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SPECIFIC HEAT

Not all objects heat the same way…

It's evening and you've been asked to empty the dishwasher before going to bed. You open it and forget to empty it for about twenty minutes. After you're reminded to finish emptying the dishwasher, you return and notice something about the dishes inside - the ceramic items (plates/bowls) are all dry, as are all of the heavy metal items (large pots and pans). Lighter metal items (like silverware) are mostly dry, but still a little damp. The plastic containers are all still wet. That is a combination of chemistry and physics at work! Answer the questions below to figure out why this is true.

1. Think about two puddles in the parking lot. One is twice as large as the other. Which puddle will be warmer after the sun has been on them for half an hour?

2. Propose an explanation why one puddle might get hotter than the other even though they are exposed to the same amount of sunlight (and therefore heat).

3. Is the relationship between ability to heat up something and its mass directly proportional or inversely proportional? In other words, is it harder to heat something of a higher mass or a lower mass? Carefully consider your answers to questions 1 and 2 to help you. Explain your answer.

Explanation:

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4. Consider the metal hood of a car on a warm sunny day. Next to the car is a large puddle of water. The puddle of water is so large that it has the same mass as the hood of the car. Assume that the hood of the car and the puddle are exposed to the same amount of sunlight. Which will be hotter after two hours—the hood of the car or the puddle?

5. Propose an explanation for the fact that even though both the hood and the puddle were exposed to the same amount of heat energy and their masses were the same, one still got much warmer than the other.

6. Which will keep you warmer longer - a bottle of hot water or a bottle of hot air? Why?

Specific Heat Capacity (C_p)

In the questions above, you probably recognized that the temperature change of a substance depends on the mass of the substance. You also have probably experienced the fact that different substances heat at different rates, like in the dishwasher example at the beginning of this sheet. This difference in energy needed to heat different substances is called the **specific heat capacity**, or just “specific heat”. The specific heat capacity is a measure of **the amount of energy needed to change the temperature of the substance**. The higher the specific heat, the more energy is required to change the temperature of the substance. You can think of specific heat as the amount of energy something can absorb before its temperature changes.

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7. You are holding a slice of pizza by the crust when you take a bite and burn the roof of your mouth. Which has the higher heat capacity - cheese or crust?

8. Think about the dishwasher example from the beginning of this worksheet again. Consider that a large amount of heat energy has been applied to all of the dishes in the dishwasher. Fill in the blank: dishes with a higher specific heat will cool down _____ than dishes with a lower specific heat in the same amount of time. **(Choose more or less)**.

9. Put the items listed in the opening paragraph in order from highest heat capacity to lowest heat capacity.

10. Given the following symbols and your answers to the above questions, which of the following equations is correct? Make sure you have the correct answer before proceeding to the next questions!

ΔT = temperature change of a substance
C_p = specific heat capacity
m = mass of substance
q = amount of heat energy applied to the substance

A) $\Delta T = (q)(m)(C_p)$ B) $\Delta T = \frac{q}{(m)(C_p)}$ C) $\Delta T = \frac{(q)(m)}{(C_p)}$ D) $\Delta T = \frac{(C_p)(m)}{q}$

Hint: Equation D is not correct because according to that equation, a large mass will lead to a large temperature change, but this is not consistent with questions 3. Apply this same reasoning to the other equations to see if an equation is logical.

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11. If ΔT is measured in °C, m is measured in grams (g), and q is measured in Joules (J), what are the units for specific heat capacity?

12. What is the temperature change of a 50 g piece of gold whose specific heat is 0.129 J/g°C after 500 J of heat energy is applied?