Name: **Date:**   **Period:**   **Seat #:**

STATION 1: ENTROPY CHANGE

For each of the following examples, decide whether the entropy is increasing or decreasing. Is ΔS + or −?

ΔS is _____   The electrolytic decomposition of water. $2H_2O(l) \rightarrow 2 H_2(g) + O_2(g)$

ΔS is _____   The freezing of water. $H_2O(l) \rightarrow H_2O(s)$

ΔS is _____   The reaction of sodium metal with water. $2Na(s) + 2H_2O(l) \rightarrow H_2(g) + 2Na^+(aq) + 2 OH^-(aq)$

ΔS is _____   The boiling of water. $H_2O(l) \rightarrow H_2O(g)$

ΔS is _____   The reaction of OF_2 and water. $OF_2(g) + H_2O(g) \rightarrow O_2(g) + 2HF(g)$

Entropy and Free Energy

STATION 2: ΔH, ΔS, ΔG, GIBB'S FREE ENERGY

$$C_2H_2(g) + 2 H_2(g) \rightarrow C_2H_6(g)$$
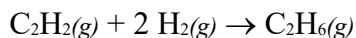
Substance	$S°$ (J/mol·K)	$\Delta H°_f$ (kJ/mol)
$C_2H_2(g)$	200.9	226.7
$H_2(g)$	130.7	0
$C_2H_6(g)$	229.6	-84.7

Calculate ΔS, ΔH, and ΔG for this reaction at 298 K.

Entropy and Free Energy

Consider the boiling of liquid bromine: $Br_{2(l)} \leftrightarrows Br_{2(g)}$

At 25°C, $\Delta H° = 30.84$ kJ/mol and $\Delta S° = 92.9$ J/mol·K for this reaction.
Calculate the value of $\Delta G°$.

Assuming that ΔH and ΔS do not change at different temperatures, calculate the normal boiling point of liquid bromine.

Entropy and Free Energy

Consider the reaction: $MgO(s) + SO_2(g) \rightarrow MgSO_3(s)$

What is the sign of ΔH for this reaction? _____ Justify your answer.

What is the sign of ΔS for this reaction? _____ Justify your answer.

This reaction will be:
   a) spontaneous at all temperatures
   b) spontaneous at high temperatures
   c) spontaneous at low temperatures
   d) non-spontaneous at all temperatures

Entropy and Free Energy

Consider the reaction: $C_2H_5Cl_{(g)} + Cl_{2(g)} \rightarrow C_2H_4Cl_{2(g)} + HCl_{(g)}$

Standard Free Energies of Formation at 298 K

Substance	$\Delta G°_f$ kJ·mol⁻¹
$C_2H_4Cl_{2(g)}$	-80.3
$C_2H_5Cl_{(g)}$	-60.5
$HCl_{(g)}$	-95.3
$Cl_{2(g)}$	0

Calculate the value of ΔG° for this reaction.

Calculate the value of K$_{eq}$ for the reaction at 298 K.   [ΔG° = -RT lnK; R = 8.31 J·mol⁻¹·K⁻¹]

From the AP Exam:

THERMOCHEMISTRY/KINETICS

$\Delta S° = \sum S°$ products $- \sum S°$ reactants

$\Delta H° = \sum \Delta H_f°$ products $- \sum \Delta H_f°$ reactants

$\Delta G° = \sum \Delta G_f°$ products $- \sum \Delta G_f°$ reactants

$\Delta G° = \Delta H° - T\Delta S°$

$\quad = -RT \ln K = -2.303\,RT \log K$

$\quad = -n\mathscr{F}E°$

$\Delta G = \Delta G° + RT \ln Q = \Delta G° + 2.303\,RT \log Q$

$q = mc\Delta T$

$C_p = \dfrac{\Delta H}{\Delta T}$

$\ln[A]_t - \ln[A]_0 = -kt$

$\dfrac{1}{[A]_t} - \dfrac{1}{[A]_0} = kt$

$\ln k = \dfrac{-E_a}{R}\left(\dfrac{1}{T}\right) + \ln A$

Gas constant, $R = 8.31\,\text{J mol}^{-1}\,\text{K}^{-1}$

$\quad = 0.0821\,\text{L atm mol}^{-1}\,\text{K}^{-1}$

$\quad = 62.4\,\text{L torr mol}^{-1}\,\text{K}^{-1}$

$\quad = 8.31\,\text{volt coulomb mol}^{-1}\,\text{K}^{-1}$