Lesson 6
Le Châtelier's Principle

Learning Goals

- ❑ I will be able to apply Le Châtelier's principle to predict how various factors would affect a chemical system at equilibrium.

Le Châtelier's Principle

"Any change in one of the variables that determines the state of a system in equilibrium causes a shift in the position of equilibrium in a direction that tends to counteract the change in the variable under consideration."

– Le Châtelier 1888

"When a chemical system at equilibrium is disturbed by a change in a property, the system adjusts in a way that opposes the change."

– *Nelson Chemistry 12*

"When a stress is applied to a system at equilibrium, the system will adjust to relieve the stress."


Henri-Louis Le Châtelier

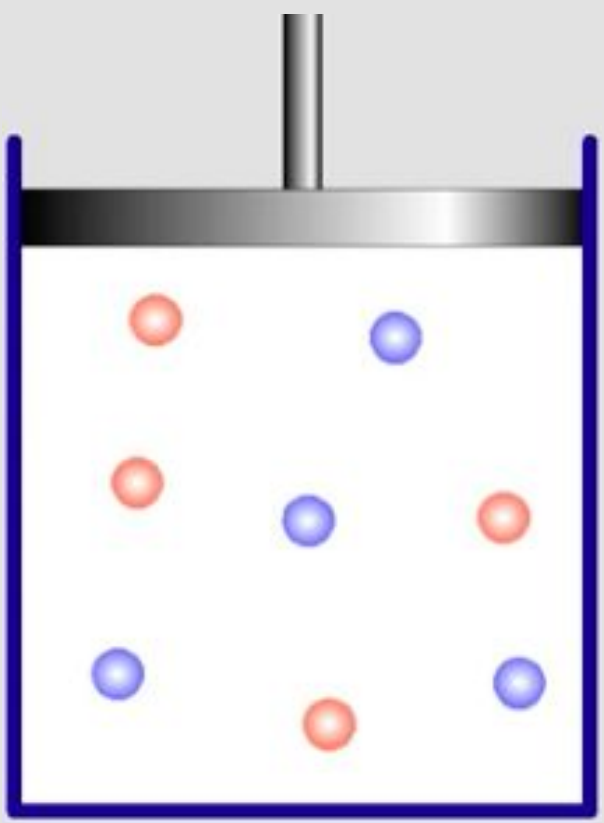
$$N_2(g) + 3\,H_2(g) \rightleftharpoons 2\,NH_3(g) + 92\ kJ$$

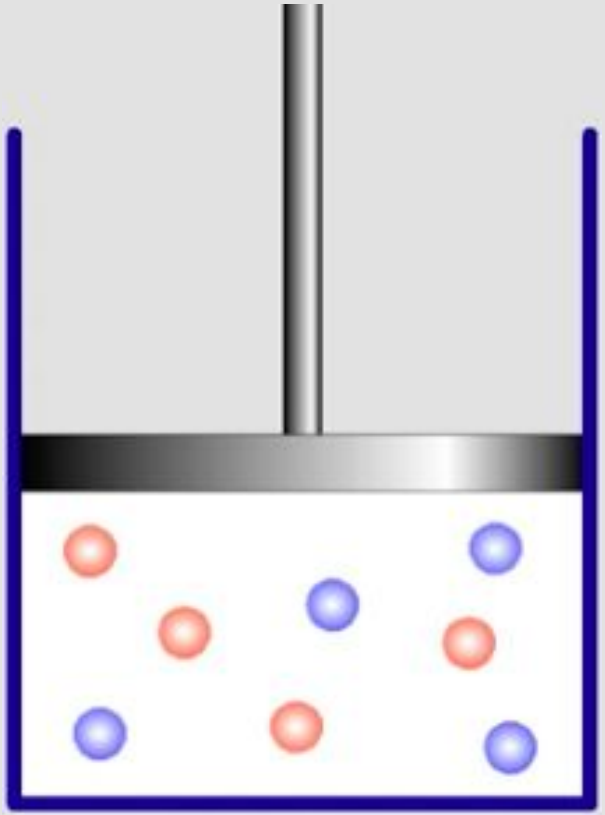
Adding nitrogen will shift the equilibrium to the . . . **RIGHT** →

Removing hydrogen will shift the equilibrium to the . . . **LEFT** ←

Increasing the temperature will shift the equilibrium to the . . . **LEFT** ←

Reducing the volume will shift the equilibrium to the . . .





