Homework No 1 (Thermochemistry)

1. Calculate the stoichiometry air/fuel ratio of ethanol (C_2H_6O).

2. A furnace, operating at 1 atm (isobaric), uses preheated air to improve its fuel efficiency. Determine the adiabatic flame temperature when the furnace is run at a mass air/fuel ratio of 18 for air and fuel mixture preheated to 600 K. Assuming the following simplified thermodynamic properties:
   $T_{ref} = 300\ K$
   $M_{fuel} = M_{air} = M_{prod} = 29\ kg/kmol$
   $c_{p,fuel} = 3500\frac{J}{kgK}, c_{p,air} = c_{p,prod} = 1200\frac{J}{kgK}$
   $\bar{h}^0_{f,air} = \bar{h}^0_{f,prod} = 0$
   $\bar{h}^0_{f,fuel} = 1.16 \times 10^9\ J/kmol$

3. Consider a chemical reaction $\mathrm{N_2 + O_2 \Leftrightarrow 2NO}$ at 1 atm and 2400 K, calculate the standard-state Gibbs functions change, and the equilibrium constant K_p.

4. Use the principle of Le Châtelier, describe the effect of pressure on the equilibrium for the following reactions, indicating if pressure increases, the reaction will shift to which side (make a short explanation):

$$\mathrm{O_2 \Leftrightarrow 2O} \quad (1)$$

$$\mathrm{N_2 + O_2 \Leftrightarrow 2NO} \quad (2)$$

$$\mathrm{CO + \frac{1}{2}O_2 \Leftrightarrow CO_2} \quad (3)$$