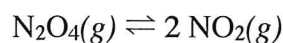


1. Several reaction mixtures containing only  $\text{N}_2\text{O}_4$  and  $\text{NO}_2$  were allowed to come to equilibrium at  $25^\circ\text{C}$ . The equilibrium concentrations of the species in each experiment are as follows:

Exp #	$[\text{N}_2\text{O}_4]_{\text{eq}} (\text{M})$	$[\text{NO}_2]_{\text{eq}} (\text{M})$
1	0.5307	0.0495
2	1.114	0.0717
3	0.7456	0.0587
4	0.679	0.056

What is the equilibrium constant for the following reaction? Show that the same value for  $K_{\text{eq}}$  is obtained from each of the experiments.



for this reaction,

$$K_{\text{eq}} = \frac{[\text{NO}_2]^2}{[\text{N}_2\text{O}_4]}$$

exp 1

$$K_{\text{eq}} = \frac{(0.0495)^2}{0.5307} = 0.00462$$

exp 2

$$K_{\text{eq}} = \frac{(0.0717)^2}{(1.114)} = 0.00461$$

exp 3

$$K_{\text{eq}} = \frac{(0.0587)^2}{0.7456} = 0.00462$$

exp 4

$$K_{\text{eq}} = \frac{(0.056)^2}{0.679} = 0.00462$$

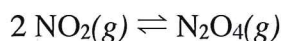
The value of the equilibrium constant doesn't depend on the specific concentrations but the equation will always be satisfied.

Use 0.00462  
for the problems  
on the next page

\*\*\* Check with Dr. Fantini that you have the right value for question 1 before continuing. \*\*\*

2. What is the equilibrium constant for the following equation at 25 °C?

(call this reaction # 2)



$$K_{eq,2} = \frac{[\text{N}_2\text{O}_4]}{[\text{NO}_2]^2}$$

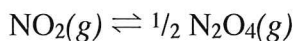
for  $\text{N}_2\text{O}_4(\text{g}) \rightleftharpoons 2 \text{NO}_2$  (prev. page),  $K_{eq} = 0.00462$

This reaction is the same reaction, but reversed.

$$\text{for this rxn, } K_{eq,2} = \frac{1}{0.00462} = \underline{216.5} \quad \text{because } K_{eq,2} = \frac{1}{K_{eq,1}}$$

3. What is the equilibrium constant for the following equation at 25 °C?

(call this reaction # 3)



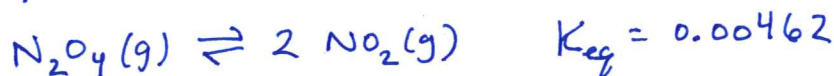
$$K_{eq,3} = \frac{[\text{N}_2\text{O}_4]^{1/2}}{[\text{NO}_2]}$$

Note the equation is like the one above, except all the coefficients have been divided through by 2.

$$\text{note } K_{eq,3} = (K_{eq,2})^{1/2} = \left( \frac{[\text{N}_2\text{O}_4]}{[\text{NO}_2]^2} \right)^{1/2} \quad \text{so } K_{eq,3} = \sqrt{216.5}$$
$$K_{eq,3} = 14.7$$

4. For a mixture of  $\text{N}_2\text{O}_4$  and  $\text{NO}_2$  that is known to be at equilibrium at 25 °C, only the  $[\text{NO}_2]$  was measured. What is  $[\text{N}_2\text{O}_4]$  at equilibrium if the  $[\text{NO}_2] = 0.0098 \text{ M}$ ?

you can do this building off any of the questions above. Using the expressions from question 1:



$$[\text{N}_2\text{O}_4]_{eq} = ?$$

$$[\text{NO}_2]_{eq} = 0.0098 \text{ M}$$

$$K_{eq} = 0.00462 = \frac{(0.0098)^2}{[\text{N}_2\text{O}_4]_{eq}} \Rightarrow [\text{N}_2\text{O}_4]_{eq} = \frac{(0.0098)^2}{0.00462}$$

$$[\text{N}_2\text{O}_4]_{eq} = 0.021 \text{ M}$$