Exercise walk-through

Reaction Quotient and Equilibrium Constant ▪ 7.3

eXercise

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

Method — The reaction quotient

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

Method — Comparing Q and K

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

Method — 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.

Method — Why it works

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

Practice 2.1 ▪ 1 mark

What does $Q = K$ mean?

Solution 2.1

Worked steps

The mixture is at equilibrium B1.

Practice 2.2 ▪ 1 mark

If $Q < K$, which way does the reaction shift?

Solution 2.2

Worked steps

Forward (toward products) B1.

Practice 2.3 ▪ 1 mark

How does the expression for Q differ from that for K?

Solution 2.3

Worked steps

Q uses the current concentrations; K uses the equilibrium concentrations B1.

Exam-style 3.1 ▪ 1 mark

If $Q > K$, the reaction shifts

A forward (toward products)

B reverse (toward reactants)

C it is at equilibrium

D it stops

Solution 3.1

A forward (toward products)

B reverse (toward reactants) ✓

C it is at equilibrium

D it stops

Worked steps

B — too many products, so it shifts reverse.

Exam-style 3.2 ▪ 1 mark

For a reaction, $K = 50$. A mixture is analyzed and $Q = 120$.
(a) Compare Q and K.
(b) State the direction of shift, with a reason.

Solution 3.2

Method: Why it works

Worked steps

(a) $Q > K$ $(120 > 50)$ B1. (b) Shifts reverse (toward reactants), because there is more product than equilibrium allows, so Q must fall to K M1 A1.

Exam-style 3.3 ▪ 3 marks

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

Solution 3.3

Worked steps

$Q = \dfrac{[\mathrm{B}]}{[\mathrm{A}]} = \dfrac{2}{2} = 1$ M1; $Q < K$ $(1 < 4)$, so it shifts **forward** to make more B M1 A1.