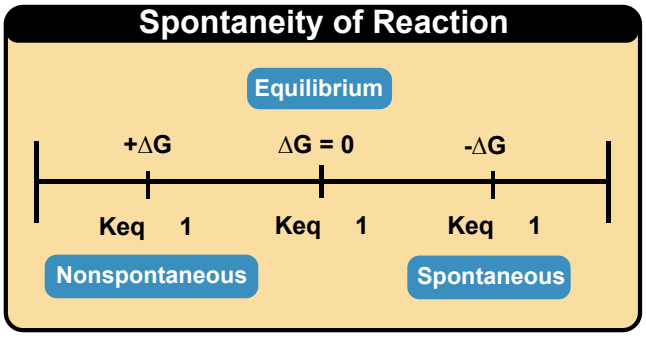
CONCEPT: GIBBS FREE ENERGY

- **Gibbs Free Energy (ΔG)** is a measure of energy _____ of a chemical or physical process that can be used to do work.
  - □ Sign of _____ and/or value of equilibrium _____ determine the spontaneity of a reaction.



EXAMPLE: If ΔG is small and positive, which of the following statements is true?

a) the forward reaction is spontaneous and system is far from equilibrium

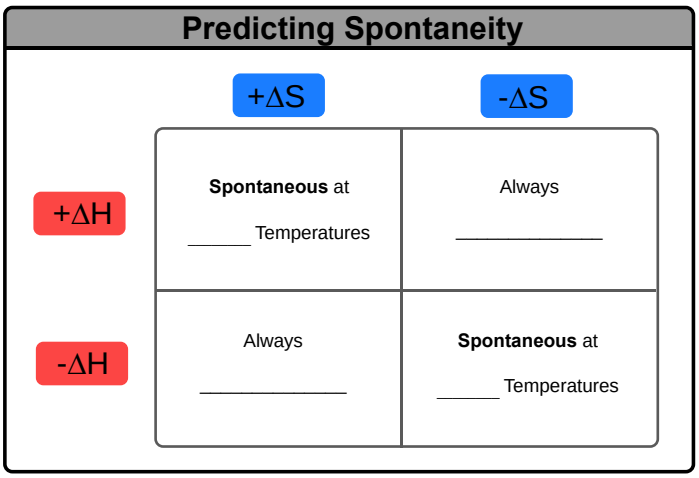
b) the forward reaction is spontaneous and system is near equilibrium

c) the reverse reaction is spontaneous and system is far from equilibrium

d) the reverse reaction is spontaneous and system is near equilibrium

Predicting Spontaneity

- When sign of ΔG is unknown, spontaneity of a reaction can be predicted from signs of Enthalpy (ΔH) and Entropy (ΔS).



EXAMPLE: $PCl_3\,(g) + Cl_2\,(g) \rightleftharpoons PCl_5\,(g)$ At 25°C, ΔH° = - 92.50 kJ. Which of the following statements is(are) true?

a. This is an endothermic reaction.

b. If the temperature is increased, the ratio of $[PCl_5] / [PCl_3]\,[Cl_2]$ will increase.

c. ΔS° for this reaction is negative.

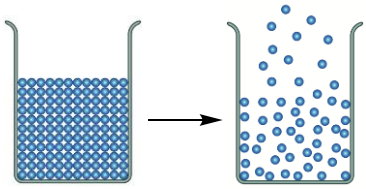
d. ΔG° for this reaction has to be negative at all temperatures.

CONCEPT: GIBBS FREE ENERGY

PRACTICE: The chemical reaction $2\ NO_2Br\ (g) \longrightarrow 2\ NO_2\ (g) + Br_2\ (g)$ has a Keq = 4.50×10^5.

Does the reaction increase the entropy of the Universe? Explain.

PRACTICE: What are the signs of ΔH, ΔS and ΔG for the spontaneous conversion of a solid into gas?



____ ΔH

____ ΔS

____ ΔG

PRACTICE: Consider the combustion of butane gas and predict the signs of ΔS, ΔH and ΔG.

$C_4H_{10}\ (g) + 13/2\ O_2\ (g) \longrightarrow 4\ CO_2\ (g) + 5\ H_2O\ (g)$

PRACTICE: You calculate the value of ΔG for a chemical reaction and get a positive value. Which would be the most accurate way to interpret this result?

a) If a mixture of reactants and products is created and left to equilibrate, the equilibrium mixture will contain more reactant than product.

b) If a mixture of reactants and products is created, we cannot say anything about its composition at equilibrium but we can say it will reach equilibrium very rapidly.

c) The reaction will not occur under any circumstances.

d) If a mixture of reactants and products is created and left to equilibrate, the equilibrium mixture will contain more product than reactant.