**Hidden energy**

Energy is used to change a substance from its solid state into its liquid state, or from its liquid state into its gas state.

Different amounts of energy are needed for each change of state.

Different amounts of energy are needed to change the state of different substances.

*The amount of energy needed can be calculated:*

**Energy**

**Mass**

**Specific**

**latent heat**

**=**

**X**

**E = m x L**

These statements are about specific latent heat (S.L.H.).

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

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| E  m  Specific latent heat, L = | | I am **sure** this is right | I think this is right | I think this is wrong | I am **sure** this is wrong |
| **A** |  |  |  |  |  |
| **B** | S.L.H. is the amount of energy needed to change the state of 1 kg of a substance. |  |  |  |  |
| **C** | Specific latent heat is measured in Joule. |  |  |  |  |

*Physics > Big idea PMA: Matter > Topic PMA3: Energy of moving particles > Key concept PMA3.3: Specific latent heat*

|  |
| --- |
| **Diagnostic question** |
| **Hidden energy** |

**Overview**

|  |  |
| --- | --- |
| Learning focus: | Specific latent heat (of a particular change of state) is the amount of energy needed to change the state of 1 kg of a substance without changing its temperature. |
| Observable learning outcome: | Make and understand calculations using the equation E = m x L |
| Question type: | Confidence grid |
| Key words: | Specific latent heat, energy, mass, Joule, Joule per kilogram |

**What does the research say?**

Rearranging formulae is something that students can often find challenging (Boohan, 2016). The difficulty in students being able to use maths in physics may be that they can’t do the maths, but it could also be to do with students struggling with the way symbols in equations are used to make meaning differently in maths and physics (Redish and Kuo, 2015).

In physics each symbol in an equation is connected to a physical variable. Students are required to perform mathematical operations with the equation and then connect the mathematical operations and the results of calculations to their implications in the physical world (Redish and Kuo, 2015). To show mastery in physics students should be able to explain their equations in words, however at age 14-16 students often hide an incomplete understanding as they can calculate correct answers by treating equations just as mathematical operations without a good understanding of the physics that may be necessary for their future studies.

**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**

Statements A and B are right.

Statement C is wrong.

**How to respond - what next?**

This question addresses students’ interpretation of the equation for specific latent heat.

The first statement checks whether students can carry out mathematical operations to rearrange an equation.

The second statement requires students to explain the equation in words. The specific latent heat is the energy divided by the number of kilograms of substance that has changed state, which means that it is the energy needed to change each kilogram. Strictly speaking, specific latent heat is the energy needed to change the state of each kilogram of a substance *without a change of temperature*.

The final statement follows on from the second. The specific latent heat measures the energy needed for each kilogram, so it is measured in Joule per kilogram\*, or J/kg (or J kg-1).

If students have misunderstandings about rearranging and interpreting the equation E = mL, a useful strategy is to guide them through several examples. To support the interpretation of the equation, it can be helpful to use examples of different masses for the same transition of a particular substance and other examples that use the same mass of different substances undergoing the same transition.

As students develop their understanding, support can be gradually withdrawn as they work through further examples on their own.

For some students it may be appropriate to include some advanced examples in which the energy needed to increase the temperature of a substance as well as to change its state is required. Such examples would need students to use both E = mL and ΔE = mcΔΘ and to add the energies calculated in each to give a final answer.

*\*Units that are named after a person are typically capitalised.*

**Acknowledgments**

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**References**

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Redish, E. F. and Kuo, E. (2015). Language of physics, language of math: Disciplinary culture and dynamic epistemology. *Science and Education,* 24**,** 561-590.