Practice for Proficiency
Calorimetry

Concept: Specific heat – This needs to be understood. There are a handful of variations here. Give them a try.

Can I do simple energy transfer to an object.

1. Two 500kg blocks (copper 0.36J/gC and aluminum 0.9J/gC) starting at 25°C each absorb 45KJ of energy. What is the final temperature of each block?

$q = m \cdot \Delta T \cdot C$ $\quad 500 \cdot \frac{9}{m \cdot C} = \Delta T$ $\quad \frac{500}{500 \cdot .36} = 2.70$ $\quad 27.7°C$

45KJ = 45000J $\quad \frac{500}{500 \cdot .9} = 1.1°C$ $\quad 25 + 1.1 = \boxed{26.1°C}$

2. A ~~500~~g block of metal at 80°C is dropped into 1000g of water at 20°C. The final temperature is measured at 28°C. Calculate the specific heat of the block.

$q = m \cdot \Delta T \cdot C$ $\quad 1000 \cdot 4.18 \cdot 8°C = 33440J$ $\quad$ Water gaining energy

$q = m \cdot \Delta T \cdot C$ $\quad 33440 = 5000 \cdot 8 \cdot C$ $\quad C = \boxed{0.83 J/g°C}$

3. A block of hot metal is dropped into a calorimeter cup (2J/°C) containing 200g of water (4.18J/g°C) at 20°C. the final temperature of the water and cup is 28°C. How much energy did the block lose?

$q = m \cdot \Delta T \cdot C$ $\quad 200 \cdot 8 \cdot 4.18 = 6688J$ to warm water

$\frac{8°}{1°C} \left| \frac{2J}{} \right. = 16J$ $\quad 6688 + 16 = \boxed{6706J}$

Can I calculate the Enthalpy change of a chemical reaction?

4. Mercury has a normal melting point of -39°C , a ΔH_{fusion}= 11.78J/gram, and the specific heat of solid mercury is 0.14J/g°C. A 100g sample of mercury at -49°C is warmed and melted. The final temperature of the liquid is -39°C.
   a. Write out the thermodynamic reaction taking place here.

$Hg(s) \rightleftharpoons Hg(\ell)$

   b. How much energy is required for this process.

$q = m \Delta T C$ $\quad 100 \cdot 10 \cdot .14 = 140J$

$\frac{100g}{1} \left| \frac{11.78J}{1g} \right. = 1178J$ $\quad 1178 + 140 = \boxed{1318J}$

5. 4.0g of Solid NH_4Cl is dissolved in 100mL of water at 35°C. The temperature drops to 31°C. Calculate the Enthalpy of dissolution.

$NH_4Cl \rightarrow NH_4^+ + Cl^-$

$\frac{4g}{53.5g} \left| \frac{1 mol}{} \right. = 0.0749 mol$ $\quad \Delta H = \frac{q}{mol}$ $\quad q = m \cdot \Delta T \cdot C$ $\quad 104.4 \cdot 4.18 = 1738J$

6. Barium hydroxide (10g) is added to HCl (10g) in 100g of water. The water warms 3°. The specific heat of the solution is 4.18J/g°C.

$\frac{10g}{171g} \left| \frac{1 mol}{} \right. = 0.05 mol$ $\quad Ba(OH)_2 + 2HCl \rightarrow BaCl_{2(s)} + H_2O \quad \Delta H_{neutralization}$

   a. Which substance is the limiting reactant?

$\frac{10g}{36.4g} \left| \frac{1 mol}{} \right. = 0.027 mol\ Ba(OH)_2$

   b. How much energy is exchanged?

$q = m \cdot \Delta T \cdot C$ $\quad 120 \cdot 3 \cdot 4.18 = \boxed{1504J}$

$23498J = \frac{1738J}{.074}$ $\quad \boxed{23.4 kJ/rxn}$

   c. Calculate the enthalpy of neutralization.

$\frac{1504J}{.05 mol} = 30080 J/mol$ $\quad \boxed{30.0 kJ/rxn}$ — Per 1 mol of $Ba(OH)_2$