Department of Chemistry
University of Texas at Austin

2nd Law of Thermodynamics – Supplemental Worksheet

1. Consider the 2nd law of thermodynamics explain what the signs of $\Delta S_{universe}$.

   a) $\Delta S_{universe} \geq 0$

   b) $\Delta S_{universe} \leq 0$

   c) $\Delta S_{universe} = 0$

2. If a system at -272 °C absorbs 545 J of heat, what is its change in entropy?

3. Consider the following reaction: $HNO_3(l) + 1/2H_2(g) \leftrightarrow H_2O(l) + NO_2(g)$ Calculate $\Delta S°_{rxn}$

	$\Delta H°_f$ ($kJ \cdot mol^{-1}$)	$\Delta S°_m$ ($J \cdot mol^{-1} \cdot K^{-1}$)
$HNO_3(l)$	-174.1	156
$H_2(g)$	not provided	131
$H_2O(l)$	-285.8	70
$NO_2(g)$	33.2	240

4. Calculate $\Delta S_{universe}$ after the completion of the following reaction:

   $2NiS(s) + 3O_2(g) \rightarrow 2SO_2(g) + 2NiO(s)$ at 25 °C $\Delta H = -890$ kJ

Substance	S(J/Kmole)
SO_2	248
NiO	38
O_2	205
NiS	53

5. Determine the ΔS_{sys} when:

$\Delta S_{universe}$ = 1303 J/K
ΔH = -387.4 kJ
T = 25 °C

6. Calculate $\Delta S_{surroundings}$ for the reactions below based on the provided data.

a. $H_2(g) + ½\ O_2(g) \rightarrow H_2O(g)$ ΔH_{rxn} = -241.82 kJ·mol^{-1} T_{surr} = 25 °C

b. $½\ N_2(g) + ½\ O_2(g) \rightarrow NO(g)$ ΔH_{rxn} = 90.00 kJ·mol^{-1} T_{surr} = -80 °C

c. $C(g) + O_2(g) \rightarrow CO_2(g)$ ΔH_{rxn} = -393.50 kJ·mol^{-1} T_{surr} = 400 °C

7. A certain reaction (the system) is endothermic by 45.68 kJ·mol^{-1} and its entropy increases by 172.3 J·mol^{-1}·K^{-1}. Calculate $\Delta S_{universe,}$ if the surroundings are at a constant temperature of 0 °C. Can the reaction occur at this temperature? If not, should we raise or lower the temperature to make it spontaneous.

8. Calculate the change in entropy that occurs when a 3.50 mol sample of water is heated from 65° to 130° at 1 atm. The molar heat capacities for H_2O (l) is 75.3 JK^{-1}mol^{-1} and H_2O (g) is 36.4 JK^{-1}mol^{-1}. The enthalpy of vaporization for water is 40.7 kJ/mol at 100°C.