



# STEM TUTOREX

## Intermolecular Forces Concept Mastery & Application

### **Grade Level**

Grade 11 Chemistry (SCH3U)

Grade 12 Chemistry (SCH4U)

Monday, March 23, 2026

Dr. Amina Ould-Brahim  
Founder of Stem Tutorex

## Ontario Curriculum Expectations

- Describe London dispersion forces, dipole–dipole interactions and hydrogen bonding
- Analyse trends in boiling point, viscosity and physical state using intermolecular forces
- Justify predictions using molecular structure and particle reasoning

### Learning Goal

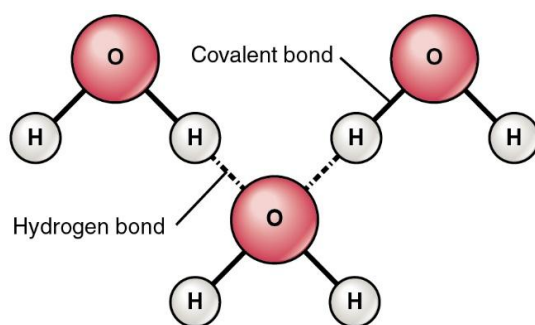
To understand how intermolecular forces influence the physical properties of substances and apply scientific reasoning to explain chemical trends.

### Part A — Concept Development

**Intermolecular forces (IMFs)** are forces of attraction and repulsion that occur between molecules due to the presence of partial or temporary charges.

These partial charges arise from differences in electronegativity between bonded atoms or from fluctuations in electron distribution within molecules, leading to regions of positive and negative charge.

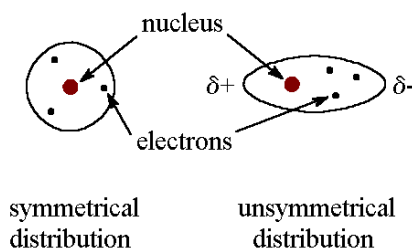
Although intermolecular forces are weaker than intramolecular forces (chemical bonds such as covalent or ionic bonds), they play a crucial role in determining the physical properties of substances, including boiling point, melting point, viscosity, and solubility.



## Types of Intermolecular Forces

### London Dispersion Forces (LDF)

London dispersion forces are present in **all molecules**, whether polar or non-polar. They arise from **temporary fluctuations in electron distribution** within a molecule. At any moment, electrons may be unevenly distributed, creating an **instantaneous dipole**. This temporary dipole can induce a dipole in a neighbouring molecule, resulting in an attractive force.



The strength of London dispersion forces increases with:

- the **number of electrons** (larger electron clouds are more easily distorted)
- the **molecular size and molar mass**
- the **surface area of contact** between molecules (linear molecules experience stronger forces than compact ones)

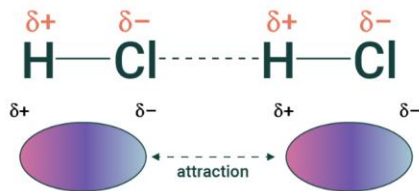
### Dipole–Dipole Forces

Dipole–dipole forces occur between **polar molecules**.

In these molecules, differences in electronegativity create **permanent partial charges**:

- a partial positive charge ( $\delta^+$ )
- a partial negative charge ( $\delta^-$ )

Molecules align so that the positive end of one molecule is attracted to the negative end of another.



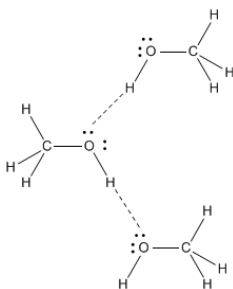
These forces are stronger than London dispersion forces (for molecules of similar size) but weaker than hydrogen bonding.

## Hydrogen Bonding

Hydrogen bonding is a **special and stronger type of dipole–dipole interaction**.

