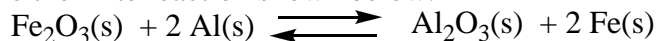


**Problem of the Day 39      CHEM 1252**

1. Consider the thermite reaction shown below.



(a) Given the following data, calculate  $\Delta H^\circ_{\text{rxn}}$ ,  $\Delta S^\circ_{\text{rxn}}$ , and  $\Delta G^\circ_{\text{rxn}}$  for the reaction at 25°C.

Compound	$\Delta H_f^\circ$ kJ/mol	$S^\circ$ J/(mol K)	Calculation of $\Delta H^\circ_{\text{rxn}}$	
Fe <sub>2</sub> O <sub>3</sub> (s)	-824.2	87.4		
Al(s)	0	28.3		
Al <sub>2</sub> O <sub>3</sub> (s)	-1676.0	50.9		
Fe(s)	0	27.3		
Calculation of $\Delta G^\circ_{\text{rxn}}$				
			$\Delta H^\circ_{\text{rxn}} =$	5
			Calculation of $\Delta S^\circ_{\text{rxn}}$	
$\Delta G^\circ_{\text{rxn}} =$			$\Delta S^\circ_{\text{rxn}} =$	5
				5

(b) Is this reaction spontaneous at 25°C? You must justify your answer.

5

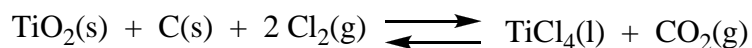
(c) Is this reaction enthalpy or entropy driven? You must justify your answer.

5

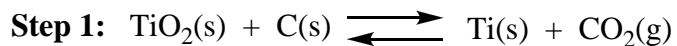
(d) Would the equilibrium constant increase or decrease if the temperature was increased? Why? (Hint: Think about Le Chatelier's Principle)

3

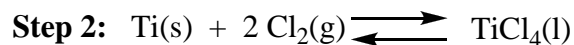
2. Titanium (IV) chloride,  $\text{TiCl}_4$ , is produced by the reaction of carbon and chlorine with  $\text{TiO}_2$ .



The reaction can be thought of as occurring in two steps. First,  $\text{TiO}_2$  is reduced by carbon to titanium metal.



Secondly, the titanium metal is oxidized by chlorine to form the product.



(a) Calculate  $\Delta G^\circ$  for Step 1.

2

(b) Calculate  $\Delta G^\circ$  for Step 2.

2

Compound	$\Delta G^\circ_f$ kJ/mol	$\Delta H^\circ_f$ kJ/mol	$S^\circ$ J/(mol K)
$\text{TiO}_2(\text{s})$	-884.5	-939.7	49.9
$\text{TiCl}_4(\text{l})$	-737.2	-804.2	252.3
$\text{CO}_2(\text{g})$	-394.3	-393.6	213.7
$\text{C}(\text{s})$	0	0	5.740
$\text{Cl}_2(\text{g})$	0	0	223.1

(c) Calculate  $\Delta G^\circ$  for the overall process.

2

(d) Calculate K for the overall process.

2

(e) Is the overall reaction enthalpy or entropy driven? You must justify your answer.

4