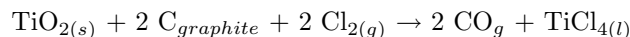


CHEM 3410: Physical Chemistry I — Fall 2009

In-class Practice Problems

September 16, 2009

1. Consider the following reaction:



for which $\Delta H_{rxn}^\circ = -80$ kJ/mole (where the standard state is defined at 298 K). Given the data below at 298 K calculate:

- (a) ΔH_{rxn} at 135.8°C
(b) ΔH_f° for $\text{TiCl}_{4(l)}$ at 298 K.

Substance	$\text{TiO}_{2(s)}$	$\text{Cl}_{2(g)}$	C (graphite)	$\text{CO}_{(g)}$	$\text{TiCl}_{4(l)}$
ΔH_f° (kJ/mol)	-945			-110.5	
$C_{P,m}$ (J/mol·K)	55.06	33.91	8.53	29.12	145.2

Assume that the heat capacities are independent of temperature.

2. (a) A 200 g block of silver at 200°C is put into contact with an identical block of Ag at 25°C. What is the final temperature of the system after thermal equilibrium has been reached?
(b) Now a 200 g block of Ag at 200°C is put into contact with a 20 g block of graphite at 25 °C. What is the final temperature of the system after thermal equilibrium has been reached?

Assume that the blocks only exchange heat with one another and do not exchange heat with the surroundings. Also assume that the heat capacities of both materials are independent of temperature and have values at constant pressure of 25.35 J/mol·K for Ag and 8.5 J/mol·K for graphite.

3. One hundred grams of iron are quenched (cooled rapidly) from a temperature of 1100°C to 0°C by throwing it in a bucket of ice water (water + ice).
a) What is the enthalpy change of the iron sample when it cools from 1100°C to 0°C?
b) What is the minimal amount of ice (in grams) that has to be present to keep the bucket at 0°C after it has equilibrated with the iron? You may assume that the bucket does not exchange heat with the environment (only with the iron).

DATA:

Iron undergoes a solid-state phase transformation from the γ -phase to the α -phase. Above 912°C Fe is γ -Fe ; below 912° C it is α -Fe.

$$\Delta H_{\text{transformation}} = H(\gamma\text{-Fe}) - H(\alpha\text{-Fe}) = 900 \text{ J/mole}$$

Heat capacity of γ -Fe: 34J/mol·K

Heat capacity of α -Fe: 38J/mol·K

Enthalpy of melting for ice: 6.048 kJ/mol

Molar mass for Fe: 56g/mole

Molar mass for H_2O : 18g/mol