

## Key concept (age 11-14)

### PMA1.4: Thermal store of energy

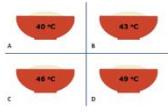
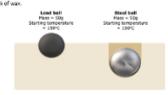
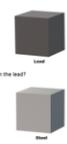
#### Progression toolkit: Thermal store of energy

<b>Learning focus</b>	Each different material will have more energy in its thermal store if either its temperature or mass is increased.				
<b>As students' conceptual understanding progresses they can:</b>					
<b>As students' conceptual understanding progresses they can:</b>	Identify which of two objects or substances has the most energy in its thermal store when the only difference between them is temperature.	Identify which of two objects or substances has the most energy in its thermal store when the only difference between them is their mass.	Explain the difference between energy (in a thermal store) and temperature.	Describe how the specific heat capacity of a material affects the amount of energy in its thermal store.	Use the equation $E = mc\Delta T$ to calculate the energy needed to increase the temperature of a material. <b>B</b>
<b>Diagnostic questions</b>	Thermal store of energy		Three bears Hot fill	Specific heat capacity	
<b>Response activities</b>		The same Bunsen	Energy vs temperature	Hot metal	How much energy?

Key:

**P** Prior understanding from earlier stages of learning

**B** Bridge to later stages of learning

<p><b>Thermal store of energy</b></p> <p><b>BEST</b> STUDENT WORKSHEET</p> <p><b>Thermal store of energy</b></p> <p>Let's have been outside building a fireman. (She is very cool)</p> <p>1. Which drink will warm us. (Is the most?) 2. Which drink has most energy in its thermal store?</p>  <p>3. Which bowl of porridge has most energy in its thermal store?</p>  <p>Developed by the University of York Science Education Group and the Salters' Institute. This document may have been edited. Download the original from <a href="http://www.BestEvidenceScienceTeaching.org">www.BestEvidenceScienceTeaching.org</a> © University of York Science Education Group. Distributed under a Creative Commons Attribution-NonCommercial (CC BY-NC) license.</p>	<p><b>Three bears</b></p> <p><b>BEST</b> STUDENT WORKSHEET</p> <p><b>Three bears</b></p> <p>The three bears were enjoying They can't decide whose porridge has most energy in its thermal store.</p>  <p>Read each statement about the bears' porridge? What do you think about each one?</p> <p>For each statement, tick (✓) or cross (✗) to show what you think.</p> <table border="1"> <thead> <tr> <th>STATEMENT</th> <th>I am sure this is right</th> <th>I think this is right</th> <th>I'm not sure</th> <th>I think this is wrong</th> <th>I am sure this is wrong</th> </tr> </thead> <tbody> <tr> <td>A. Paddy Bear has the most energy in his porridge.</td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>B. Mummy Bear has more spoonfuls of porridge than baby Bear.</td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>C. The amount of energy Bear porridge has is more energy than one spoonful of porridge that I eat today.</td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>D. Mummy Bear has more energy in her porridge than baby Bear.</td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> </tbody> </table> <p>Developed by the University of York Science Education Group and the Salters' Institute. This document may have been edited. Download the original from <a href="http://www.BestEvidenceScienceTeaching.org">www.BestEvidenceScienceTeaching.org</a> © University of York Science Education Group. Distributed under a Creative Commons Attribution-NonCommercial (CC BY-NC) license.</p>	STATEMENT	I am sure this is right	I think this is right	I'm not sure	I think this is wrong	I am sure this is wrong	A. Paddy Bear has the most energy in his porridge.						B. Mummy Bear has more spoonfuls of porridge than baby Bear.						C. The amount of energy Bear porridge has is more energy than one spoonful of porridge that I eat today.						D. Mummy Bear has more energy in her porridge than baby Bear.						<p><b>Hot fill</b></p> <p><b>BEST</b> STUDENT WORKSHEET</p> <p><b>Hot fill</b></p> <p>Lots of people mix up ideas about temperature and energy.</p> <p>NOT in the gaps to complete each sentence.</p> <p>You should only use the words <b>energy</b> and <b>temperature</b>.</p> <p><b>Energy or temperature?</b></p> <ol style="list-style-type: none"> <li>_____ is a measure of how hot or cold something is.</li> <li>A thermometer measures _____.</li> <li>A candle flame has a bigger _____ than a bath of lukewarm water.</li> <li>A bath of lukewarm water has a bigger _____ than a white hot spark.</li> <li>A cup of boiling water has the same _____ as a kettle full of boiling water.</li> <li>Adding water at 40°C to a cup of water at 40°C increases its _____.</li> </ol> <p>Developed by the University of York Science Education Group and the Salters' Institute. This document may have been edited. Download the original from <a href="http://www.BestEvidenceScienceTeaching.org">www.BestEvidenceScienceTeaching.org</a> © University of York Science Education Group. Distributed under a Creative Commons Attribution-NonCommercial (CC BY-NC) license.</p>	<p><b>Specific heat capacity</b></p> <p><b>BEST</b> STUDENT WORKSHEET</p> <p><b>Specific heat capacity</b></p> <p>Two metal balls are heated to 100°C in an oven. The mass of each ball is the same. The balls are put on top of a brick of wax. The metal balls melt the wax. This is what happens.</p>  <p>Read each statement about the metal balls. What do you think about each one?