Specific Heat Practice Set KEY Name____

Specific heat tells you how difficult something is to heat up or cool down. It is the measure of how much heat is needed to cause a given quantity of a substance to increase its temperature by a certain amount. Water has a high specific heat so it's harder to heat up. Metals have low specific heats, so they are easier to heat up. The specific heat of water is 4.18 J/g ^{0}C.

There is another side to specific heat. A substance that takes a long time to heat up, also takes a long time to cool down. The lower the specific heat of a substance, the more its temperature will change in a given time period. The higher the specific heat of a substance, the less its temperature will change in a given time.

Specific heat of selected substances:

Alcohol	2.299 J/g^{o}C
Water	4.18 J/g^{o}C
Iron	0.46 J/g ^{0}C
Copper	0.38 J/g ^{0}C
Zinc	0.386 J/g ^{0}C
Silver	0.251 J/g ^{0}C
Lead	0.138 J/g ^{0}C
Aluminum	0.961 J/g ^{0}C

Using this table, answer the following questions. Be sure to explain your answers.

1. Two similar beakers are placed side by side on a hot plate. One contains alcohol, and the other contains water, both at 20°C. Which will reach a temperature of 50ºC first? Explain Why or how you know.
   Alcohol has a specific heat (c) of 2.299 J/g°C and water has a specific heat of 4.18 J/g°C. The specific heat describes how much heat must be added to a particular material to heat 1 gram of the material and change the temperature of a material by 1 °C. Since both alcohol and water are on the same beaker, they will have the same amount of heat applied. The alcohol heats up quicker due to its lower specific heat and therefore will reach the temperature of 50°C first.

2. Explain how an experiment could be done to see if a sample was pure silver, or if some lead had been mixed with the silver. Explain.
   You can determine the identity of a substance by experimentally determining its specific heat. Silver should have a specific heat of 0.251 J/g°C and lead should have a specific heat of 0.138 J/g°C. You can heat the unknown metal (measure the mass) sample to a known temperature and put it in a calorimeter with a known mass of water at a known temperature. The metal will cool in turn giving its heat to the water. When the water and metal reach thermal equilibrium, you can find the –ΔT for the metal and the +ΔT for the water. Once you know both the ΔTs, you can solve for the heat absorbed by the water with $Q = m \cdot c \cdot \Delta T$. The heat absorbed by the water +Q is equal to the heat released by the metal –Q. Now that you know –Q for the metal you can solve for the specific heat (c) of the unknown metal with the formula: $c = \frac{Q}{m \cdot \Delta T}$

3. Two blocks of metal, each weighing 1000g, are placed in a 1,000 °C furnace for 10 seconds. When removed one block is felt to be much warmer than the other. Which of the blocks is zinc and which is aluminum? How do you know? Explain.

Zinc has a specific heat (c) of 0.386 J/g°C and Aluminum has a specific heat of 0.961 J/g°C. Since both blocks were exposed to the same amount of heat in the same furnace for the same about of time, the difference in how they heated up is related to the specific heat of the metal. The Zinc would be the block the heats up the most and feel warmer after the 10 seconds in the furnace. In fact the zinc block's change in temperature (ΔT) will be approximately three times greater than the change in the aluminum block.

4. Volcanic rocks have a specific heat of about 2.09 J/g°C. Water has a specific heat of 4.2 J/g°C. Lead has a specific heat of 0.129 J/g°C. If you were designing a passively heated solar house, what material would be best to use for heat storage?

   a. Large drums of water b. Large volcanic rocks c. Large slabs of lead

   A. The water would be the best material used for heat storage in a passively heated solar house. While the larger specific heat means that it will take a longer amount of time for the water to heat up, it will also hold that heat a lot longer once the temperature has cooled of at night.

Solving Heat Problems

$Q = m\, c_p\, \Delta T$

where q= total heat flow, m= mass, c_p = specific heat, and ΔT= change in temperature.

5. How many joules are needed to warm 25.5 grams of water from 14.0°C to 22.5°C?

   $Q = m \cdot c \cdot \Delta T \quad Q = 25.5g \cdot 4.186\ {}^{J}/_{g°C} \cdot 8.5°C = 907.3\,J$

6. Calculate the number of joules released when 75.0 grams of water are cooled from 100.0°C to 24.0°C.

   $Q = m \cdot c \cdot \Delta T \quad Q = 75.0g \cdot 4.186\ {}^{J}/_{g°C} \cdot -76.0°\,C = -23{,}860.2\ J$

7. The specific heat of gold is 0.128 J/g °C. How much heat would be needed to warm 250.0 g of gold from 25.0 °C to 100.0 °C?

   $Q = m \cdot c \cdot \Delta T \quad Q = 250.0g \cdot 0.128\ {}^{J}/_{g°C} \cdot 75.0\,°C = 2400\ J$

8. The specific heat of zinc is 0.386 J/g °C. How many joules would be released when 454 grams of zinc at 96.0 °C were cooled to 28.0 °C?

   $Q = m \cdot c \cdot \Delta T \quad Q = 454g \cdot 0.386\ {}^{J}/_{g°C} \cdot -68° = -11{,}916.5\ J$

9. A sample of lead, specific heat 0.138 J/g °C, released 1200 J when it cooled from 93.0 °C to 29.5°C. What was the mass of this sample of lead?

   $Q = m \cdot c \cdot \Delta T \quad so \quad m = \frac{Q}{c \cdot \Delta T} \qquad m = \frac{1200\,J}{0.138\,\frac{J}{g \cdot °C} \cdot -63.5°C} = -136.94g$

10. Calculate the specific heat of platinum if 1092 J of heat were released when 125 g of platinum cooled 62.5 °C.

   $Q = m \cdot c \cdot \Delta T \quad so \quad c = \frac{Q}{m \cdot \Delta T} \qquad c = \frac{1092\,J}{125\ g \cdot 62.5°C} = 0.1397\ {}^{J}/_{g\,\cdot\,°C}$