Specific Heat problems **ANSWER KEY**

1. Burning propane heats up a 10 kilogram sample of water from 5 to 20 °C. How much energy was absorbed by the water?

\[ q = mC\Delta T \]

\[ q = (10,000 \text{ g}) \times \left( 4.18 \frac{\text{J}}{\text{g}^\circ\text{C}} \right) \times (15 \circ\text{C}) \]

\[ q = 627,000 \text{ J} \]

2. When it burns, a candle heats 45 grams of water from 21 to 28 °C. How much energy did the candle give off?

\[ q = mC\Delta T \]

\[ q = (45 \text{ g}) \times \left( 4.18 \frac{\text{J}}{\text{g}^\circ\text{C}} \right) \times (7 \circ\text{C}) \]

\[ q = 1317 \text{ J} \]

3. If a sample of water releases 4500 J of energy as the temperature decreases from 30 to 12 °C, what was the mass of the sample? Also, what is the number of molecules in the sample?

\[ q = mC\Delta T \]

\[ m = \frac{q}{C\Delta T} \]

\[ m = \frac{4500 \text{ J}}{\left( 4.18 \frac{\text{J}}{\text{g}^\circ\text{C}} \right) (18 \circ\text{C})} \]

\[ m = 59.8 \text{ g} \]

How many molecules of water? 59.8 g \(\times\) \(\frac{6.02 \times 10^{23} \text{ molecules}}{18.0 \text{ g}}\) = \(2 \times 10^{24} \text{ molecules}\)
4. Burning alcohol releases a lot of energy! How much heat from this combustion reaction must be absorbed by 375 grams of water to raise its temperature by 25 °C?

\[ q = mC\Delta T \]

\[ q = (375 \text{ g}) \times (4.18 \frac{\text{J}}{\text{g} \cdot \text{°C}}) \times (25 \text{ °C}) \]

\[ q = 39187.5 \text{ J} \]

5. What is the final temperature when 625 grams of water at 75 °C gains 7.96 x 10^4 J from the combustion of hexanol?

Solve for \( \Delta T \).

\[ \Delta T = \frac{q}{mC} \]

\[ \Delta T = \frac{7.96 \times 10^4 \text{ J}}{(625 \text{ g}) \times (4.18 \frac{\text{J}}{\text{g} \cdot \text{°C}})} \]

\[ \Delta T = 30.5 \text{ °C} \]

The final temperature is 75 °C + 30.5 °C = 105.5 °C.

6. The temperature of a sample of water is raised from 15 °C to 96 °C when 85 kJ of energy are added to the water. What is the mass of this sample of water?

\[ q = mC\Delta T \]

\[ m = \frac{q}{C\Delta T} \]

\[ m = \frac{85,000 \text{ J}}{(4.18 \frac{\text{J}}{\text{g} \cdot \text{°C}})(81 \text{ °C})} \]

\[ m = 251 \text{ g} \]
Hall of fame question- depends on your answers for 1-5:

A brilliant chemistry student harnesses all of the energy released from problems 1, 2, and 4 to heat up an unknown sample with 1000 times the mass of water in problem 3. She raises the temperature from 50 °C to the same final temperature as problem 5. What is the specific heat capacity of this unknown sample? Include units!

Total energy released = 627,000 J + 1317 J + 39,187.5 J = 667,504.5 J.

Unknown sample mass = 1000 x 59.8 g = 59,800 g

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\Delta T = \frac{7.96 \times 10^4 \text{ J}}{625 \text{ g} \left(4.18 \frac{\text{ J}}{\text{ g} \cdot ^\circ \text{C}}\right)}
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\Delta T = 105.5 \degree \text{C} - 50 \degree \text{C} = 55.5 \degree \text{C}
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C = \frac{q}{m \Delta T}
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\[
C = \frac{667,504.5 \text{ J}}{(59,800 \text{ g})(55.5 \degree \text{C})}
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\[
C = 2.01 \frac{\text{ J}}{\text{ g} \cdot ^\circ \text{C}}
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