Worksheet 7

1. 2 NO(g) + 2 H_2(g) → N_2(g) + 2 H_2O (g)

experimental rate law = k [NO]^2 [H_2]

The following mechanism has been proposed for the gas-phase reaction of NO and H_2.

step 1: \[ \text{NO} + \text{NO} \xrightleftharpoons[k_1]{\nu} \text{N}_2\text{O}_2 \] fast equilibrium

step 2: \[ \text{N}_2\text{O}_2 + \text{H}_2 \xrightarrow[k_2]{\nu} \text{N}_2\text{O} + \text{H}_2\text{O} \] slow

step 3: \[ \text{N}_2\text{O} + \text{H}_2 \xrightarrow[k_3]{\nu} \text{N}_2 + \text{H}_2\text{O} \] fast

a) What is the molecularity of each step?  b) List any intermediates.  c) Does the overall reaction agree with the experimental reaction?  d) Show that the predicted rate law equals (or does not equal) the experimental rate law.

2. Cl (g) + HBr (g) → HCl (g) + Br (g) has an overall enthalpy change of –66 kJ. The activation energy for the reaction is 7 kJ. a) Sketch the energy profile for the reaction, and label E_a and ΔH.  b) What is the activation energy for the reverse reaction?

3. Write the equilibrium constant expression, K_e, for the following reactions. In each case indicate whether the reaction is homogeneous or heterogeneous

a) 3 NO (g) ⇋ N_2O (g) + NO_2 (g)

b) C (s) + 2 H_2 (g) ⇋ CH_4 (g)

c) Ti (s) + 2 Cl_2 (g) ⇋ TiCl_4 (l)