It occurs when hydrogen is covalently bonded to a **highly electronegative atom** such as Nitrogen (N), Oxygen (O), or Fluorine (F)

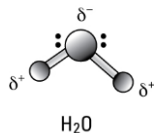
This creates a **very strong dipole**, where hydrogen carries a significant partial positive charge. This hydrogen is strongly attracted to a lone pair of electrons on a nearby N, O, or F atom.



Hydrogen bonding leads to:

- unusually **high boiling points**
- increased **viscosity**
- strong **molecular cohesion**

Example:  
Water (H<sub>2</sub>O)



## Part B — Interactive Exploration — Intermolecular Forces

Before answering the questions, explore how particles behave using the simulation below:

### PhET Simulation: States of Matter (Basics)

[Molecule polarity](#)

[States-of-matter](#)

#### What to observe

As you interact with the simulation, pay attention to:

- ✓ how particles move in solids, liquids, and gases
- ✓ how closely particles are packed
- ✓ how temperature affects motion
- ✓ how attraction strength influences particle behaviour

#### Guided Exploration

1. Compare different substances (e.g., Neon, Argon, Oxygen)
2. Increase and decrease temperature
3. Observe changes in particle movement and spacing
4. Identify which substances show stronger intermolecular forces

### Thinking Question (connect to worksheet)

How do intermolecular forces influence:

- particle motion?
- spacing between particles?
- phase (solid, liquid, gas)?

### Part C — Guided Questions

1. Order in increasing boiling point the following compounds:  $\text{CH}_4$  —  $\text{C}_2\text{H}_6$  —  $\text{C}_4\text{H}_{10}$ . Explain.
2. Which has stronger intermolecular forces:  $\text{HCl}$  or  $\text{H}_2$ ? Explain.
3. Why does water have a higher boiling point than methane?

### Part D — Application

4. Which has higher viscosity: Pentane or Octane? Explain.
5. Which has a higher boiling point: Propanol or Propane? Explain.
6. Why is iodine solid at room temperature while fluorine is a gas?

### Extension

Explain how molecular shape influences London dispersion forces using hexane and neopentane as examples.

## Success Criteria

- Identify intermolecular forces
- Predict boiling point trends
- Justify answers using particle reasoning
- Connect molecular structure to physical behaviour

## Ontario Achievement Chart — Intermolecular Forces

Category	Level 1 (50–59%)	Level 2 (60–69%)	Level 3 (70–79%)	Level 4 (80–100%)
<b>Knowledge &amp; Understanding</b>	Limited understanding of intermolecular forces	Some understanding of concepts	Considerable understanding of forces and properties	Thorough and accurate understanding of all intermolecular forces
<b>Thinking &amp; Investigation</b>	Limited ability to analyze and compare substances	Some ability to identify trends	Appropriate analysis of trends and comparisons	Insightful and accurate analysis with clear justification
<b>Communication</b>	Explanations are unclear or incomplete	Some clarity in explanations	Clear explanations using appropriate terminology	Precise, clear, and well-structured scientific explanations
<b>Application</b>	Limited connection between structure and properties	Some correct connections made	Appropriate application of concepts	Strong and consistent application to new situations

## Intermolecular Forces — Quick Reference

### Strength order:

London < Dipole–Dipole < Hydrogen Bonding

### Boiling point increases when:

- size increases
- electrons increase
- hydrogen bonding present

### Key idea:

Stronger forces → more energy needed → higher boiling point.

## Intermolecular Forces — Answer Key

### Questions

1.  $\text{CH}_4 < \text{C}_2\text{H}_6 < \text{C}_4\text{H}_{10}$  — boiling point increases due to stronger London dispersion forces.
  2. HCl has stronger intermolecular forces (dipole–dipole);  $\text{H}_2$  has only dispersion forces.
  3. Water forms hydrogen bonds → higher boiling point than methane.
  4. Octane has higher viscosity due to stronger dispersion forces.
  5. Propanol has a higher boiling point due to hydrogen bonding.
  6. Iodine has strong dispersion forces → solid; fluorine has weak forces → gas.
- Extension: Hexane has greater surface contact → stronger dispersion forces than neopentane.