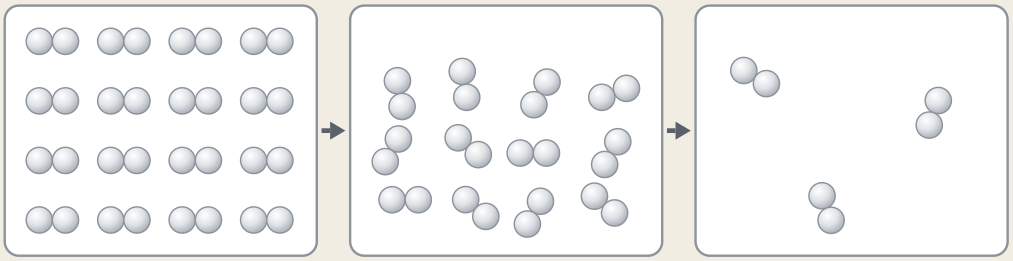
A12 · Predicting boiling points and solubility · Notes

Goals: Explain why stronger intermolecular forces give higher melting and boiling points. Compare the boiling points of two molecular substances from their forces and their electrons. Predict whether two liquids mix, and compare ionic and molecular substances.

Name: _____ Date: _____

Slide 1 of 7 · Stronger forces, higher melting and boiling points

In lesson A11 you listed the forces between molecules. Today those forces explain something you can see. Why is one substance a gas and another a solid in the same room?



solid
held in place

liquid
close, but moving

gas
far apart

Key ideas

To boil a liquid, its molecules must be pulled _____.

This needs _____ to overcome intermolecular forces.

No _____ breaks.

Stronger forces give _____ melting and boiling points.

Example

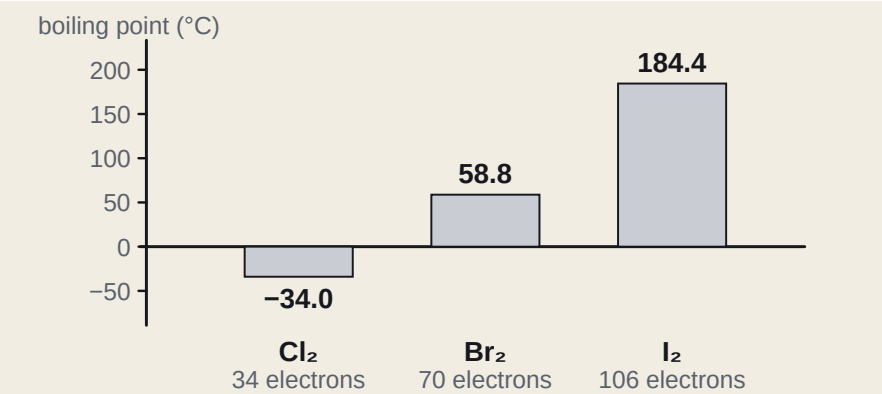
Substance X has stronger intermolecular forces than substance Y. Which has the higher boiling point? Say why.

Try it

When water boils, do the bonds inside the H_2O molecules break? Say what happens.

Slide 2 of 7 · Same kinds of force: count the electrons

On the last slide, stronger forces gave a higher boiling point. Now test that with real values. Start with a family where only one thing changes.



Key ideas

Cl_2, Br_2 and I_2 each have _____ only.

I_2 has _____ electrons, the most of the three.

More electrons give _____ London forces.

So I_2 boils at the highest temperature, _____ °C.

Example

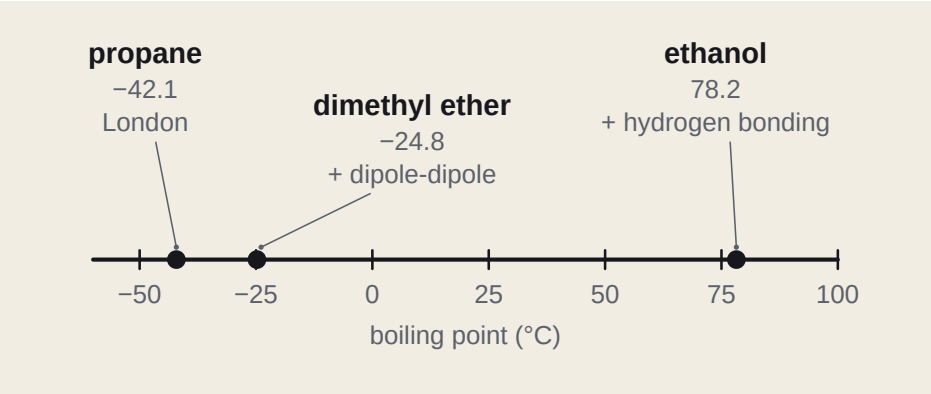
Neon has 10 electrons and argon has 18. Both have London forces only. Which has the higher boiling point? Say why.

Try it

Methane, CH_4, has 10 electrons. Propane, C_3H_8, has 26. Both are non-polar. Which has the higher boiling point? Say why.

Slide 3 of 7 · Same number of electrons: compare the kinds of force

On the last slide, the kind of force stayed the same and the electrons changed. Now hold the electrons steady and change the kinds of force.



Key ideas

Propane, dimethyl ether and ethanol each have _____ electrons.

Their London forces are about _____.

Dimethyl ether is polar, so it adds _____.

Ethanol adds _____, so it boils highest.

