SCIENCE FOUNDATIONS

Equilibrium constants

Difficulty level: Advanced

Science Foundations

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Overview of the concept

This is how a winemaker or a water treatment plant predicts how far a reversible chemical reaction will go before it settles into balance. A winemaker controls the balance of a reaction to keep the wine from turning to vinegar. A water plant adjusts the balance to keep lead and other metals dissolved or settled out of the drinking water. Knowing equilibrium constants tells you whether a reaction will mostly finish or mostly stay as starting materials.



Rule

Equilibrium constants: the equilibrium constant is K = $\frac{\text{concentration of products}}{\text{concentration of reactants}}$ at equilibrium, each raised to its coefficient.

A large K means mostly products at equilibrium, and a small K means mostly reactants. Solids do not appear in the expression.

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Worked examples

EXAMPLE 1

Q **Find K for ethanol -> ethanoic acid with [ethanoic acid] 0.8 mol/L and [ethanol] 0.2 mol/L at equilibrium.**

SOLUTION

Write the expression:

K = [ethanoic acid] ÷ [ethanol]

Substitute:
K = 0.8 ÷ 0.2

K = 4

The result is K = 4.

EXAMPLE 2

Q **Find K for ethanol -> ethanoic acid with [ethanoic acid] 0.1 mol/L and [ethanol] 0.5 mol/L at equilibrium.**

SOLUTION

Write the expression:

K = [ethanoic acid] ÷ [ethanol]

Substitute:
K = 0.1 ÷ 0.5

K = 0.2

The result is K = 0.2.

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Practice questions

1. Find K for ethanol -> ethanoic acid with [ethanoic acid] 0.5 mol/L and [ethanol] 0.2 mol/L at equilibrium.

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2. For the reaction 2A -> B at equilibrium, [B] is 0.4 mol/L and [A] is 0.2 mol/L. Find K. Each concentration is raised to its coefficient.

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3. A reaction has K = 4 at equilibrium. The reactant concentration is 0.5 mol/L. Find the product concentration.

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The equilibrium constant for a reaction is K = 1. What does that tell you about the products and reactants at equilibrium?

A They are present in equal amounts

B Mostly products

C Mostly reactants

D No reaction happened

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How is K written for ethanol -> ethanoic acid?

A Products divided by reactants

B Reactants divided by products

C Products plus reactants

D Products minus reactants

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A reaction has a large K. What is mostly present at equilibrium?

A Products

B Reactants

C Both equally

D Neither

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7

A reaction has a small K. What is mostly present at equilibrium?

A Reactants

B Products

C Both equally

D Neither

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8 A solid is present in the reaction. Does it appear in the K expression?

- A Yes
- B No

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9 K = 8: products or reactants favoured?

- A Products
- B Reactants
- C Both equally
- D Neither

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K = 0.05: products or reactants favoured?

A Reactants

B Products

C Both equally

D Neither

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ANSWER KEY

1. 2.5

2. 10

3. 2

4. They are present in equal amounts

5. Products divided by reactants

6. Products

7. Reactants

8. No

9. Products

10. Reactants

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