**Melting a polymer**

Polymers are made of molecules that are very long.

In the solid state the polymer molecules are strongly held together.

When the polymer melts, the molecules can move around.

Some students use string to represent these long molecules.

A close up of a logo

Description automatically generated

The students use different lengths of string to investigate how easy it is for different lengths of molecules to move across each other.

A polymer with longer molecules melts at a high temperature than a polymer made of molecules with shorted molecules.

1. Give one way in which the string model is a **good** representation to explain this.
2. Given one way in which the string model is **not a good** representation.

*Chemistry > Big idea CMS: Materials science > Topic CMS2: Designing materials > Key concept CMS2.1: Polymer properties*

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| **Response activity** |
| **Melting a polymer** |

**Overview**

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| Learning objective: | Materials scientists can design polymers with specific properties. |
| Observable learning outcome: | Explain why a long molecule has a higher melting point than a similar but shorter molecule. |
| Activity type: | Critiquing a representation |
| Key words: | molecule, polymer, melting point |

This activity can help develop students’ understanding by addressing the misunderstandings revealed by the following diagnostic question:

* Melting points

**What does the research say?**

As part of a study (Johnson, 2002), elements and compounds were explained in terms of atoms and molecules with both ‘molecular’ and ‘giant’ structures being given as possibilities. This is earlier than these ideas are typically introduced in chemistry courses however Johnson suggests that the idea is useful in explaining, in general terms, the low and high melting points of different substances.

Another paper (Nakhleh, 1992) which considers a range of chemical misconceptions, notes that many students were found not to be aware of the general difference in magnitude that exists between strength of a covalent bond and an intermolecular force.

As a substance with a giant structure is heated and as it changes from the solid, to liquid to gas state, many strong bonds between atoms must be broken. In a substance made up of separate molecules weaker intermolecular force must be overcome

Although the link between length of molecule and size of intermolecular forces is usually taught at a much older age, students of this age group should be able to understand that the difference in melting point relates to forces between the molecules and not the those between atoms within the molecule.

**Ways to use this activity**

Students should complete this activity in pairs or small groups, and the focus should be on the discussions. It is through the discussions that students can check their understanding and rehearse their explanations.

Philosophically science can be said to be a description of the ‘best model’ we have for the world. In this activity students should identify ways in which this particular model is a good representation of the real world, and ways in which it is not.

Students should work together to follow the instructions on either the worksheet or the PowerPoint. Giving each group one worksheet to complete between them is helpful for encouraging discussion, but each member should be able to report back to the class. Listening in to the conversations of each group will often give you insights into how your students are thinking.

In this activity it can be helpful to take feedback whilst using the model to demonstrate what makes it a useful model and perhaps the ways in which it is less good. A good approach might be to encourage your students to suggest their ideas and make clear their reasons and to demonstrate how this works with the model. You might ask other students why they think it was a good contribution, or when appropriate, if they can improve on the idea’s clarity.

Ending with the students completing the worksheet or questions from the PowerPoint individually, might help them to consolidate their learning.

*Differentiation*

You may choose to use simplified worksheets for some students, for example with gaps to fill in so they can focus on the science. In some situations, it may be more appropriate for a teaching assistant to read and/or scribe for one or two students.

**Equipment**

For each student/pair/group:

* string
* scissors

An alternative is shredded tissue paper.

**Expected answers**

The string model is a good representation because it feels harder to move the longer pieces of string passed each other.

The string model is not a good representation because it does not effectively model the existence of forces between the molecules.

**Acknowledgments**

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Images: Peter Fairhurst (UYSEG)

**References**

Johnson, P. (2002). Children's understanding of substances, part 2: Explaining chemical change. *International Journal of Science Education,* 24(10)**,** 1037-1054.

Nakhleh, M. B. (1992). Why don't some students don't learn chemistry. *Journal of chemical education,* 69(3)**,** 191-196.