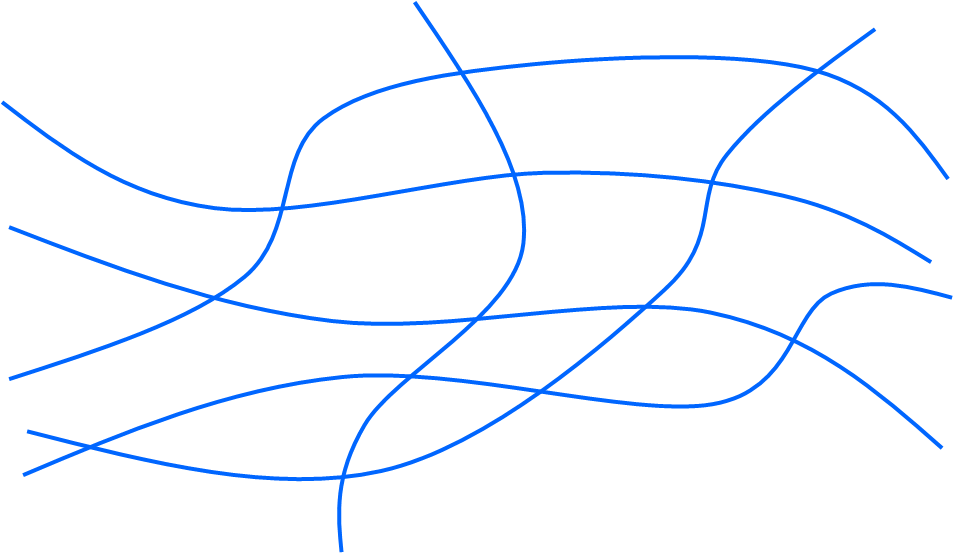
**Thermoset plastic**

Thermoplastic is made of separate polymer molecules.

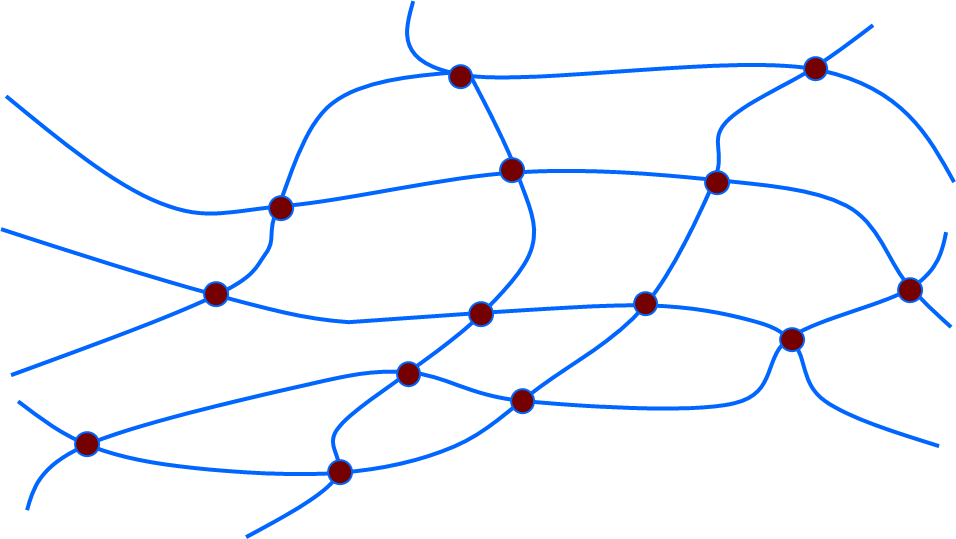
The polymer molecules are held together only by forces of attraction between the molecule.



An object made of a thermoplastic can be heated and formed into a new shape.

Thermoset polymer is made of polymer molecules that are connected.

The polymer molecules are connected by cross links to form a single large network.



An object made of a thermoset plastic cannot be heated and formed into a new shape.

These statements are about why objects made from thermoset plastics cannot be heated and reformed into new objects.

For each statement, tick (✓) **one** column to show what you think*.*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | | I am **sure** this is right | I think this is right | I think this is wrong | I am **sure** this is wrong |
| **A** | The molecules are connected making one large structure. |  |  |  |  |
| **B** | The molecules are strongly held together by cross-links. |  |  |  |  |
| **C** | The polymer molecules are heavier. |  |  |  |  |

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

|  |
| --- |
| **Diagnostic question** |
| **Thermoset Plastic** |

**Overview**

|  |  |
| --- | --- |
| Learning focus: | Materials scientists can design polymers with specific properties. |
| Observable learning outcome: | Explain how cross links between polymer molecules affect the properties of a polymer. |
| Question type: | confidence grid |
| Key words: | Polymer, molecule, cross link |

**What does the research say?**

A paper (Cooper, Williams and Underwood, 2015) cited research that about a quarter of grade 12 students (US) thought that intermolecular forces occurred within a molecule.

Another paper (Nakhleh, 1992) reports that some students are not aware of the general difference in magnitude that exists between the strength of a covalent bond and an intermolecular force.

If students have learnt that cross links are stronger than forces between molecules, then they should be able to make links between this feature of the structure and the resulting properties.

**Ways to use this question**

Students should complete the confidence grid individually. This could be a pencil and paper exercise, or you could use an electronic ‘voting system’ or mini white boards and the PowerPoint presentation.

If there is a range of answers, you may choose to respond through structured class discussion. Ask one student to explain why they gave the answer they did; ask another student to explain why they agree with them; ask another to explain why they disagree, and so on. This sort of discussion gives students the opportunity to explore their thinking and for you to really understand their learning needs.

*Differentiation*

You may choose to read the questions to the class, so that everyone can focus on the science. In some situations, it may be more appropriate for a teaching assistant to read for one or two students.

**Expected answers**

The molecules in a thermoset plastic are strongly held together by cross links to make one large structure so students should agree with statements A and B.

**How to respond - what next?**

A student who agrees with C may not understand that melting point is affected by the strength of attraction between molecules or that cross links are stronger than forces between the molecules.

If students have misunderstandings about the influence of cross links on properties, they could be shown how to make slime. Students should be encouraged to notice the difference between the un-crosslinked PVA glue and the slime (which has cross links).

The following BEST ‘response activities’ could be used in follow-up to this diagnostic question:

* Cross linked PVA

Links to practical details are provided in the response activity. Please note that not all methods of making slime that may be found online are safe.

**Acknowledgments**

Developed by Helen Harden (UYSEG)

Images: Peter Fairhurst (UYSEG)

**References**

Cooper, M. M., Williams, L. C. and Underwood, S. M. (2015). Student understanding of intermolecular forces: A multimodal study. *Journal of Chemical Education,* 92**,** 1288-1298.

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