</p> <p>For each statement, tick (✓) or cross (✗) to show what you think.</p> <table border="1"> <thead> <tr> <th>statement</th> <th>I am sure this is right</th> <th>I think this is right</th> <th>I'm not sure</th> <th>I think this is wrong</th> <th>I am sure this is wrong</th> </tr> </thead> <tbody> <tr> <td>A. 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What do you think will happen?</p> <p><b>Explain</b></p> <p>Why do you think this will happen?</p> <p>Now carry out the investigation.</p> <p><b>Observe</b></p> <p>Record how much the temperature goes up for each volume of water:</p> <p><b>Explain</b></p> <p>Where your prediction and explanation correct? If not, can you explain what you observed?</p>  <p>Developed by the University of York Science Education Group and the Salters' Institute. This document may have been edited. Download the original from <a href="http://www.BestEvidenceScienceTeaching.org">www.BestEvidenceScienceTeaching.org</a> © University of York Science Education Group. Distributed under a Creative Commons Attribution-NonCommercial (CC BY-NC) license.</p>
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<p><b>Energy vs temperature</b></p> <p><b>BEST</b> STUDENT WORKSHEET</p> <p><b>Energy vs temperature</b></p> <p>This model uses dice to represent energy. Each die has two sides of energy.</p>  <p><b>Activity 1</b></p> <ol style="list-style-type: none"> <li>Your teacher divides the class into two groups. One group is twice as big as the other.</li> <li>Each group is given some dice to share out equally between themselves.</li> </ol> <p><b>To answer:</b></p> <ul style="list-style-type: none"> <li>How many dice does each person get?</li> <li>Which group has the higher temperature?</li> <li>Which group has the higher energy?</li> </ul> <p>How do you explain your answers?</p> <p><b>Activity 2</b></p> <ol style="list-style-type: none"> <li>Each person takes two dice (just all the other ones back).</li> <li>Each group bets on how many times in a row they will get a 6.</li> </ol> <p><b>To answer:</b></p> <ul style="list-style-type: none"> <li>Which group has got the most energy?</li> <li>Which group has the higher temperature?</li> </ul> <p>How do you explain your answers?</p> <p>Developed by the University of York Science Education Group and the Salters' Institute. This document may have been edited. Download the original from <a href="http://www.BestEvidenceScienceTeaching.org">www.BestEvidenceScienceTeaching.org</a> © University of York Science Education Group. Distributed under a Creative Commons Attribution-NonCommercial (CC BY-NC) license.</p>	<p><b>Hot metal</b></p> <p><b>BEST</b> STUDENT WORKSHEET</p> <p><b>Hot metal</b></p> <p>These cubes are made out of metal. They are put into a beaker of water hot water to heat up. Each one is put into a new beaker with 100cm<sup>3</sup> of cold water.</p>  <p><b>Predict</b></p> <p>Does the steel have more than twice the energy in its thermal store than the lead? What will you observe if it does?</p> <p><b>Explain</b></p> <p>What are the reasons for your prediction?</p> <p>Now carry out the investigation.</p> <p><b>Observe</b></p> <p>Measure how much the temperature of the water goes up for each metal.</p> <p><b>Explain</b></p> <p>Where your prediction and explanation correct? If not, can you explain what you observed?</p> <p>Developed by the University of York Science Education Group and the Salters' Institute. This document may have been edited. Download the original from <a href="http://www.BestEvidenceScienceTeaching.org">www.BestEvidenceScienceTeaching.org</a> © University of York Science Education Group. Distributed under a Creative Commons Attribution-NonCommercial (CC BY-NC) license.</p>	<p><b>How much energy?</b></p> <p><b>BEST</b> STUDENT WORKSHEET</p> <p><b>How much energy?</b></p> <p>The energy needed to heat an object can be calculated using:</p> $E = m \times c \times \Delta T$ <p><math>E = \text{energy (Joules)}</math>      <math>c = \text{specific heat capacity (Joules per gram } ^\circ\text{C)}</math>  <math>m = \text{mass (grams)}</math>      <math>\Delta T = \text{increase in temperature (degrees } ^\circ\text{C)}</math></p> <p><b>To answer</b></p> <ol style="list-style-type: none"> <li>A metal ball has a mass of 10g. The specific heat capacity of metal is 0.5 J/g °C. How much energy is needed to heat the metal ball by 20°C?  <math display="block">\text{so: } E = m \times c \times \Delta T</math> <math display="block">= 10 \times 0.5 \times 20</math> <b>200 Joules of energy are needed.</b> </li> <li>A metal ball has a mass of 10g. The specific heat capacity of metal is 0.5 J/g °C. How much energy is needed to heat the metal ball by 30°C?</li> <li>A metal container's mass is 10g. The specific heat capacity of metal is 0.5 J/g °C. How much energy is needed to heat the water by 10°C?</li> <li>A cup contains 10g of water. The specific heat capacity of water is 4.2 J/g °C. How much energy is needed to heat the water at 100°C by 5°C?</li> </ol> <p>Developed by the University of York Science Education Group and the Salters' Institute. This document may have been edited. Download the original from <a href="http://www.BestEvidenceScienceTeaching.org">www.BestEvidenceScienceTeaching.org</a> © University of York Science Education Group. Distributed under a Creative Commons Attribution-NonCommercial (CC BY-NC) license.</p>																																																														
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