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Entropy and Free Energy Worksheet

1. Write the expression for the crystallization of sodium acetate trihydrate from its supersaturated solution.

2. What is the sign of ΔS for this change? Explain.

3. Write the expression the change in free energy, ΔG, in terms of ΔH and ΔS. For the process to be spontaneous, does the crystallization need to be endothermic or exothermic? Explain.

4. What was the initial and final temperature of the water in the beaker? What was the sign of the temperature change? Explain in terms of the heat released and/or absorbed by the system and the surroundings.

Hess's Law Worksheet
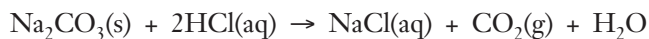
Decomposition Reaction—Data Table

Reaction (1)

$NaHCO_3(s) + HCl(aq) \rightarrow NaCl(aq) + CO_2(g) + H_2O(l)$
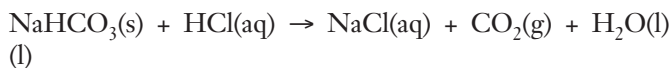
Volume 3 M HCl	_____ mL
Mass $NaHCO_3$	_____ g
Temperature HCl Solution-initial	_____ °C
Final Temperature Solution	_____ °C

Reaction (2)

$Na_2CO_3(s) + 2HCl(aq) \rightarrow NaCl(aq) + CO_2(g) + H_2O(l)$

Volume 3 M HCl	_____ mL
Mass Na_2CO_3	_____ g
Temperature HCl Solution-initial	_____ °C
Final Temperature Solution	_____ °C

1. Calculate the change in heat, q_{rxn}, for each reaction (1) and (2). Use the total mass of the reactants as the mass of the surroundings and 4.185 J/g·°C for the value of the specific heat. Assume the density of the solution at 20 °C is 1.05 g/mL.

2. Calculate $\Delta H°$ for each reaction (1) and (2).

3. Use Hess's Law to calculate ΔH_{rxn} for the Reaction (3) decomposition reaction of sodium bicarbonate (3) the appropriate algebraic sum of reactions (1) and (2)

$$2NaHCO_3(s) \rightarrow Na_2CO_3(s) + CO_2(g) + H_2O(l)$$

4. The following data comes from the CRC Handbook of Chemistry and Physics.

Entropy Values, $S°$, J/mol·K

$NaHCO_3(s)$	101.7	$Na_2CO_3(s)$	135.0
$CO_2(g)$	213.8	$H_2O(l)$	70.0

5. Calculate the temperature at which he decomposition reaction of sodium bicarbonate will become reactant-favored.

Free Energy and Redox Reactions Worksheet

1. Write the expression relating free energy (ΔG) and a redox cell potential (ε).

2. Write an equation for the overall reaction in a copper concentration cell.

3. Write the Nernst equation for a copper concentration cell. a) What is the value of ε° for a concentration cell? b) Under what conditions will a concentration cell be spontaneous?

4. Identify the anode and the cathode in the copper concentration cell. Be specific!

5. Mixing two solutions of different concentrations provides an analogy for the concentration cell. Explain in terms of what is meant by a spontaneous reaction.