**Melting points**

Some substances are made of short molecules.

Other substances are made of atoms of the same elements have longer molecules.

A picture containing man

Description automatically generated

Usually the longer the molecules, the higher the melting point.

A picture containing person

Description automatically generated

Why do longer molecules tend to have higher melting points?

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** | Atoms in longer molecules are more strongly held together. |  |  |  |  |
| **B** | There are greater forces between molecules. |  |  |  |  |
| **C** | More atoms need to be separated. |  |  |  |  |

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

|  |
| --- |
| **Diagnostic question** |
| **Melting points** |

**Overview**

|  |  |
| --- | --- |
| Learning focus: | 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. |
| Question type: | confidence grid |
| Key words: | molecule, polymer, melting point |

**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 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**

B

**How to respond - what next?**

A student who is confident about A or C, may have misunderstandings about what happens when a substance that is made up of separate molecules melts (or boils). The student is thinking that the molecules break down into separate atoms rather than understanding that the molecules remain intact. They may benefit from revisiting key concept CPS2.1: Atoms and molecules. The diagnostic question “Element differences” and the response activity “Changing to the gas state” relate to this idea.

If students have misunderstandings about what happens when a substance made up of long molecules melts you could try providing them with a physical modelling activity (using string or shredded tissue).

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

* Melting a polymer

**Acknowledgments**

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**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.