Equilibrium 3

Name:
Period: Key

$N_2O_{4(g)} \rightleftharpoons 2NO_{2(g)}$

1) A 5.67 g sample of liquid N2O4 was placed in a 1.25 L container and heated. By 375 K the sample has completely vaporizes and begins to decompose based on the reaction given above. The reaction is endothermic.

a) What would be the pressure of the $N_2O_{4(g)}$ before any decomposition takes place?

$5.67\text{ g } N_2O_4 \cdot \frac{1\text{ mol } N_2O_4}{92.02\text{ g}} = 0.0616\text{ mol } N_2O_4$

$P_{N_2O_4} = \frac{0.0616\text{ mol} \cdot 0.0821 \frac{\text{atm}\cdot L}{\text{mol}\cdot K} \cdot 375\text{ K}}{1.25\text{ L}} = 1.52\text{ atm}$

b) After the system reaches equilibrium the total pressure in the container is found to be 2.48 atm. Calculate the partial pressures of $N_2O_{4(g)}$ and $NO_{2(g)}$ in the container at 375K.

$P_T = 2.48 = P_{N_2O_4} + P_{NO_2}$

$N_2O_4 \rightleftharpoons$	$2NO_2$
1.52	0
$-x$	$+2x$
$1.52-x$	$2x$

$2.48 = (1.52 - x) + 2x$

$2.48 = 1.52 + x$

$x = 0.960$

$P_{N_2O_4} = 0.560\text{ atm}$ $P_{NO_2} = 1.92\text{ atm}$

c) For the reaction at 375 K,

i) write the equilibrium-constant expression K_p for the reaction and

ii) calculate the value of the equilibrium constant, K_p.

$K_p = \frac{P_{NO_2}^2}{P_{N_2O_4}}$ $K_p = \frac{(1.92)^2}{0.560} = 6.58$

d) If some additional NO2(g) was added to the container would the value of K_p increase, decrease or remain the same? Justify your answer.

Stay the same, changing the pressure or concentration does not change the equilibrium constant

e) If the temperature of the original mixture was decreased to 350 K will the value of K_p increase, decrease or remain the same? Justify your answer.

Increasing the temperature will cause the k_p value to decrease, the reaction is endothermic so lowering the temperature will cause the forward reaction to slow down more than the reverse reaction shifting the ration of products to reactants.

f) In a different experiment, $N_2O_{4(g)}$ and $NO_{2(g)}$ are pumped in to a container so that the initial pressure of each gas is 1.0 atm at 375 K. Will the amount of N2O4(g) in the container increase, decrease or remain the same? Justify your answer.

The amount of N_2O_4 will decrease, to reach equilibrium the ratio of products to reactants need to be 6.58. We need more products and less reactants to reach equilibrium