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# SCH4U – Intermolecular Forces

**Define the following:**

Intermolecular Forces:

Intramolecular Forces:

## Intermolecular Forces & Changes of State Simulation

Use the PHET simulator to observe the movement and location of molecules their different states.
http://moodle.rosedaleacademy.com/mod/page/view.php?id=23371

**Instructions:**

1. Select "States"
2. Select "Neon" from the box on the right.
3. Select "Solid" and observe how the molecules move and how the molecules are organized (compared to the other molecules). Record your observations in the table.
4. Record the temperature (in units of Kelvin (K) in the table.
5. Select "Liquid"
6. Repeat steps 3 &4.
7. Select "Gas" and repeat steps 3 & 4.
8. Select "Oxygen" from the box on the right.
9. Repeat steps 3-7.
10. Select "Water"
11. Repeat steps 3-7

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| Atom/ Molecule | State | Observations: Movement of molecules | Observations: Organization of molecules | Temp. (K) |
|---|---|---|---|---|
| Neon (Ne) | Solid | | | |
| | Liquid | | | |
| | Gas | | | |
| Oxygen ($O_2$) | Solid | | | |
| | Liquid | | | |
| | Gas | | | |
| Water ($H_2O$) | Solid | | | |
| | Liquid | | | |
| | Gas | | | |

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Describe the movement and locations of molecules in each of the 3 states:

**Solid:**

**Liquid:**

**Gas:**

Describe how changes in intermolecular forces relate to changes of state:
(Solid ←→ Liquid ←→ Gas)

List the 3 types of van der Waals forces

1.
2.
3.

## Dipole-dipole forces:

Dipole-dipole forces hold together molecules that are polar due to bond _____.
Example:

Dipole-dipole forces are relatively weak. The are ~1% as strong as_____ bonds.

Draw a diagram of dipole-diople forces binding 2 molecules to each other.

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## Hydrogen Bonds:

Hydrogen bonding occurs in molecules in which a hydrogen atom is bonded to a:

List the 3 elements that hydrogen bonding occurs with:

1.
2.
3.

Hydrogen bonds are _____% as strong as covalent bonds.

Draw a diagram showing hydrogen bonding between water atoms:

Substances with hydrogen bonding tend to have higher _____ and _____ points.

## London Dispersion Forces

Electrons are in constant movement. In a non-polar molecule, if there is a momentary, non-symmetrical distribution of electrons, an instantaneous _____ can develop.

When an instantaneous dipole forms on a molecule this temporary dipole can _____ on a neighbouring atom.

Induced dipoles are relatively weak forces, however for _____ atoms or molecules, this intermolecular force can be significant.

List the 3 van der Waals forces in order of increasing strength:

Describe how intermolecular forces relate to boiling and melting points:

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Predict which of the following has the highest boiling point: $H_2$, $I_2$, $F_2$, $Br_2$

| Molecule | Molecular Mass (u) |
|---|---|
| | |
| | |
| | |
| | |

**Highest predicted boiling point:**

Describe how the structure of solids relates to the following properties:

**Hardness**

**Melting Point:**

**Electrical Conductivity:**

## Ionic Crystals:

Example:

Ionic crystals form when:

Describe the following properties of ionic crystals:

**Hardness:**

**Electrical Conductivity:**

**Melting Point:**

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## Metallic Crystals:

Example:

A metallic crystal is made up of closely packed_____ held together by _____ interactions and fee moving _____.

Describe the "sea of electrons" model of metallic crystals:

Metallic crystals are held together by what type of bonding?:

Describe the following properties of ionic crystals:

**Hardness:**

**Electrical Conductivity:**

**Melting Point:**

## Molecular Crystals:

Example:

Metallic crystals are held together by what type of bonding?:

Describe the following properties of ionic crystals:

**Hardness:**

**Electrical Conductivity:**

**Melting Point:**

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## Covalent Network Crystals:

Example:

Metallic crystals are held together by what type of bonding?:

Describe the following properties of ionic crystals:

**Hardness:**

**Electrical Conductivity:**

**Melting Point:**