

7.10 The Reaction Quotient and Le Chatelier's Principle

Name: _____ Class: _____ Date: _____ **Total: 9 marks****KEY WORDS** reaction quotient 反应商 • le chatelier's principle 勒沙特列原理

Objective

Build the skills to answer exam questions on **the reaction quotient and Le Chatelier's principle** — using Q vs K to explain a shift.

You must be able to:

- show how a stress changes Q relative to K
- predict the shift that restores $Q = K$
- connect the Q/K view to Le Chatelier

1 Worked examples

Study these first. Each one shows the method for a question type used later — follow the steps and you can do the Practice and Exam-style questions yourself.

■ A stress changes Q

Adding or removing a species instantly changes Q but not K . The system then shifts to bring Q back to K — the quantitative reason behind Le Chatelier.

■ A worked concentration change

At equilibrium $Q = K$. **Add reactant** $\rightarrow$ the denominator grows $\rightarrow Q$ **drops below** $K \rightarrow$ reaction shifts **forward** until $Q = K$ again.

■ Removing a product

Remove product $\rightarrow$ the numerator shrinks $\rightarrow Q$ drops below $K \rightarrow$ shifts **forward** to remake product.

■ Why temperature is different

Concentration and pressure changes move Q toward a fixed K . A **temperature** change instead changes K **itself**, so the system shifts to reach the new K .

2 Practice

Now apply the methods above.

2.1 Adding a reactant makes Q do what (relative to K)? [1]

2.2 If $Q < K$ after a stress, which way does the reaction shift? [1]

2.3 Does adding a reactant change K ? [1]

3 Exam-style questions

3.1 Removing a product from an equilibrium causes Q to [1]

- **A** rise above K
- **B** fall below K
- **C** stay equal to K
- **D** become zero

3.2 For $A \rightleftharpoons B$ at equilibrium, more B is suddenly added.

(a) State how Q changes relative to K . [1]

(b) State the direction of shift and explain using Q and K . [2]

3.3 Explain why a concentration change shifts the equilibrium but leaves K unchanged, whereas a temperature change alters K . [2]

Solutions

2.1 Q falls below K .

2.2 Forward (toward products).

2.3 No.

3.1 B — removing a product lowers the numerator, so Q falls below K .

3.2 (a) Q rises above K (more product in the numerator). (b) Shifts **reverse** (toward A), because $Q > K$ so the reaction consumes B to bring Q back down to K .

3.3 Concentration changes only move the current Q ; the reaction shifts to restore the same K . Temperature changes the equilibrium position by changing K itself (since K depends on temperature).