**How much energy?**

The energy needed to heat an object can be calculated using:

Energy = mass x specific heat capacity x increase in temperature

**E** = **m** x **c** x **ΔT**

E = energy (Joules)

m = mass (grams)

C = specific heat capacity (Joules per gram oC)

ΔT = increase in temperature (degrees C)

**To answer**

1. A steel ball has a mass of 50g.

The specific heat capacity of steel is 0.5 J/g oC

How much energy is needed to heat the steel ball by 30oC?

*Using:**E = m x c x ΔT*

*E = 50 x 0.5 x 30*

*= 750*

*750 Joules of energy are needed*

1. A lead ball has a mass of 50g.

The specific heat capacity of steel is 0.15 J/g oC

How much energy is needed to heat the lead ball by 30oC?

1. A kettle contains 1200g of water.

The specific heat capacity of water is 4.2 J/g oC

How much energy is needed to heat the water by 80oC?

1. A cup contains 200g of water.

The specific heat capacity of water is 4.2 J/g oC

How much energy leaves the water as it cools by 65oC?

*Physics > Big idea PMA: Matter > Topic PMA1: Heating and cooling > Key concept PMA1.4: Thermal store of energy*

|  |
| --- |
| **Response activity** |
| **How much energy?** |

**Overview**

|  |  |
| --- | --- |
| Learning focus: | Each different material will have more energy in its thermal store of if either its temperature or mass is increased |
| Observable learning outcome: | Use the equation E = mcΔT to calculate the energy needed to increase the temperature of a material |
| Activity type: | Application and practice - calculations |
| Key words: | Thermal store of energy, temperature, specific heat capacity |

This activity can help develop students’ understanding by extending ideas about specific heat capacity, in order to calculate changes in the amount of energy in thermal stores.

|  |  |
| --- | --- |
| **B** | **BRIDGING**  This activity explores ideas that are usually taught at age 14-16, to build a bridge to later stages of learning. |

**What does the research say?**

Apart from mass and temperature, the other factor that affects the amount of energy in the thermal store of a material is the specific heat capacity of the material. It is common for students to experience specific heat capacity, c, for the first time as the constant in the equation E=mcΔT (which they often learn in their later studies at age 14-16). Although they are often able to calculate values with this equation, students do not often understand what specific heat capacity tells us about a material. Using an investigative approach has been shown to help develop a clearer understanding of specific heat capacity. (Herrington, 2011)

This question introduces students to the equation E=mcΔT and could follow the investigative approach to understanding specific heat capacity covered in the response activity: Hot metal.

**Ways to use this activity**

This activity gives students the opportunity to practise applying their understanding and to clarify their thinking through discussion. To support this, students should answer the questions in pairs or small groups.

Listening to individual groups as they work often highlights any difficulties they might have. These can often be overcome, through a whole class clarification or redirection part way through the activity.

Allowing only one student in each pair or small group to write down the answer on behalf of the group encourages discussion of both the science and of the presentation of the answer. Mini-white boards allow groups to show you their answers for immediate feedback.

*Differentiation*

If some students are working with a teaching assistant, then a list of prompt questions for the TA could help to make this activity more purposeful.

It may be appropriate for some students to convert answers 3 and 4 into kilojoules (kJ).

**Expected answers**

1. 750 J
2. 225 J
3. 403 200 J
4. 54 600 J

**Acknowledgments**

Developed by Peter Fairhurst (UYSEG).

**References**

Herrington, D. G. (2011). The heat is on: an inquiry-based investigation for specific heat. *Journal of Chemical Education,* 88(11)**,** 1558-1561.