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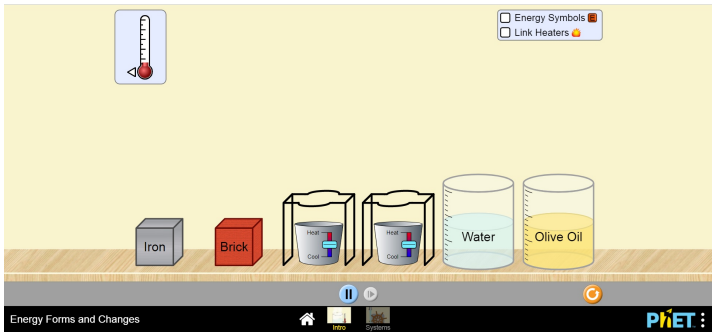
Energy Forms & Changes Virtual Lab

Introduction: You will use the PhET simulation Energy Forms & Changes to predict, experiment, discover and interpret the meaning of the material property known as Specific Heat Capacity.



Warm-Up:

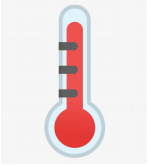
1. Describe what the following terms mean

   Temperature – the measure of the average kinetic energy per molecule of a substance.

   Heat – the energy that flows from one object to another due to a temperature difference between them.

2. Using your definition for temperature above, explain how a thermometer works to provide a visual representation of the temperature
   Ans: Many thermometers are thin glass filled with a liquid. A change in temperature causes a small change in the volume of the liquid. Most thermometers measure temperature by the by means of expansion or contraction of the liquid. When the liquid expands in the tube of the thermometer it is magnified, there is a change in height and that is what we see.

3. Thermometers in the past were filled with mercury but most are now filled with alcohol instead due to safety reasons. Why do you think alcohol is used instead or water?

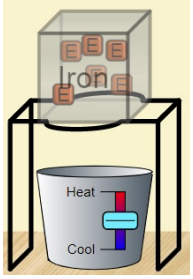
   

   Ans: Alcohol is used instead of water because it boasts a higher thermal expansion. In addition, alcohol has a very low freezing point of -114°C (-173.5 °F) while water freezes at 0°C (32 °F). Water would hinder the use of a thermometer when it's freezing outside.

4. The simulator allows you to add the same amount of heat energy to different materials e.g. water, oil, iron, brick. If you can measure the temperature of these materials as you are heating them would you predict that each will have the same temperature changes? Explain.

Ans: I think the temperature would change for all of them just at a different rate. The amount of heat needed to raise the temperature for each material is different. They all have different specific heat capacity. For example, the oil would heat up faster than water because it has a lower heat capacity.

Experiment:



5. Position the Iron block on one of the ring stands and move a thermometer to the block to measure the temperature of it. Then click the Energy Symbols tab and begin increasing the heat under the iron. Describe what you observe.

   Ans: As the heat increased, the temperature increased. The energy symbols were increasing and escaping one at a time. Therefore, the temperature increased, and the thermal energy increased also.

6. Predict what you would see if you are able to measure the temperature of the Iron block and Brick block as you supply the same amount of heat to each block.

   Ans: The temperature of the brick block will be higher than the temperature of the iron block.

7. Click the reset button, then drag the iron block on one stand and the brick block on the second stand. Again, put a thermometer in both blocks to measure the temperature of each. Click the Energy Symbols and Link Heaters tabs. Before adding any heat to the blocks, observe any differences in the blocks and provide a reason for this

   Ans: Before adding heat to the blocks, the brick showed less energy symbols when compared to the iron block because the iron holds more thermal energy than the brick.

Observation & Analysis:

8. Increase the temperature on the blocks and observe the thermometers and record observations

   Ans: The temperature increased on both blocks. However, the brick heats up faster than the iron resulting in a higher temperature. The iron still had more energy symbols because it holds more thermal energy than the brick. Lastly, they both lost energy symbols (thermal energy) into the air.

9. If you wanted to use these experiments to get quantitative observations and create a graph showing trends, list the variables in such an experiment

Independent – time
Dependent – temperature
Control – same amount of heat that is being added to the materials

10. Repeat the comparison done with the blocks above, this time comparing the two liquids. Record your observations.
    Ans: The water has more energy symbols than the olive oil. The olive oil heats up faster than water because the heat capacity of oil is lower than the heat capacity of water.

11. Repeat again this time comparing water and iron. Records your results.
    Ans: Water has more energy symbols than the iron block. The iron heats up faster than water even though the same amount of heat energy is being added.

12. What does your experiment tell you about water?

Ans: Water has the highest specific heat capacity when compared to the iron block and olive oil.

Discussion:

Specific Heat Capacity is the amount of heat energy required to raise the temperature of a substance per unit of mass e.g. 1 g. It is essentially a property of a material that describes its ability to store heat. Different materials have different specific heat capacities.

13. Conduct research to find the specific heat capacity of water _____4.18 J/g°C _____ and iron _____0.450 J/g°C. _____. The specific heat of iron is 0.450 J/g°C. The specific heat of water is 4.18 J/g°C.

14. Based on your observations & analysis from above explain what you would expect to see when you research the Specific Heat Capacity value for copper.

    I would expect to see that the specific heat capacity value for copper is less than water.

15. The specific heat capacity of copper is ____0.385 J/g°C._____ this means it takes 0.385 Joules of heat to raise 1 gram of copper 1-degree Celsius.

16. Clay bricks are used as building materials in construction. Do some research on specific heat capacities of brick, concrete, stone etc. and advise on what this means for society.

Ans: Stone and concrete have a high capacity to store heat and are referred to as 'high thermal mass' materials. Concrete absorb the heat then releases it during cooler periods, for example at night. Reducing the cement may reduce the heat-generating capacity of the mix. In addition, concrete does crack sometime. Bricks help to reduce the heat inside the house, and they are fire resistance. One of the main important things to do is to plan construction operations with hot weather in mind.

Extend:

17. An igloo, or snow hut, is a type of shelter built out of snow traditionally used only by the people of Canada's Central Arctic and Greenland's Thule area. Conduct research to find the specific heat capacity values of the materials that igloos are built from. Then explain whether these are an efficient choice for design of a home in colder climates.
    Ans: An igloo is typically made from blocks of snow and ice. The specific heat capacity of snow is 2090 J/kg C°. Igloos are efficient in colder climates because snow and ice work as insulators to trap body heat inside the igloo. Also, the walls of the igloo block the wind.