[TP] For the reaction

$$2\,A + B \rightarrow 2\,C$$

at a certain time the value of its reaction quotient is $Q = 7$. This means the value of the equilibrium constant for the reaction is ...

25% 1. < 7
25% 2. 7
25% 3. > 7
25% 4. Further information needed

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Lecture 13 CH102 A1 (MWF 9:05 am)

Wednesday, February 20, 2019

- Review: Reaction quotient, Q, spontaneity, and equilibrium
- Predicting direction of change
- Q depends on how a reaction is written
- Knowing K does not fix individual concentrations.

Next: Disturbing equilibrium (Le Chatelier); Begin ch14: Acid-base equilibria in aqueous solutions

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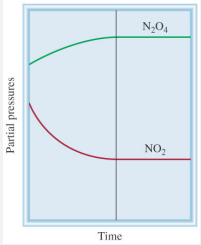
[TP] The figure shows how the partial pressures of the N_2O_4 and NO_2 change with time due to the chemical reaction

$$N_2O_4 \rightarrow 2\,NO_2$$

for certain initial conditions (far left). At these initial conditions, the following is known about the chemical reaction.

25% 1. It is spontaneous
25% 2. It is at equilibrium
25% 3. It is non-spontaneous
25% 4. Its spontaneity is not known without further information



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Q versus K is the key to assessing spontaneity

If $Q < K$, product must form to get to equilibrium,
so spontaneous

If $Q > K$, reactants must form to get to equilibrium,
so nonspontaneous

If $Q = K$, no change in amounts of reactants and products,
so equilibrium

So, Q/K is the key quantity to monitor.

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Predicting direction of change

The key is Q versus K.

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[TP] For the reaction

$$2\,A + B \rightarrow 2\,C$$

at a certain time the value of its reaction quotient is $Q = 7$. This means the value of the equilibrium constant for the reaction is ...

25% 1. < 7
25% 2. 7
25% 3. > 7
25% 4. Further information needed

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[TP] The value of the equilibrium constant for the gas-phase reaction

$$2\,A + B \rightarrow C$$ is $K = 10$.

At a certain time the partial pressures are A, B and C are, respectively, 1 bar, 1 bar and 2 bar.
The value of the reaction quotient is $Q =$ ...

33% 1. 2
33% 2. 10
33% 3. Further information needed

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[Quiz] The value of the equilibrium constant for the gas-phase reaction

$$2\,A + B \rightarrow C$$ is $K = 10$.

At a certain time the partial pressures are A, B and C are, respectively, 1 bar, 1 bar and 2 bar.
Under these conditions, the value of the equilibrium constant is $K =$ ...

33% 1. 2
33% 2. 10
33% 3. Further information needed

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[TP] The value of the equilibrium constant for the gas-phase reaction

$2\ A + B \rightarrow C$ is $K = 10$.

At a certain time the partial pressures are A, B and C are, respectively, 0.2 bar, 1 bar and 4 bar.

The value of the reaction quotient is $Q =$ ...

20% 1. 0.04
20% 2. 4
20% 3. 10
20% 4. 100
20% 5. None of the these

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[TP] The value of the equilibrium constant for the gas-phase reaction

$2\ A + B \rightarrow C$ is $K = 10$.

At a certain time the partial pressures are A, B and C are such that the value of the reaction quotient is $Q = 100$.

As time passes, the value of Q will ...

33% 1. increase
33% 2. stay the same
33% 3. decrease

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[Quiz] The value of the equilibrium constant for the gas-phase reaction

$2\ A + B \rightarrow C$ is $K = 10$.

At a certain time the value of the reaction quotient is $Q = 6$.

As time passes, the value of Q will ...

33% 1. increase
33% 2. stay the same
33% 3. decrease

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Q depends on how a reaction is written

At a certain time, the value of the reaction quotient for the reaction

$2\ A + B \rightleftharpoons 2\ C$

is $Q_1 = 4.0$.

