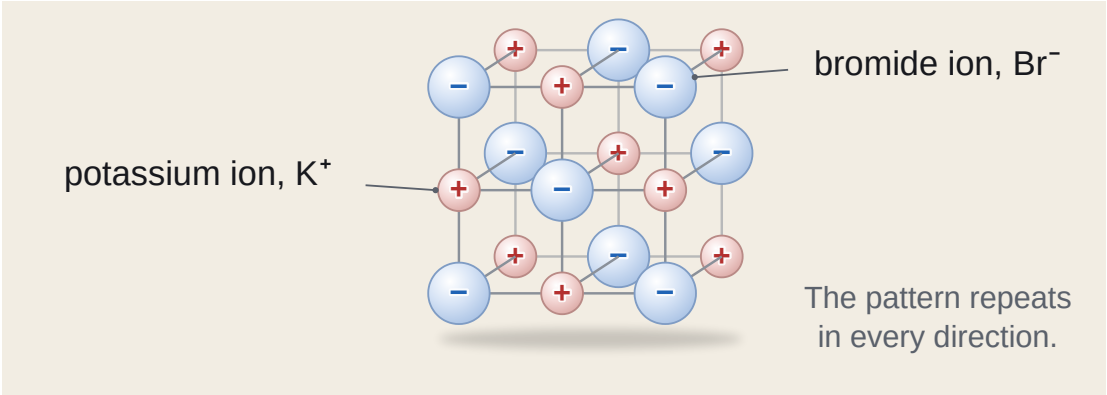
A4 · Ionic lattices and the properties they explain · Completed notes

Goals: Describe an ionic solid as a crystal lattice of ions. Explain why ionic compounds are hard, brittle and hard to melt, why many dissolve in water, and when they conduct electricity. Compare the melting points of two ionic compounds from the charges and sizes of their ions.

These are the completed notes. The blanks are filled in and each question is worked.

Slide 1 of 6 · An ionic solid is a lattice

In lesson A3 you drew one K^+ ion and one Br^- ion. A real crystal holds billions of each. Today you see how they fit together.



Key ideas

Ions pack together in a repeating pattern called a **crystal lattice**.

Each positive ion is surrounded by **negative** ions.

An ionic solid has no separate **molecules**.

So an ionic formula is a **ratio**.

Example

What does the formula CaF_2 tell you about a crystal of calcium fluoride?

1. The formula is a ratio.
2. The crystal has two fluoride ions for every calcium ion.
3. It is not one molecule.

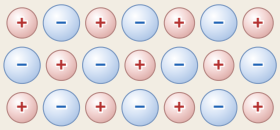
Try it

What does the formula KBr tell you about a crystal of potassium bromide?

1. The formula is a ratio.
2. The crystal has one potassium ion for every bromide ion.
3. It is not one molecule.

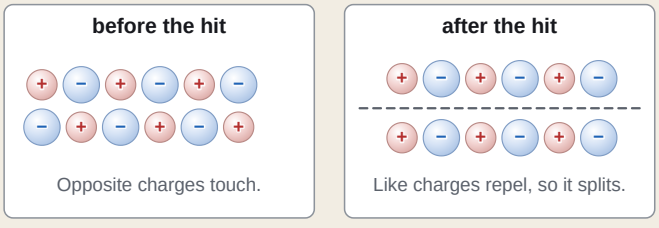
Slide 2 of 6 · Hard, brittle and hard to melt

On the last slide, every ion was pulled by all its neighbours. Those pulls explain what you see when you heat or hit an ionic solid.



Strong pulls act in every direction.

Potassium bromide **melts at 734 °C.**



Key ideas

An ionic solid is **hard**. Its pulls are strong and act in every direction.

It has a **high melting point**. Melting means the ions break free of the pattern.

It is **brittle**. A hard hit makes it shatter.

A hit slides one layer along. Then like charges **repel** and the crystal splits.

Example

After a layer slides, why do the two layers push apart?

1. Ions with the same charge are now side by side.
2. Like charges repel.
3. So the layers push apart.

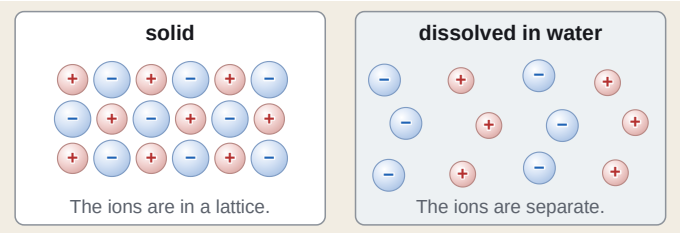
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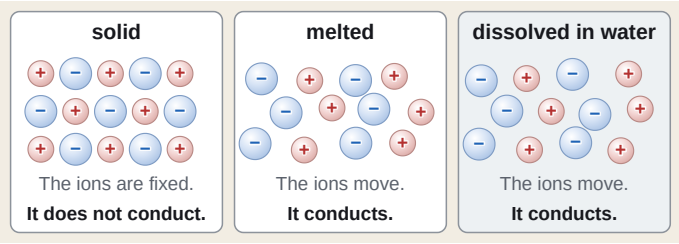
Why does an ionic solid need a high temperature to melt?

1. Each ion is held by strong pulls from all its neighbours.
2. Melting means the ions break free.
3. That takes a lot of energy.

