Chemistry 534 **Names_____**
_____

Heat of Reaction

Purpose: In this experiment you find and compare the amount of heat released in three different exothermic chemical reactions.

1. Reaction: Solid NaOH dissolves in water and releases heat:

$NaOH_{(s)} \rightarrow NaOH_{(aq)}$ + heat

Procedure a. Using a graduated cylinder, measure 100 mL of cool water and pour into a styrofoam cup.

b. Record the initial temperature of the water to 1 decimal place.

Initial temperature of the water (^oC)	

c. 2.00 g of $NaOH_{(s)}$ have already been massed for you.(Our technician is very kind.) Add it to the styrofoam cup containing the water. Stir until all of it has dissolved.

d. Watch the thermometer carefully. Take note of the *highest* temperature attained.

Maximum temperature of the water (^oC)	

e. Discard the solution and rinse the cup and thermometer before continuing with reaction 2.

2. Reaction: Solid NaOH neutralizes HCl acid and releases heat:

$NaOH_{(s)} + HCl_{(aq)} \rightarrow \quad H_2O \quad + NaCl_{(aq)}$ + heat

Procedure a. Using a graduated cylinder, measure 100 mL of cool HCl (0.50 M) and pour into a styrofoam cup.

d. Record the initial temperature of the dilute acid (HCl) to 1 decimal place.

Initial temperature of the HCl (^oC)	

e. 2.00 g of $NaOH_{(s)}$ have already been massed for you.(Our technician is as kind as he was in part 1.) Add it to the styrofoam cup containing the acid. Stir until all of it has dissolved.

d. Watch the thermometer carefully. Take note of the *highest* temperature attained.

Maximum temperature of the acid (^oC)	

e. Discard the solution and rinse the cup and thermometer before continuing with reaction 3.

3. Reaction: *Aqueous* NaOH neutralizes acid and releases heat:

$$NaOH_{(aq)} + HCl_{(aq)} \rightarrow H_2O + NaCl_{(aq)} + \text{heat}$$

Procedure a. Using a graduated cylinder, measure 50 mL of cool 1.0 M NaOH solution and pour into a styrofoam cup.

b. Record the initial temperature of the NaOH solution to 1 decimal place.

Initial temperature of NaOH(^oC)	

c. Measure 50 mL of 1.0 M HCl in a clean beaker. Measure its temperature.

Initial temperature of HCl(^oC)	
Avg. Initial temperature (^oC)	

d. Add it to the styrofoam cup containing the NaOH. Stir until all of it has dissolved.

e. Watch the thermometer carefully. Take note of the *highest* temperature attained.

Maximum temperature of the solution (^oC)	

f. Discard the solution and rinse the cup and thermometer .

Analysis

1. Complete the table below:
   Note in column three, the mass of liquid used should be 100g in each case. Here we are assuming that the dilute solutions in parts 2 and 3 have the same density as water = 1 g/ cm^3.

Reaction	$\Delta T = T_{maximum} - T_{initial}$	$Q = [m_{liquid}]c\Delta T$ = 100 g(4.19 J/[g C]) **ΔT**	$\Delta H = -Q$	*n* = Moles of NaOH	Molar enthalpy = ΔH/n
1					
2					
3				Use n = $C_1V_{1(L)=}$ 1.0mole/L*(.050L) =	

2. Use algebra to combine chemical equations 1 and 2 (see procedure) in order to get target equation 3. Use the enthalpy changes from the last column in the above table to predict what ΔH/mole should be for reaction 3.

(1) $NaOH_{(s)} \rightarrow NaOH_{(aq)}$ ΔH = _____

(2) $NaOH_{(s)} + HCl_{(aq)} \rightarrow H_2O + NaCl_{(aq)}$ ΔH = _____

target: $NaOH_{(aq)} + HCl_{(aq)} \rightarrow H_2O + NaCl_{(aq)}$ $\Delta H_{theoretical}$ =

3. Compare your answer for part 2 to the experimental value from the table. Calculate the %error.