Year 12 Chemistry

Equilibrium Questions

1. For a chemical system at equilibrium:
   (a) state the necessary conditions /2
   (b) describe how the system has dynamic nature /2

2. Write an expressions for the equilibrium constant K_c (balance first) for this reaction:
   $NH_{3(g)} + O_{2(g)} \rightleftharpoons NO_{(g)} + H_2O_{(g)}$
   /2

3. Two experiments were conducted on the following equilibrium reaction at a constant temperature of 450°C in a 1 litre sealed vessel:
   $4HCl_{(g)} + O_{2(g)} \rightleftharpoons 2H_2O_{(g)} + 2Cl_{2(g)}$

   (a) In Experiment 1, the initial concentration of HCl is 3.0 mol L^{-1}. When equilbrium is achieved, the concentration of HCl is 1.0 mol L^{-1} and the concentration of O_2 is 0.5 mol L^{-1}.
      (i) Determine the initial concentration of O_2. /1
      (ii) Determine the final concentrations of the products, if both had an initial concentration of 0.0 mol L^{-1}. /1
      (iii) Hence determine the K_c value. /2

   (b) In Experiment 2, different initial concentrations are used. The final concentrations of HCl, H_2O and Cl_2 are all 0.1 mol L^{-1}.
   Using the K_c value calculated in 3(a)(iii), determine the final concentration of O_2. /2

   (c) This reaction is then carried out in exactly the same conditions but using a 500 mL sealed vessel.
      (i) State the effect of this change on the K_c value /1
      (ii) State the effect of this change on the equilibrium position /1

4. Consider the equilibrium between dark brown NO_2 and pale yellow N_2O_4.
   $2NO_{2(g)} \rightleftharpoons N_2O_{4(g)}$
   (a) State two ways you could determine whether the above mixture was at equilibrium /2
   (b) A particular mixture of NO_2 and N_2O_4 in a sealed container is dark brown when it establishes equilibrium at 80°C and light yellow when it establishes equilibrium at 10°C.
   State and explain the sign for ΔH for the equation. /3
   (c) At 40°C, 2 litres of the gas mixture at equilibrium was found to contain 0.08 mol of N_2O_4 and 0.038 mol of NO_2. Calculate K_c at 40°C. /2
   (d) State and explain the effect decreasing the volume of this equilibrium mixture at 40°C would have on the composition of the mixture. /3
   (e) Sketch an example concentration vs time graph to illustrate the effect of decreasing the volume. Consider that the mixture begins at equilibrium, the pressure is increased at 10 mins, and equilibrium is re-achieved at 20 mins. Begin with N_2O_4 concentration at double the concentration of NO_2.
   /3

5. Ammonia can be produced according to the equation below:
   $N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)} \quad \Delta H = -ve$
   In terms of Le Chatelier's Principle, state and explain the temperature/pressure conditions which would maximise yield of ammonia (NH_3). /4