

Chemistry 12

Notes on Equations and Keq Values

These notes explain what happens to the value of Keq when:

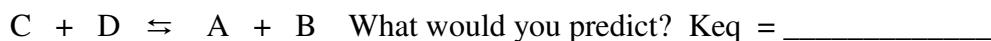
- Equations are Reversed
- Equations are Doubled (All Coefficients Doubled)
- Equations are Halved (All Coefficients Halved)
- Two Equations are Added to Give a Third Equation

FOR THESE NOTES ASSUME ALL SPECIES ARE GASES AND THE TEMPERATURE IS HELD CONSTANT

1. Reversing Equations

Given an equation: $A + B \rightleftharpoons C + D$, the value of Keq is 5.0

Let's say you were asked to find the value of Keq for the equation:



Let's check your prediction:

Since the Keq for: $A + B \rightleftharpoons C + D$, is 5.0, that means that the ratio:

$$\frac{[C][D]}{[A][B]} = 5.0$$

The Keq expression for: $C + D \rightleftharpoons A + B$ would be:

$$\frac{[A][B]}{[C][D]} \text{ and this, as you can see is the } \mathbf{\text{reciprocal}} \text{ of } \frac{[C][D]}{[A][B]} = 5.0$$

So
$$\frac{[A][B]}{[C][D]} = \frac{1}{5} = 0.20$$

To summarize: When you reverse an equation, the new Keq is the reciprocal (inverse) of the original equation.

2. Doubling Equations

Given that the value of Keq for: $A + B \rightleftharpoons C + D$ is 5.0,

Predict the value of Keq for: $2A + 2B \rightleftharpoons 2C + 2D$? _____

Let's check your prediction!

Since the value of Keq for: $A + B \rightleftharpoons C + D$ is 5.0, that means that the ratio:

$$\frac{[C][D]}{[A][B]} = 5.0$$

The Keq expression for $2A + 2B \rightleftharpoons 2C + 2D$ would be:

$$\frac{[C]^2[D]^2}{[A]^2[B]^2} \text{ which would be equal to } (5.0)^2 = 25$$

To summarize: When you double an equation, the new Keq value is the square of the Keq for the original equation.

3. Halving Equations (Multiplying all coefficients by 1/2)

Given that the value of Keq for: $A + B \rightleftharpoons C + D$ is 5.0,

Predict the value of Keq for: $\frac{1}{2}A + \frac{1}{2}B \rightleftharpoons \frac{1}{2}C + \frac{1}{2}D$? _____

Let's check your prediction!

Since the value of Keq for: $A + B \rightleftharpoons C + D$ is 5.0, that means that the ratio:

$$\frac{[C][D]}{[A][B]} = 5.0$$

The Keq expression for $\frac{1}{2}A + \frac{1}{2}B \rightleftharpoons \frac{1}{2}C + \frac{1}{2}D$ would be:

$$\frac{[C]^{1/2}[D]^{1/2}}{[A]^{1/2}[B]^{1/2}} \text{ which would be equal to } \sqrt{\frac{[C][D]}{[A][B]}} = \sqrt{5.0} = 2.2 \text{ (to 2 sig.digs)}$$

To summarize: When you halve an equation, the new Keq value is the square root of the Keq for the original equation.

4. Adding Equations

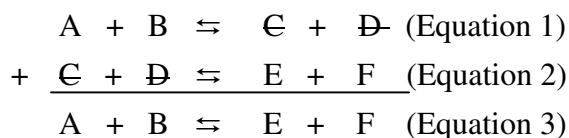
Given that the value of Keq for: $A + B \rightleftharpoons C + D$ is 5.0,

And the value of Keq for: $C + D \rightleftharpoons E + F$ is 3.0

Predict the value of the Keq for the equation: $A + B \rightleftharpoons E + F$? _____

Lets check our prediction:

Notice that if you ADD the first two equations, you get the third one:



Look at what happens when you MULTIPLY the Keq expressions for Equation 1 and Equation 2:

$$K_1 \times K_2 = \frac{[C][D]}{[A][B]} \times \frac{[E][F]}{[C][D]} = \frac{[E][F]}{[A][B]}$$

You can see the the last expression: $\frac{[E][F]}{[A][B]}$ is the Keq expression for Equation 3

So the value of K_3 (or the Keq for Equation 3) would be

$$K_1 \times K_2 = 5.0 \times 3.0 = \mathbf{15}$$

To summarize: When you add 2 equations to get a third one, the Keq value for the third one is the product of the Keq's for the original equations.

Questions:

- Given the equilibrium: $2 \text{NO}_{2(g)} \rightleftharpoons \text{N}_2\text{O}_{4(g)}$ Keq = 2.2

Find the value of the Keq for $\text{NO}_{2(g)} \rightleftharpoons \frac{1}{2} \text{N}_2\text{O}_{4(g)}$ at the same temperature.

Answer _____



Find the value of the Keq for $4\text{NO}_{2(g)} \rightleftharpoons 2\text{N}_2\text{O}_{4(g)}$ at the same temperature.

Answer _____



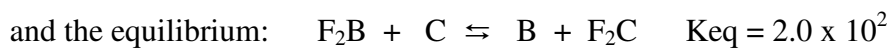
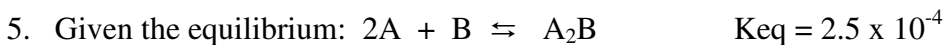
Find the value of the Keq for $\text{N}_2\text{O}_{4(g)} \rightleftharpoons 2\text{NO}_{2(g)}$ at the same temperature.

Answer _____



Find the value of the Keq for $6\text{NO}_{2(g)} \rightleftharpoons 3\text{N}_2\text{O}_{4(g)}$ at the same temperature.

Answer _____



Find the value of Keq for the equilibrium: $2\text{A} + \text{F}_2\text{B} + \text{C} \rightleftharpoons \text{A}_2\text{B} + \text{F}_2\text{C}$

Answer _____