

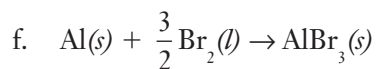
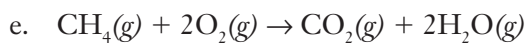
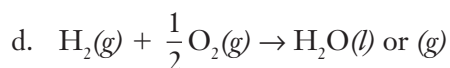
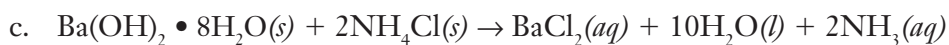
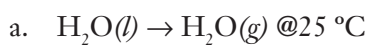
# SPONTANEITY AND FREE ENERGY

NAME \_\_\_\_\_

SECTION \_\_\_\_\_

1. Summarize the signs (+ or -) of  $\Delta H^\circ_{\text{rxn}}$  and  $\Delta S^\circ_{\text{rxn}}$  for each of the following reactions (refer to the previous activities).

$\Delta H^\circ_{\text{rxn}}$      $\Delta S^\circ_{\text{rxn}}$      $\Delta G^\circ_{\text{rxn}}$



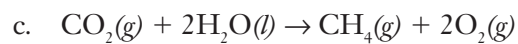
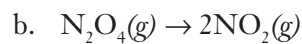
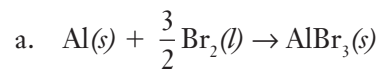
2. Circle which driving forces account for the spontaneity of each of the previous reactions.

3. In which reactions do the driving forces oppose each other?

4. The net driving force for a chemical reaction is called the free energy ( $\Delta G^\circ$ ) for the reaction. It is the energy that is free to drive the reaction rather than oppose another driving force. It can be calculated from free energies of formation ( $\Delta G_f^\circ$ ) in the same way as enthalpies of formation. Calculate  $\Delta G_{\text{rxn}}^\circ$  for the reactions in question 1.
5. Another way to calculate the free energy is to combine the two driving forces of enthalpy and entropy to recognize the contribution of each and to compensate for any way they oppose each other. The equation for doing this (called the Gibbs free energy equation) is:  $\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ$ . Calculate the free energy of the equations in question 1 using this equation, and compare your results with the values you determined from free energies of formation.
6. Use your data from question 1 to complete the blank cells for  $\Delta G_{\text{rxn}}^\circ$  when the driving forces drive in the same direction. What does the sign for  $\Delta G_{\text{rxn}}^\circ$  signify for the spontaneity of the reaction?

Sign of $\Delta H_{\text{rxn}}^\circ$ (25 °C)	Sign of $\Delta S_{\text{rxn}}^\circ$ (25 °C)	Sign of $\Delta G_{\text{rxn}}^\circ$ (25 °C)	Sign of $\Delta G_{\text{rxn}}^\circ$ at high temperature	Sign of $\Delta G_{\text{rxn}}^\circ$ at low temperature
-	+			
+	-			
-	-			
+	+			

7. How does  $\Delta G^\circ$  change with increasing temperature for each of the following reactions?



8. Use the Gibbs free energy equation to predict how the sign of  $\Delta G^\circ$  changes with temperature. Complete the cells in the previous table.

9. Calculate the temperature at which  $\Delta G^\circ$  is zero for the reaction.

