Lab Activity: The Equilibrium Constant

Consider the system:

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

When this system had attained equilibrium, it was analyzed at four different pressures, and the following data in Table I was obtained:

Table I: The Equilibrium Concentrations of $NO_{2(g)}$ and $N_2O_{4(g)}$ for four states of chemical Equilibrium at 25^{O}C

Experiment Number	$[NO_{2(g)}]$ (mol dm^{-3})	$[N_2O_{4\,(g)}]$ (mol dm^{-3})
1	8.1×10^{-3}	1.2×10^{-2}
2	1.6×10^{-2}	4.5×10^{-2}
3	3.2×10^{-2}	1.8×10^{-1}
4	4.8×10^{-2}	4.0×10^{-1}

Data Analysis

1. Calculate the value of each of the following expressions for each experiment in Table I, using the above equilibrium concentrations.

a. $[NO_{2(g)}]\,[N_2O_{4(g)}]$

b. $$\frac{[N_2O_{4\,(g)}]}{[NO_{2(g)}]}$$

c. $$\frac{[N_2O_{4\,(g)}]}{[NO_{2(g)}]^2}$$

2. What, if any, deductions can you make about the value obtained in each of the calculations?

3. In which expression, is the value obtained nearly the same in all four experiments?

4. It can thus be deduced that no matter what mixture is used, the ratio of _____ to _____ at equilibrium will always have the numerical value of _____.

5. What are the units in which this numerical value of the ratio expressed in?

6. From the numerical value obtained from the above ratio, what may be deduced about the relative concentrations of the reactants and the products? Is this reaction reactant or product favoured at equilibrium?

7. If this reaction is considered to be an exothermic reaction, explain how you would expect the numerical value of the ratio to change as the temperature increases.