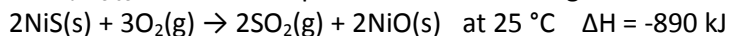


**Free Energy – Supplemental Worksheet**

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



Substance	$S$ (J/Kmole)
SO <sub>2</sub>	248
NiO	38
O <sub>2</sub>	205
NiS	53

2. Determine the  $\Delta G$  when:

$$\Delta S_{\text{universe}} = 1303 \text{ J/K}$$

$$\Delta S_{\text{surr}} = 1.300 \text{ kJ/K}$$

$$T = 25^\circ\text{C}$$

3. Determine the minimum temperature for a reaction with  $\Delta H = 271 \text{ kJ}$  and  $\Delta S = 195 \text{ J/K}$  to be spontaneous.

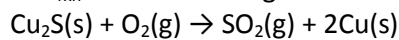
4. Consider the reaction:  $\text{CO}(g) + \text{Cl}_2(g) \rightarrow \text{COCl}_2(g)$  Calculate  $\Delta G_{\text{rxn}}$  at  $25^\circ\text{C}$ .

Substance	$\Delta H_f$ (kJ/mol)	$S$ (J/ mol K)
CO	-110.5	197.6
Cl <sub>2</sub>	0.0	223.0
COCl <sub>2</sub>	-223.0	289.2

5. Determine  $\Delta G_f$  for  $\text{SO}_2(\text{g})$ . Assume 25 °C for all reactions.

$$\Delta H_{f,\text{SO}_2}(\text{g}) = -297 \text{ kJ/mol} \quad S_{m,\text{SO}_2}(\text{g}) = 248 \text{ J/(K mol)}$$

Then determine  $\Delta G_{\text{rxn}}$  of the following reaction:  $\Delta G_f \text{Cu}_2\text{S}(\text{s}) = -86.2 \text{ kJ/mol}$



6. Calculate  $\Delta G^\circ$  for the reactions below using the provided data. Assume 298 K is standard temperature for your calculations.

	$\Delta H_f^\circ (\text{kJ}\cdot\text{mol}^{-1})$	$\Delta S_m^\circ (\text{J}\cdot\text{mol}^{-1}\cdot\text{K}^{-1})$
$\text{Ag}^+(\text{aq})$	105.6	72.68
$\text{AgCl}(\text{s})$	-127.1	96.2
$\text{C}_{\text{graphite}}(\text{s})$		5.740
$\text{CH}_3\text{OH}(\text{l})$	-238.7	126.8
$\text{Cl}^-(\text{aq})$	-167.2	56.5
$\text{H}_2(\text{g})$		130.6
$\text{O}_2(\text{g})$		205.0

