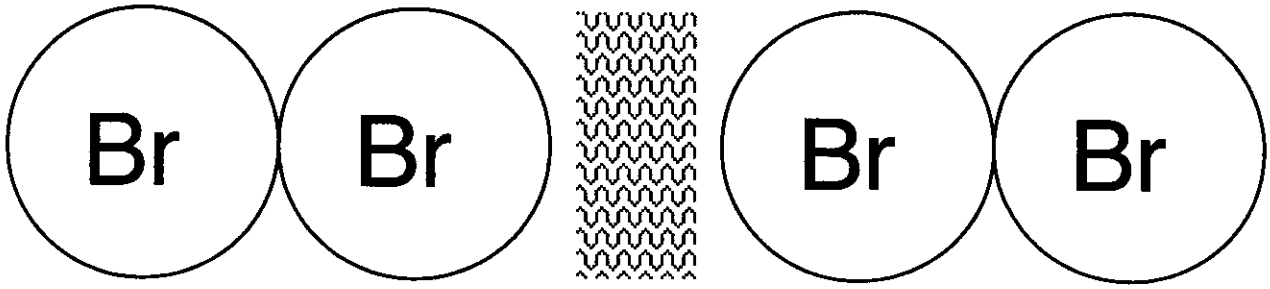
Van Der Waals Force of Attraction is a **weak** force of attraction between non-polar molecules. Non-polar molecules are symmetrical and do not have opposite ends. Therefore; non-polar molecules can't have a dipole force of attraction. This weak force is due to an instantaneous imbalance of electrons around the nucleus of the atoms. Substances with only Van Der Waals force of attraction have high vapor pressures and low melting and boiling points. Why? because the molecules do not hold together tightly.
The relative melting and boiling points of non-polar molecules are determined by the strength of their Van Der Waals forces.
A strong force will result in higher melting and boiling points.
A weak force will result in lower melting and boiling points.
Not all non-polar substances have equal strength Van Der Waals forces.
The greater the mass of an molecule, the greater the Van Der Waals force.

Ex: Which molecule has the highest melting and boiling point? F_2, Br_2 or I_2.
To solve: Use the periodic table to compare the mass of F_2, Br_2 and I_2.
I_2 has the greatest mass, therefore,the highest melting and boiling point.


This shape represents the Van Der Waals force of attraction.



F_2 has a small mass.The Van Der Waals force for F_2 is small.
F_2 is a gas at room temperature due to its very weak Van Der Waals intermolecular force of attraction.

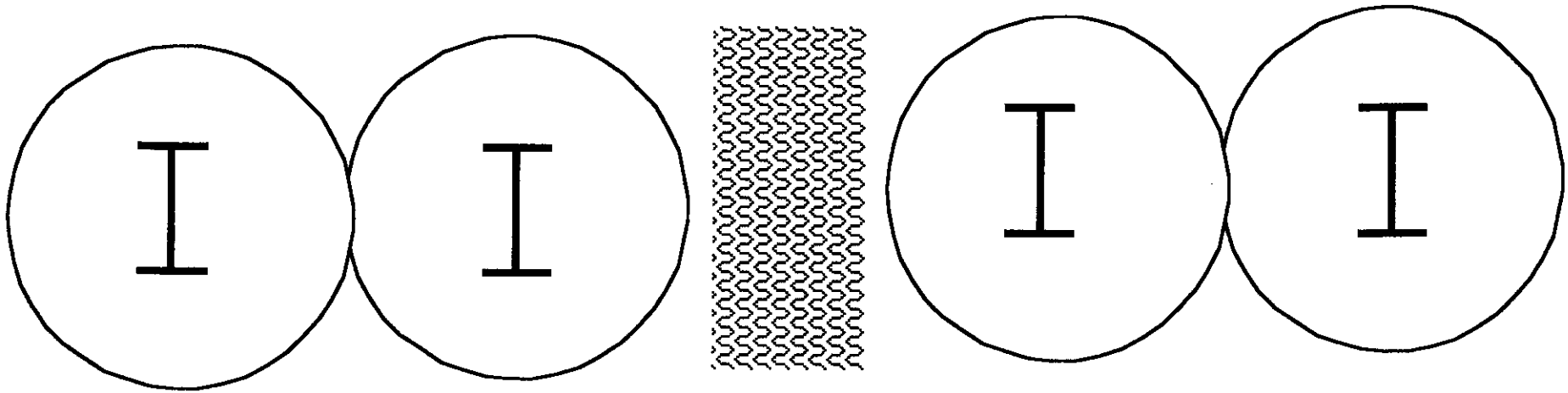


Br_2 has a larger mass. The Van Der Waals force for Br_2 is larger.
Br_2 is a liquid at room temperature since its Van Der Waals intermolecular force is large enough to hold its molecules together as a liquid.

Important! An intermolecular force of attraction **is** a force of attraction between molecules!

Important! An intermolecular force of attraction **is not** a chemical bond between atoms!

I_2 has a larger mass than F_2 or Br_2. Therefore; its Van Der Waals force is larger.
I_2 is a solid at room temperature since its Van Der Waals intermolecular force is large enough to hold its molecules together as a solid at room temperature.



Important! An intermolecular force of attraction **is** a force of attraction between molecules!

Important! An intermolecular force of attraction **is not** a chemical bond between atoms!

Notepacket # 11

Answer questions 1 – 11 with complete sentences.

1. Describe "dipole attraction"

2. Describe "hydrogen bonding"

3. Describe "molecule-ion attraction"

4. Name 3 substances with hydrogen bonding.

5. Why does water have a relatively high boiling point compared to other similar molecules?

6. What is a "hydrated ion"?

7. Name 3 nonpolar molecules with polar bonds.

8. What are Van Der Waals Forces.

9. What determines the strength of Van Der Waals forces?

10. Which substance has a stronger force of attraction between molecules, Cl_2 or Br_2?... Why?

11. Explain, with respect to intermolecular forces, why fluorine is a gas, bromine is a liquid, and iodine is a solid at room temperature.

12. Fill in the blanks for a, b and c with either **high** or **low**.

a) **Strong** intermolecular forces result in _____ vapor pressure.

b) **Weak** intermolecular forces result in _____ boiling point.

c) **Strong** intermolecular force results in _____ melting point.