

Physical Properties of Two Solids

Some solids consist of molecules in which the atoms are held together by covalent bonds. These compounds are called molecular solids because they are made of molecules (instead of ions). Other solids consist of an array of positive and negative ions, arranged in such a way that every positive ion has only negative neighbours and vice versa; the solid is held together because of the attractions between ions of opposite charge. These substances are called ionic solids. In this experiment, you will examine the physical properties of the molecular solid “camphor” (in which atoms are joined by covalent bonds) and the ionic solid sodium chloride (in which atoms are held together with ionic bonds). Please note that pure camphor can irritate your skin; handle camphor with forceps at all times.

Procedure:

1. Set up your retort stand with a ring clamp and clay triangle. You should also have the fume hood in place. Rest an inverted crucible cover in the clay triangle. The cover should be large enough so that it will not pass through the triangle. If the triangle is too large, get another one. Do not light your Bunsen burner yet.
2. Place **a few** crystals of NaCl on the inverted crucible lid. Smell the sodium chloride; record your observation.
3. Place one small piece of camphor on the lid beside the NaCl. Smell the camphor; record your observation.
4. Place the crucible lid on a clay triangle attached to a retort stand. Set up your fume hood and position the opening directly over the lid. Use a very low Bunsen burner flame (air valve closed, flame about 5 cm high) to gently heat the crucible cover until one of the solids melts. Heat the crucible cover strongly for about one minute. Record which compound melts and boils off (only one will disappear). Turn off the Bunsen burner.
5. Get a watch glass and plastic spoon from the front of the room. Onto the watch glass place a sample of NaCl and a piece of camphor (same sizes as before). Crush each of the chemicals with the back of the spoon (by pushing down on the face of the spoon). In the table below, record the hardness of each solid.
6. Obtain two test tubes. Place a few crystals of NaCl in one tube and a sample of camphor in the other. Fill each tube about $\frac{1}{4}$ full with distilled water. Mix the contents of the tubes by “flicking” the base of the tubes with your finger for about one minute (“flicking” tubes with your fingernail can hurt – use the pad of your finger instead). Note which compound is soluble in water. Keep the test tubes for the next step.
7. Get a plastic spot plate and a conductivity tester (with battery attached). Using the samples at the front of the room, test the conductivity of a large salt crystal and a large camphor crystal. Record your findings. Next, pour some of the liquid from the test tubes (step 6) into two wells of the spot plate. Measure and record the conductivity of the solutions. Dump the contents of the tubes down the sink (place any pieces of camphor in the trash). Rinse and dry the tubes and the spot plate. Return all equipment.
8. This last step will be done as a demonstration: place a sample of NaCl in one tube and a sample of camphor in the other. Fill each tube about $\frac{1}{4}$ full with the “non-polar” solvent cyclohexane. Mix the contents of the tubes by “flicking” the base of the tubes. Note which compound is soluble in cyclohexane.

Observations and Conclusions

	Sodium chloride	Camphor (C ₁₀ H ₁₆ O)
1. Odour (strong, weak, or nil)		
2. Type of bonds between atoms (ionic or covalent)		
3. Melting point (high or low)		
4. Boiling point (high or low)		
5. Hardness (hard/brittle or soft)		
6. Solubility in a polar solvent such as water (soluble or insoluble)		
7. Electrical conductivity of solid (good or poor)		
8. Electrical conductivity when dissolved in water (good or poor)		
9. Solubility in a non-polar solvent (soluble or insoluble)		

Questions:

1. Which substance had the strongest odour? What does odour likely indicate about the ease with which the particles in a solid leave its surface? (hint: what does smell mean?)
2. Based on your observations of hardness and melting points, in which substance do you think the molecules were most tightly bonded?
3. Predict which compound is more soluble in water: I₂ or CuCl₂.
4. Predict which compound would have the lower melting and boiling point: Na₂S or NO₂.