At the same time, what would be the value of Q be for the reaction

$4\ A + 2\ B \rightleftharpoons 4\ C$?

$$Q_4 = \frac{(C)^4}{(A)^4(B)^2} = Q_1^2 = 16$$

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Q depends on how a reaction is written

At a certain time, the value of the reaction quotient for the reaction

$2\ A + B \rightleftharpoons 2\ C$

is $Q_1 = 4.0$.

At the same time, what would be the value of Q be for the reaction

$2\ C \rightleftharpoons 2\ A + B$?

$$Q_2 = \frac{(A)^2(B)}{(C)^2} = \frac{1}{Q_1} = 0.25$$

Q depends on how a reaction is written

At a certain time, here are the values of the reaction quotients for two different reactions,

$2\ A \rightleftharpoons B$, $Q_5 = \frac{(B)}{(A)^2} = 2$

$C \rightleftharpoons 3\ D$, $Q_6 = \frac{(D)^3}{(C)} = 5$

At the same time, what would be the value of Q be for the reaction

$2\ A + C \rightleftharpoons B + 3D$?

$$Q_7 = \frac{(B)(D)^3}{(A)^2(C)} = Q_5 \times Q_6 = 10$$

[TP] The value of the equilibrium constant for the reaction

$2\ A + B \rightleftharpoons C$

is $K = 10$. The value of the equilibrium constant for the reaction

$6\ A + 3\ B \rightleftharpoons 3\ C$

is ...

0% 1. 10
0% 2. 30
0% 3. 100
0% 4. 1000
0% 5. None of the above

[TP] The value of the equilibrium constant for the reaction

$2\ A + B \rightleftharpoons C$

is $K = 10$. The value of the equilibrium constant for the reaction

$2\ C \rightleftharpoons 4\ A + 2\ B$

is ...

20% 1. −10
20% 2. 0.1
20% 3. 0.01
20% 4. −0.001
20% 5. None of the above

[Quiz] The value of the equilibrium constant for the reaction

$2\ A \rightleftharpoons C$ is $K_1 = 4$

and that for the reaction

$D \rightleftharpoons C$ is $K_2 = 0.5$.

The value of the equilibrium constant for the reaction

$2\ A \rightleftharpoons D$ is $K_3 =$ ...

20% 1. 2
20% 2. 4
20% 3. 6
20% 4. 8
20% 5. None of the above

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Knowing K does not fix individual concentrations

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Chapter 13 equilibrium calculations

Pages 505—507 illustrate how to calculate equilibrium concentrations by solving polynomial (quadratic, etc.) equations for the change in concentration.

This is doable but can be time consuming.

We will not need to use this method.

Rather, in chapter 14, we will learn to use an approximate method that is broadly applicable to aqueous acid-base equilibria.

Here, in chapter 13, we will illustrate equilibration by providing the equilibrium values.

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Equilibration examples

Essential lesson:
Knowing K does not fix individual equilibrium concentrations.

Let's see how this works for

$H_2(g) + I_2(g) \rightleftharpoons 2\ HI(g), K = 33$

for three different sets of initial concentrations

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Worked Example 13.5, p 505

$H_2(g) + I_2(g) \rightleftharpoons 2\ HI(g), K = 33$

Different starting points ...

	$H_2(g)$	$I_2(g)$	$HI(g)$	Q
Initial	0.00600	0.00600	0	0
Initial	0.00600	0	0.00200	∞
Initial	0.00600	0.0000100	0.00200	66.7

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Worked Example 13.5, p 505

$H_2(g) + I_2(g) \rightleftharpoons 2\ HI(g), K = 33$

Different starting points ...
different equilibrium concentrations

	$H_2(g)$	$I_2(g)$	$HI(g)$	Q
Equilibrium	0.00155	0.00155	0.00890	33
Equilibrium	0.00602	0.0000194	0.00196	33
Equilibrium	0.00601	0.0000198	0.00198	33

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