Slide 3 of 6 · Dissolving and conducting

So far the lattice stayed whole. Water can take a lattice apart. Then the ions can move, and the compound behaves in a new way.





Key ideas

Many ionic compounds **dissolve** in water. Water pulls the ions out of the lattice.

A substance **conducts** electricity when charged particles can move through it.

In the solid, the ions are **fixed**. The solid does not conduct.

A solution that conducts is called an **electrolyte**.

Example

Solid potassium bromide does not conduct, but melted potassium bromide does. Why?

1. In the solid, the ions are fixed in the lattice.
2. In the liquid, the ions can move.
3. Moving ions carry the current.

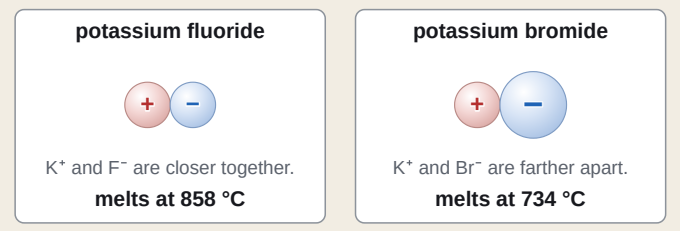
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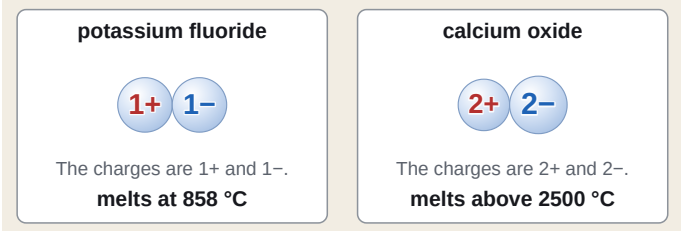
Will potassium bromide dissolved in water conduct? Say why.

1. Yes.
2. Water pulls the ions out of the lattice.
3. The separate ions are free to move, so the solution conducts.

Slide 4 of 6 · Comparing melting points

On slide 2, potassium bromide melted at 734 °C. Other ionic compounds melt higher or lower. Two things about the ions decide it.





Key ideas

Potassium bromide melts at 734 °C. Potassium fluoride melts at 858 °C.

Bigger ions sit farther apart, so they pull less strongly.

So **smaller** ions give a higher melting point.

Bigger **charges** pull much more strongly, so they give a higher melting point.

Example

Potassium iodide has a bigger negative ion than potassium bromide. Will it melt above or below 734 °C?

1. The charges are the same, so compare the sizes.
2. Bigger ions are farther apart and pull less strongly.
3. Potassium iodide melts below 734 °C.

Try it

Which melts higher, rubidium chloride (ions 1+ and 1−) or strontium sulfide (ions 2+ and 2−)?

1. The charges differ, so compare the charges.
2. Bigger charges pull more strongly.
3. Strontium sulfide melts higher.

Slide 5 of 6 · Method: how to compare the melting points of two ionic compounds

You just compared two pairs of compounds. Each time you looked at the charges and the sizes. Here that is as four steps.

1. **Write** the ions of each compound, with charges.
2. **Compare** the charges. Bigger charges melt higher.
3. **Compare** the sizes. Smaller ions melt higher.
4. **State** which melts higher, and why.



Check: only one thing differs between the two compounds.

Used again in: lesson A12

Key ideas

Step 1: write the **ions** of each compound, with charges.

Step 2: compare the **charges**. Bigger charges melt higher.

Step 3: compare the **sizes**. Smaller ions melt higher.

Step 4: **state** which melts higher, and why.

Example

Use the four steps to decide which melts higher, sodium fluoride or sodium iodide.

1. Step 1: NaF has Na^+ and F^-. NaI has Na^+ and I^-.
2. Step 2: the charges are the same, 1+ and 1−.
3. Step 3: fluoride is smaller than iodide.
4. Step 4: sodium fluoride melts higher, because its ions are closer and pull harder.

Try it

Use the four steps to decide which melts higher, calcium sulfide or potassium chloride.

1. Step 1: CaS has Ca^{2+} and S^{2-}. KCl has K^+ and Cl^-.
2. Step 2: the charges in CaS are bigger, 2+ and 2−.
3. Step 3 is not needed, because the charges decide.
4. Step 4: calcium sulfide melts higher, because bigger charges pull harder.

Slide 6 of 6 · Ionic compounds around us

In this lesson, ionic compounds were hard, brittle and hard to melt. Many also dissolved in water. People choose them for jobs that suit those properties.

calcium chloride $CaCl_2$ It melts road ice.	**potassium chloride** KCl It is a fertilizer (potash).
sodium fluoride NaF It is in toothpaste.	**calcium carbonate** $CaCO_3$ It is chalk and antacid tablets.

Key ideas

Calcium chloride melts **ice** on winter roads.

Potassium chloride is a **fertilizer**.

Sodium fluoride in **toothpaste** hardens teeth.

Each ionic compound is chosen for its **properties**.

Example

Calcium chloride is used to melt road ice. Which property makes that possible?

1. It dissolves in water.
2. Its separate ions lower the temperature at which water freezes.

Try it

Name one ionic compound you use at home, and say what it is used for.

1. One answer is sodium fluoride.
2. It is in toothpaste and hardens teeth.
3. Calcium carbonate in antacid tablets is another answer.