

Exercise walk-through

7.9

Introduction to Le Chatelier's Principle

AP Chemistry

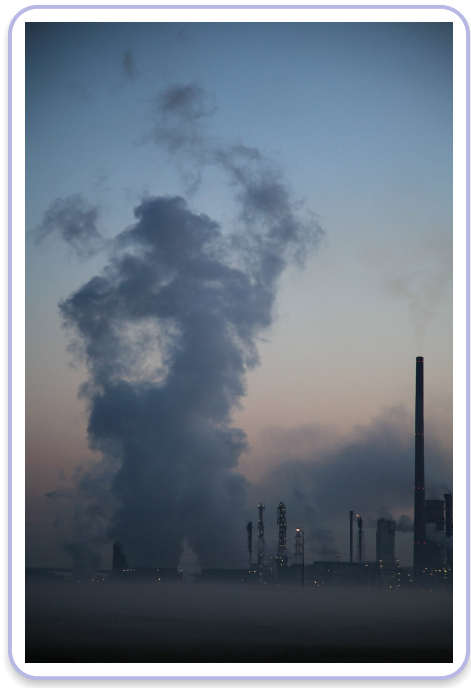
Le Chatelier's principle

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 State Le Chatelier's principle.

[1]

2.2 For $A + B \rightleftharpoons C$, which way does adding more A shift it?

[1]

2.3 Which single change alters the value of K ?

[1]

Exercises 2.1-2.3

2.1 State Le Chatelier's principle. [1]

2.1

- A system at equilibrium shifts to counteract an applied stress and restore equilibrium
-

2.2 For $A + B \rightleftharpoons C$, which way does adding more A shift it? [1]

2.2

- Toward products (forward)
-

2.3 Which single change alters the value of K ? [1]

2.3

- A temperature change

Exercise 3.1

3.1 Increasing the pressure on a gas equilibrium shifts it toward the side with [1]

☐

A more gas moles

B fewer gas moles

C solids

D no change ever

Exercise 3.1

3.1 Increasing the pressure on a gas equilibrium shifts it toward the side with [1]

☐

A more gas moles

B fewer gas moles

C solids

D no change ever

3.1 B

- fewer gas moles

Exercise 3.2 (a)

3.2 Consider $\text{N}_2(g) + 3\text{H}_2(g) \rightleftharpoons 2\text{NH}_3(g)$, $\Delta H < 0$.

(a) State the shift when the pressure is increased.

[2]

Exercise 3.2 (a)

3.2 Consider $\text{N}_2(g) + 3\text{H}_2(g) \rightleftharpoons 2\text{NH}_3(g)$, $\Delta H < 0$.

(a) State the shift when the pressure is increased.

[2]

(a)

- There are 4 gas moles left, 2 right; increasing pressure shifts toward the fewer-mole side – **toward products**

Exercise 3.2 (b)

3.2 Consider $\text{N}_2(g) + 3\text{H}_2(g) \rightleftharpoons 2\text{NH}_3(g)$, $\Delta H < 0$.

(b) State the shift when the temperature is increased, with a reason.

[2]

Exercise 3.2 (b)

3.2 Consider $\text{N}_2(g) + 3\text{H}_2(g) \rightleftharpoons 2\text{NH}_3(g)$, $\Delta H < 0$.

(b) State the shift when the temperature is increased, with a reason.

[2]

(b)

- Exothermic, so heat is a product; increasing temperature shifts **toward reactants** (backward)

Exercise 3.3

3.3 For $2\text{SO}_2 + \text{O}_2 \rightleftharpoons 2\text{SO}_3$ ($\Delta H < 0$), state and explain the effect of removing SO_3 . [2]

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3.3

- Removing SO_3 (a product) shifts the equilibrium **forward** to replace it, making more SO_3