What Makes It Boil?

Use boiling-point data to compare molecular attractions.

CHE.2.g "Analyze and interpret data to compare the strengths of intermolecular forces and to explain how these forces affect physical properties."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline the sentences about molecular size and O-H bonds, circle the four boiling points, then write 1 beside each substance in the equal-mass pair and 2 beside each alkane.

Clues in a Boiling Point

1. At a fragrance lab, a technician checks how easily liquids escape into the air. A normal boiling point is the temperature at which a liquid's vapor pressure matches standard atmospheric pressure. When measured at the same pressure, a higher boiling point usually signals stronger attractions between molecules. This clue helps compare substances without seeing individual molecules.

2. Several forces matter. All molecules have London dispersion forces, which generally increase as molecules become larger and more easily distorted. Polar molecules also attract through dipole-dipole forces. Molecules with an O-H bond can form hydrogen bonds with each other. Comparing substances with the same formula helps limit the effect of molecular mass.

BOILING POINTS AND MOLECULAR STRUCTURES

Substance	Condensed structure	Molar mass (g/mol)	Normal boiling point (°C)
Methoxymethane	CH_3OCH_3	46.07	−24.8
Ethanol	CH_3CH_2OH	46.07	78.4
Pentane	$CH_3(CH_2)_3CH_3$	72.15	36.1
Hexane	$CH_3(CH_2)_4CH_3$	86.18	68.7

3. The table reports measurements for four pure substances at standard atmospheric pressure. Each value marks the temperature where that substance boils, not the temperature at which it first begins to evaporate. A liquid can evaporate below its boiling point. At the same temperature, weaker attractions generally mean faster evaporation, although conditions such as airflow also matter.

2 ANSWER WITH EVIDENCE

Use the passage

1. Ethanol and methoxymethane have the same molar mass. Which has stronger intermolecular attractions? Use their boiling points and structures to explain.

2. Compare pentane and hexane. What do their boiling points suggest about the strength of their attractions, and how does molecular size help explain the difference?

3. Ethanol has a lower molar mass than hexane but a higher boiling point. What does this suggest about their attractions? Explain using the passage.

4. At 25 °C, both pentane and ethanol are liquids. Under the same conditions, which would generally evaporate faster? Support your prediction with the data.

3 YOUR TURN

Your own words

At standard atmospheric pressure, propan-1-ol, $CH_3CH_2CH_2OH$, boils at 97.2 °C, while methoxyethane, $CH_3OCH_2CH_3$, boils at 7.4 °C. In three sentences, compare their intermolecular attractions using the data, explain the structural cause, and predict which is a gas at 20 °C.

ANSWER KEY

What Makes It Boil?

PART 1 · READ AND MARK

Underline the sentences about molecular size and O-H bonds, circle the four boiling points, then write 1 beside each substance in the equal-mass pair and 2 beside each alkane. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	Ethanol and methoxymethane have the same molar mass. Which has stronger intermolecular attractions? Use their boiling points and structures to explain.	**Ethanol has stronger attractions: it boils at 78.4 °C, compared with −24.8 °C for methoxymethane. Its O-H bond allows ethanol molecules to hydrogen-bond with each other.**
2	Compare pentane and hexane. What do their boiling points suggest about the strength of their attractions, and how does molecular size help explain the difference?	**Hexane has stronger attractions because it boils at 68.7 °C, compared with pentane's 36.1 °C. Hexane is larger, so its London dispersion forces are generally stronger.**
3	Ethanol has a lower molar mass than hexane but a higher boiling point. What does this suggest about their attractions? Explain using the passage.	**Ethanol's attractions are stronger overall, as its 78.4 °C boiling point exceeds hexane's 68.7 °C. Ethanol molecules can hydrogen-bond, while hexane molecules rely on dispersion forces.**
4	At 25 °C, both pentane and ethanol are liquids. Under the same conditions, which would generally evaporate faster? Support your prediction with the data.	**Pentane would generally evaporate faster. Its lower boiling point, 36.1 °C versus 78.4 °C, suggests weaker intermolecular attractions.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

Propan-1-ol has stronger intermolecular attractions than methoxyethane, as shown by its higher boiling point of 97.2 °C versus 7.4 °C. Its O-H group allows hydrogen bonding between its molecules, while methoxyethane molecules cannot hydrogen-bond with one another. At 20 °C and standard atmospheric pressure, methoxyethane is a gas.

Accept explanations that use the boiling-point data to infer relative attraction strength and correctly connect O-H bonds or molecular size to the relevant forces. For evaporation, accept pentane as the prediction when conditions are held the same.