

## LESSON 11

### Solids

The molecules you modelled in the last lesson all make liquids: but suppose you now put one of those liquids in the freezer, so that the molecules move more and more slowly. Let's see what happens.

There comes a point when the molecules have got so little energy they stop moving around each other. They are trapped by their stickiness. They still move, but they can only vibrate about fixed positions in a crystal lattice. The liquid has changed into a solid.

*Children can act this by moving closely around each other, moving more and more slowly, until at the melting point they get into ranks and files, staying very close together. They bob up and down on the same spot to show vibration. Even with two people this is worth acting, to help get the ideas across.*

There is just one temperature at which the solid and the liquid can stay together. A fraction above that temperature the stuff is all liquid, a fraction below, it's all solid. That particular temperature is called the melting point or freezing point.

**Q1.** Here are samples of naphthalene (a moth repellent) and urea (a fertilizer). Are their melting points below 25°C (room temperature) or are they above it? *[Your pupil will see two solids, so both must have melting points above room temperature.]*

We shall find which of these two substances has the higher melting point.

*Mount a flat diamond-shaped trowel horizontally, and put match-head amounts of naphthalene and urea on opposite sides of its widest part. Now heat the tip of the trowel with a flame and note which solid is the first to melt. (The melting points are: naphthalene 80°C, urea 133°C.)*

*This is a very safe experiment if you do it away from combustibles, and keep your pupil away from the flame. Use meths in a spirit lamp, or one of the heating tablets sold in camping shops, or as a last resort, a sooty candle flame!*

**Q2.** Which has the stickier molecules, naphthalene or urea? *[Urea. At the temperature naphthalene melted, the stickiness of the urea molecules was still able to hold the urea molecules in their fixed positions.]*

## ***Notes for Parents***

*If you are cooling a liquid it seems natural to call the temperature at which solid appears the freezing point. If you are heating a solid it seems natural to call the temperature at which liquid appears the melting point. For any pure substance however these temperatures are exactly the same.*

*Some teachers would say “when you lower the temperature, molecules move more slowly”. That is not wrong, but if you want to implant the idea that “hotness is molecular motion” you can use different wording.*

*An example of this more instructive wording is in this lesson’s first paragraph: “. . . put one of those liquids in the freezer, so that the molecules move more and more slowly.”*

*When you heat the tip of the trowel, the iron atoms vibrate more vigorously. The increasing movement energises neighbouring iron atoms, and the effect passes along the trowel. Since the piles of urea and naphthalene are the same distance from the tip, their molecules vibrate more and more but always to the same degree.*

*By this stage, your pupil should be giving Google the name or formula of each new molecule, whenever he/she has access to the Internet. The details so obtained are not important, but the growing familiarity with molecules is all-important.*