

Exercise walk-through

7.10

Reaction Quotient and Le Chatelier's Principle

AP Chemistry

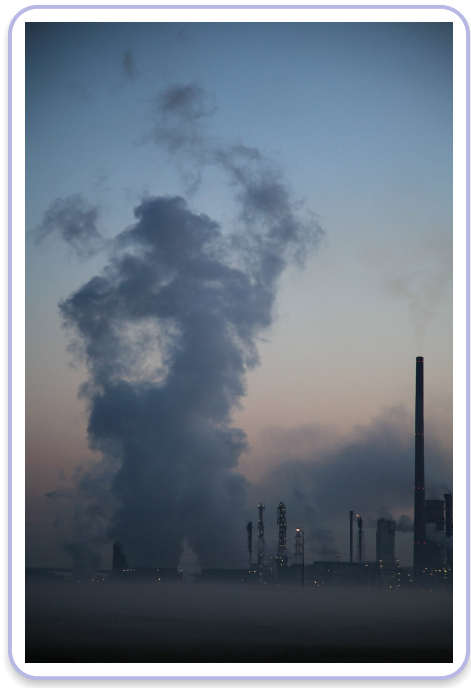
Le Chatelier's principle

Le Chatelier : a disturbed system shifts to **partly undo** the change.

add a substance $\Rightarrow$ shift *away* from it

raise pressure $\Rightarrow$ toward fewer gas moles

add heat $\Rightarrow$ shift as if heat were added



Industry shifts equilibrium with Le Chatelier

Justifying every Le Chatelier shift with Q

 Q

the reaction quotient – the same expression as K , evaluated at **any** moment

 $Q < K$

too few products, so the reaction shifts **right**

 $Q > K$

too many products, so it shifts **left**

 $Q = K$

at equilibrium; no net change

the method

a disturbance changes Q , and the system reacts to bring Q back to K

why it is better

this makes the reasoning **quantitative** rather than a memorised rule about stress

Only **temperature** changes K itself. Everything else changes Q , which is why every other disturbance can be reasoned about this way.

Exercises 2.1-2.3

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]

Exercises 2.1-2.3

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

2.1

- Q falls below K
-

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

2.2

- Forward (toward products)
-

2.3 Does adding a reactant change K ? [1]

2.3

- No

Exercise 3.1

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

Exercise 3.1

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

3.1 B

- removing a product lowers the numerator, so Q falls below K

Exercise 3.2 (a)

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

(a) State how Q changes relative to K .

[1]

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(a) State how Q changes relative to K .

[1]

(a)

- Q rises above K (more product in the numerator)

Exercise 3.2 (b)

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

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

[2]

Exercise 3.2 (b)

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

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

[2]

(b)

- Shifts **reverse** (toward A), because $Q > K$ so the reaction consumes B to bring Q back down to K

Exercise 3.3

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

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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)