Thermodynamics

This worksheet should help you identify how we can use thermodynamics to understand chemical reactions and builds off the previous work in the unit. It is intended for you to work through it in order. *(Don't skip ahead.)*

Mercury chloride is an incredible toxic compound, where even a small exposure (<1 g) can kill a human in less than 24 hours. You are tasked with studying the dissolution of mercury chloride in water.

$$HgCl_{2\,(s)} \leftrightarrow \_\_\_\ Hg^{2+}_{\ (aq)} + \_\_\_\ Cl^{-}_{\ (aq)}$$

	S^o (J/mol K)	ΔH^o_f (kJ/mol)
$HgCl_{2\,(s)}$	146.0	-224.3
$Hg^{2+}_{(aq)}$	84.5	172.4
$Cl^{-}_{\ (aq)}$	56.5	-167.2

Use the table above to…

Calculate the standard change in entropy for the reaction.

Calculate the standard enthalpy of reaction.

Based on signs of enthalpy and entropy, do you expect the reaction to be spontaneous or nonspontaneous at standard conditions (25 ºC)? Explain!

Calculate the standard free energy change of the reaction.

How would you characterize the reaction? Reactants- or products-favored? Why?

Is the reaction always spontaneous or always nonspontaneous? Or is it dependent on temperature? If the reaction is dependent on temperature, when will the reaction be spontaneous?

If you were to add excess solid $HgCl_2$ to water at room temp, the concentration of dissolved $HgCl_2$ would be 0.2752 M. How would you describe the solution? What IMF are present?

How would the concentration change if you increased the temperature of the solution? Why?

Determine the properties of 100.0 mL of the 0.2752 M $HgCl_2$ solution (assume a density of 1.03 g/mL). What is the vapor pressure, boiling point, and freezing point of the solution? The vapor pressure of pure water 25 ºC is 23.8 mmHg.

If 25.0 mg is the threshold of toxicity for humans, what volume of the 0.2752 M solution would be enough to be lethal?