Exercise walk-through

Introduction to Le Chatelier's Principle ▪ 7.9

eXercise

You must be able to

- predict the shift when **concentration**, **pressure/volume**, or **temperature** changes
- state **Le Chatelier's principle** 勒沙特列原理
- treat a temperature change using the reaction's ΔH

Method — The principle

If a stress is applied to a system at equilibrium, it shifts to **counteract** the stress and restore equilibrium.

Method — Concentration

Adding a reactant shifts **toward products** (to use it up); removing a product shifts **toward products** (to replace it).

Method — Pressure and volume (gases)

Increasing pressure (smaller volume) shifts toward the side with **fewer gas moles**. If both sides have equal moles, pressure has no effect.

Method — Temperature

Treat heat as a reactant/product using ΔH:

- **exothermic** (heat is a product): heating shifts **toward reactants** (backward);
- **endothermic** (heat is a reactant): heating shifts **toward products** (forward).

Only temperature changes the value of K.

Practice 2.1 ▪ 1 mark

State Le Chatelier's principle.

Solution 2.1

Worked steps

A system at equilibrium shifts to counteract an applied stress and restore equilibrium B1.

Practice 2.2 ▪ 1 mark

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

Solution 2.2

Worked steps

Toward products (forward) B1.

Practice 2.3 ▪ 1 mark

Which single change alters the value of K?

Solution 2.3

Worked steps

A temperature change B1.

Exam-style 3.1 ▪ 1 mark

Increasing the pressure on a gas equilibrium shifts it toward the side with

A more gas moles

B fewer gas moles

C solids

D no change ever

Solution 3.1

Method: Pressure and volume (gases)

A more gas moles

B fewer gas moles ✓

C solids

D no change ever

Worked steps

B — fewer gas moles.

Exam-style 3.2 ▪ 2 marks

Consider $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$, $\Delta H < 0$.

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

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

Solution 3.2

Method: Temperature

Worked steps

(a) There are 4 gas moles left, 2 right; increasing pressure shifts toward the fewer-mole side — **toward products** M1 A1. (b) Exothermic, so heat is a product; increasing temperature shifts **toward reactants** (backward) M1 A1.

Exam-style 3.3 ▪ 2 marks

For $2SO_2 + O_2 \rightleftharpoons 2SO_3$ ($\Delta H < 0$), state and explain the effect of removing SO_3.

Solution 3.3

Worked steps

Removing SO_3 (a product) shifts the equilibrium **forward** to replace it, making more SO_3 M1 A1.