

## AP LAB 09AB: Entropy and Endothermic Reactions

**Aim** To investigate the relationship between entropy and enthalpy

**Apparatus** Coffee-cup calorimeter, thermometer, weighing boat, spatula, goggles, electronic balance

**Chemicals** 1.0 M Citric acid solution, sodium hydrogen carbonate solid

### **Method**

1. Measure 25.0 mL of the citric acid solution into a coffee-cup calorimeter, and record the temperature of the solution. (Allow a few minutes for the temperature to become constant before recording.)
2. Record the exact mass of approx. 6.40-6.60 g of sodium hydrogen carbonate.
3. With the thermometer already in the calorimeter, **carefully** add the sodium hydrogen carbonate to the acid.

**(NOTE: The solid must be added VERY SLOWLY, a little at a time, to avoid the contents of the cup effervescing and the contents being lost)**

4. Gently stir the contents of the calorimeter monitoring the temperature constantly. **Record the lowest temperature reached.**
5. Repeat the experiment to obtain data in a second trial.

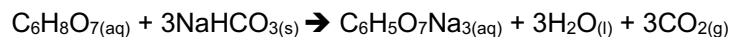
## Results

	Trial 1	Trial 2
Initial temperature of solution in °C		
Final temperature of solution in °C		
Mass of sodium hydrogen carbonate added in g		



### Calculations/Conclusions

**Make the assumption that the specific heat capacity of the solution is  $4.18 \text{ J g}^{-1} \text{ }^\circ\text{C}^{-1}$ , and that the density of the solution is  $1.00 \text{ g mL}^{-1}$ . You may ignore the heat capacity of the calorimeter.**



1. Determine the limiting reactant in the reaction.
2. Calculate the change in energy of the surroundings,  $q_{\text{surroundings}}$ , in units of Joules for each trial, and then average the two values.
3. Use your answer in Q2 to calculate a value for the  $q_{\text{system}}$  in  $\text{kJ molrxn}^{-1}$ , i.e., calculate  $\Delta H^\circ$  for the reaction. **(Use the average number of moles of the limiting reactant in your calculation).**
4. *Based only upon your calculation of  $\Delta H^\circ$* , predict the sign of  $\Delta S^\circ$  for the reaction. Justify your choice.
5. *Based only on the balanced equation*, predict the sign of  $\Delta S^\circ$  for the reaction. Justify your choice.