Example

F_2 and HCl each have 18 electrons. F_2 is non-polar and HCl is polar. Which has the higher boiling point? Say why.

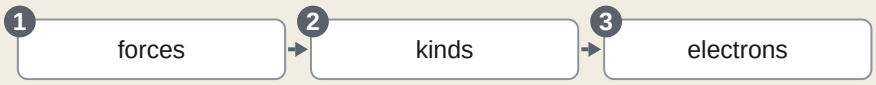
Try it

Ethane, C_2H_6, and methanol, CH_3OH, each have 18 electrons. Methanol has a hydrogen bonded to oxygen. Which has the higher boiling point? Say why.

Slide 4 of 7 · Method: how to compare two boiling points

You just compared two sets of boiling points. Each time you looked at the electrons and the kinds of force. Here that is as three steps.

1. **List** the forces of each substance.
2. **Compare** the kinds of force.
3. **Count** electrons if the kinds are the same.



Check: stronger forces give a higher boiling point.

Used again in: the unit review

Key ideas

Step 1: list the _____ of each substance.

Step 2: compare the _____ of force.

Step 3: if the kinds are the same, compare the _____.

Example

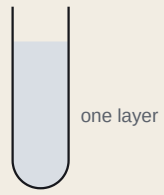
Use the three steps to compare the boiling points of ethane, C_2H_6, and propane, C_3H_8.

Try it

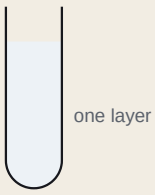
Use the three steps to compare the boiling points of water, H_2O, and methane, CH_4.

Slide 5 of 7 · Will two liquids mix?

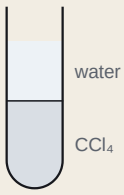
So far the forces acted between molecules of one substance. The same forces act between two different liquids. They decide whether the liquids mix.



Br_2 and CCl_4
Both are non-polar, so they mix.



H_2O_2 and water
Both hydrogen bond, so they mix.



CCl_4 and water
Their forces are not alike, so two layers form.

Key ideas

Two liquids mix when their intermolecular forces are _____.

Bromine and carbon tetrachloride are both _____, so they mix.

Hydrogen peroxide and water both have _____, so they mix.

Water and carbon tetrachloride stay apart, in _____.

Example

Will ethanol and water mix? Say why.

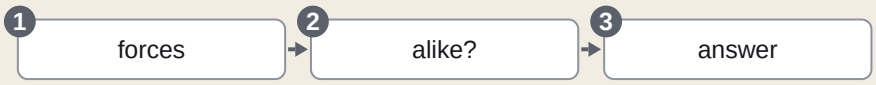
Try it

Hexane, C_6H_{14}, is non-polar. Will hexane and water mix? Say why.

Slide 6 of 7 · Method: how to predict whether two liquids mix

You just judged three pairs of liquids. Each time you compared their forces. Here that is as three steps.

1. **List** the forces of each liquid.
2. **Compare** the kinds of force. Are they alike?
3. **Predict** mixing if alike, two layers if not.



Check: like mixes with like.

Used again in: Unit C, solutions

Key ideas

Step 1: list the _____ of each liquid.

Step 2: ask if the forces are _____.

Step 3: write the _____: they mix, or they do not mix.

Example

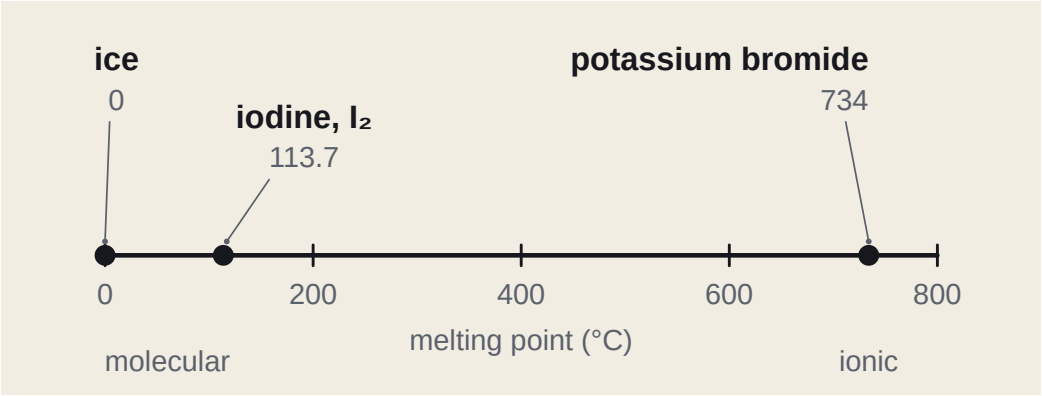
Use the three steps on bromine, Br_2, and hexane, C_6H_{14}. Both are non-polar.

Try it

Use the three steps on methanol, CH_3OH, and water. Methanol has a hydrogen bonded to oxygen.

Slide 7 of 7 · Ionic or molecular?

Lessons A3 and A4 were about ionic compounds. Lessons A5 to A12 were about molecules. Put the two halves of this unit side by side.



Key ideas

Melting an ionic solid pulls _____ apart.

Ionic bonds are _____.

Melting a molecular solid overcomes only _____.

So ionic compounds melt far _____ than molecular substances.

Example

Sodium chloride is ionic. Sugar is molecular. Which melts at the higher temperature? Say why.

Try it

Calcium oxide is ionic. Ice is molecular. Which melts at the higher temperature? Say why.