AP CHEMISTRY • EXERCISE SHEET

7.3 The Reaction Quotient and Equilibrium Constant

Name: _____ Class: _____ Date: _____ **Total: 10 marks**

Objective

Build the skills to answer exam questions on the **reaction quotient** Q and its comparison to K.

You must be able to:

- calculate Q with the same form as K but current (non-equilibrium) concentrations
- compare Q to K to predict the direction of shift
- state what $Q = K$ means

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.

The reaction quotient

Q has the **same expression** as K but uses the **current** concentrations (not necessarily at equilibrium).

Comparing Q and K

- $Q < K$: too few products → shifts **forward** (toward products);
- $Q > K$: too many products → shifts **reverse** (toward reactants);
- $Q = K$: **at equilibrium**, no shift.

A worked comparison

If $K = 10$ and the current $Q = 2$, then $Q < K$, so the reaction proceeds **forward** to make more product until Q rises to 10.

Why it works

Q measures "how far along" the mixture is. The reaction always moves to bring Q toward K.

2 Practice

Now apply the methods above.

2.1 What does $Q = K$ mean? [1]

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

2.3 How does the expression for Q differ from that for K? [1]

3 Exam-style questions

3.1 If $Q > K$, the reaction shifts [1]

- **A** forward (toward products)
- **B** reverse (toward reactants)
- **C** it is at equilibrium
- **D** it stops

3.2 For a reaction, $K = 50$. A mixture is analyzed and $Q = 120$.

(a) Compare Q and K. [1]

(b) State the direction of shift, with a reason. [2]

3.3 For $\mathrm{A} \rightleftharpoons \mathrm{B}$ with $K = 4$, a mixture has $[\mathrm{A}] = 2$ M and $[\mathrm{B}] = 2$ M. Find Q and predict the shift. [3]

4 Go further

You are now ready for the real exam questions on this subtopic:

- work through the **7.3 The Reaction Quotient and Equilibrium Constant** lesson on the **Learn** page;
- read the **The Reaction Quotient and Equilibrium Constant** section of the AP Chemistry handout on the **Know** page.

Solutions

2.1 The mixture is at equilibrium.

2.2 Forward (toward products).

2.3 Q uses the current concentrations; K uses the equilibrium concentrations.

3.1 B —too many products, so it shifts reverse.

3.2 (a) $Q > K$ ($120 > 50$). (b) Shifts reverse (toward reactants), because there is more product than equilibrium allows, so Q must fall to K.

3.3 $Q = \dfrac{[\mathrm{B}]}{[\mathrm{A}]} = \dfrac{2}{2} = 1$; $Q < K$ ($1 < 4$), so it shifts **forward** to make more B.