N**ame _____** **Honors Chemistry** **___/___/___**

Heat of Solution & Calorimetry

Demo 1. I will pour 100. g of H_2O into a Styrofoam coffee cup calorimeter. Record the initial temperature. Add approximately 10. grams of calcium chloride to the water. Record the final temperature. Identify which substance is endothermic and which substance is exothermic.

Initial Temperature: **21.9°C** Final Temperature: **29.1°C**

H_2O mass: **100.04g** $CaCl_2$ mass: **10.11 g**

Total mass: **110.15g** $CaCl_2$ moles: **0.09110**

Endothermic: **H_2O** Exothermic: **$CaCl_2$**

Determine the heat flow using the formula: $q = (mC\Delta T)_{solution}$
q= 3318 J

Determine the heat of solution in kJ/mol using the formula: $\Delta H_{solution} = \frac{q}{\text{moles of salt}}$
36.4 kJ/mol

Demo 2. I will pour 100. grams of H_2O into a Styrofoam coffee cup calorimeter. Record the initial temperature. Add approximately 10. grams of sodium nitrate to the water.

Initial Temperature: **21.7°C** Final Temperature: **15.9°C**

H_2O mass: **98.54g** $NaNO_3$ mass: **11.90 g**

Total mass: **110.44 g** $NaNO_3$ moles: **0.1400**

Endothermic: **$NaNO_3$** Exothermic: **H_2O**

Determine the heat flow using the formula: $q = (mC\Delta T)_{solution}$
-2680 kJ

Determine the heat of solution in kJ/mol using the formula: $\Delta H_{solution} = \frac{q}{\text{moles of salt}}$
-19.14 kJ/mol

Demo 3: Determine the specific heat capacity of a rock.

Initial Temperature Rock: **225 °C** Initial Temperature Water: **21.4 °C**

Final Temperature: **29.9°C**

Mass of Water: **105.71 g** Mass of Rock: **37.15 g**

Endothermic: **H_2O** Exothermic: **Rock**

Use the formula **$(mC\Delta T)_{water} = -(mC\Delta T)_{rock}$** to determine the specific heat capacity of the rock:

C= 0.52 J/g °C

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Heat of Solution & Calorimetry Answers

Solve each of the following calorimetry problems.

1. An unknown metal with a mass of 45.68 grams is heated to a constant temperature of 300.0°C. The object is then submerged in 200.0 grams of water at 22.0°C. The final temperature of the water is 44.7°C. The specific heat capacity of water is 4.184 J/g°C. Determine the specific heat capacity of the unknown substance.

$(mC\Delta T)_{water} = -(mC\Delta T)_{metal}$
(200.0)(4.184)(44.7-22.0) = -(45.68)(C)(44.7 - 300.0)
(18995.36) = 11662.104 (C)
C = 1.63 J/g°C

Substance	Specific Heat Capacity ($J \cdot g^{-1} \cdot °C^{-1}$)
Au	0.129
H_2O	4.184

2. A gold ring that weighs 3.81 g is heated to 84.0°C and placed in 50.0 g of H_2O at 22.1°C. What is the final temperature?

$(mC\Delta T)_{water} = -(mC\Delta T)_{gold}$
$(50.0)(4.184)(T_f - 22.1) = -(3.81)(0.129)(T_f - 84.0)$
$209.2x - 4623.32 = -0.491x + 41.29$
$T_f = 22.2°C$

3. A piece of metal weighing 418.4 grams was put into a boiling water bath. After 10 minutes, the metal was immediately placed in 250.0 grams of water at 40.0°C. The maximum temperature that the system reached was 50.0 °C. What is the specific heat of the metal?

$(mC\Delta T)_{water} = -(mC\Delta T)_{metal}$
(250.0)(4.184)(50.0 – 40.0) = -(418.4)(C)(50.0 - 100.0)
C = 0.50 J/g°C

Substance	Specific Heat Capacity ($J \cdot g^{-1} \cdot °C^{-1}$)
Al	0.89
H_2O	4.184

4. An aluminum bar that weighs 13.81 g is heated to 250.0°C and placed in 120.0 g of H_2O at 23.9°C. What is the final temperature?

$(mC\Delta T)_{water} = -(mC\Delta T)_{aluminum}$
$(120.0)(4.184)(T_f - 23.9) = -(13.81)(0.89)(T_f - 250.0)$
$502.08x - 11999.71 = -12.29 + 3072.73$
$T_f = 29.3°C$

Theoretical Values

Solute	Heat of Solution
$CaCl_2(s)$	-82.9 kJ/mol
$NaNO_3(s)$	35 kJ/mol

Teacher Notes:
Demo 1. Pour 100 mL of H_2O into a Styrofoam coffee cup calorimeter. Record the initial temperature. Add 10 grams of calcium chloride to the water. The temperature will rise. Ask the students if the reaction is endothermic or exothermic. You will get a variety of answers. Then clarify and ask which is endothermic and which is exothermic? The water is endothermic and the $CaCl_2$ is exothermic.

Demo 2. Pour 100 mL of H_2O into a Styrofoam coffee cup calorimeter. Record the initial temperature. Add 10 grams of sodium nitrate to the water. The temperature will drop. Ask the students if the reaction is endothermic or exothermic. This time they will explain that the water is exothermic and the $NaNO_3$ is endothermic.

Demo 3: Prior to class, measure the mass of a rock(it should be about 50 grams) and the place it in the oven and heat it to 200°C. Set up a calorimeter. Place approximately 150 grams of water in a calorimeter.