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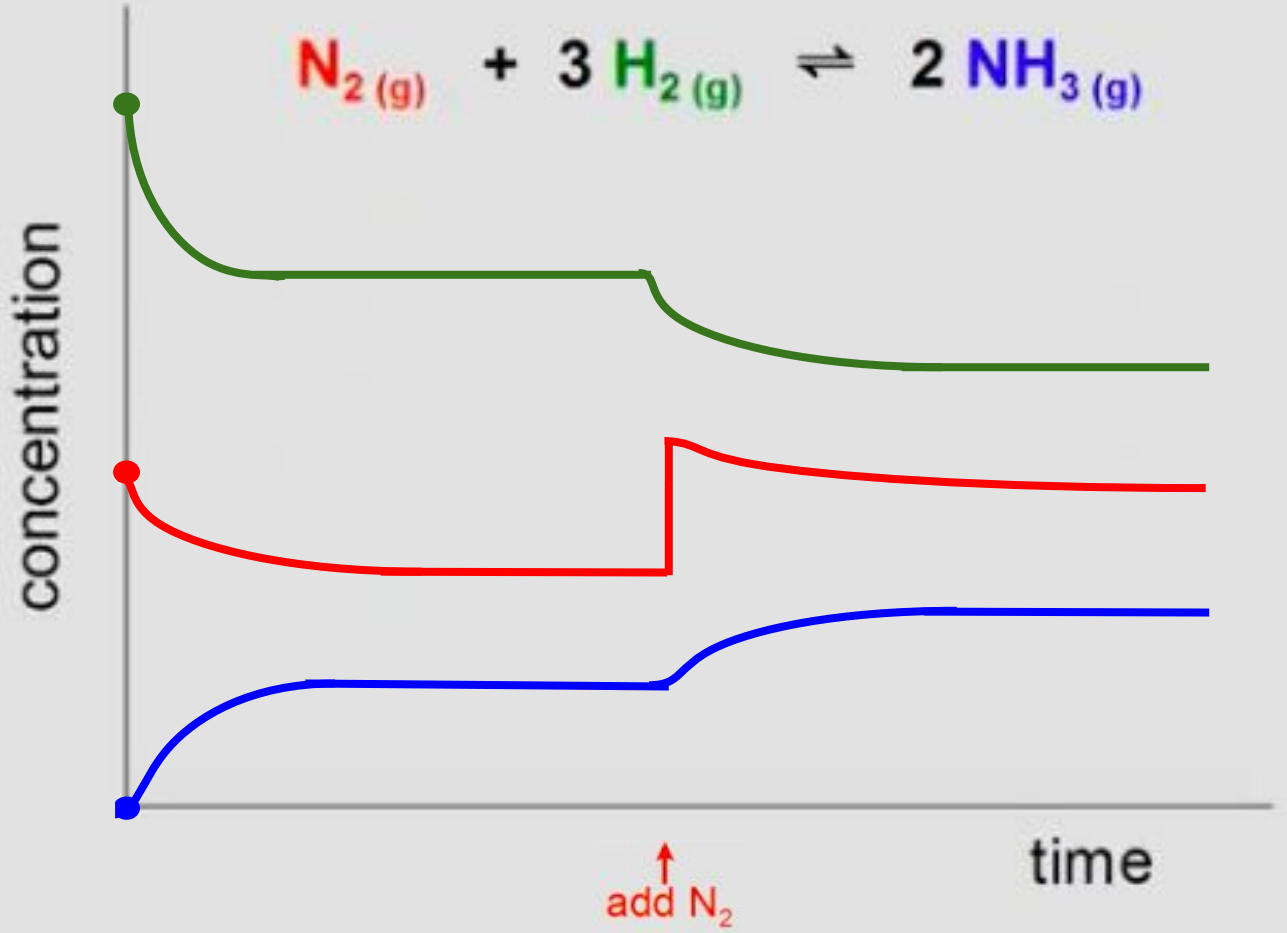

$N_{2\,(g)}$ + 3 $H_{2\,(g)}$ ⇌ 2 $NH_{3\,(g)}$
concentration
time
add N_2

Le Châtelier’s Principle: Summary of Effects

- Increasing a concentration on one side of the equation shifts the equilibrium toward the opposite side.
- Increasing the temperature shifts the equilibrium away from the energy term.
- Increasing the pressure by reducing the volume shifts the equilibrium toward the side with fewer molecules of gas.

Changes that Do Not Shift the Equilibrium

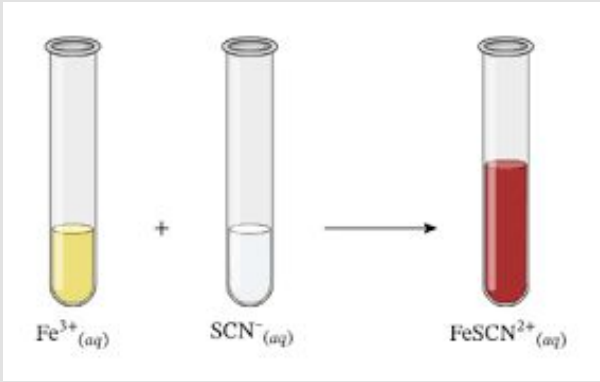
- Increasing pressure by adding an inert gas.
- Adding a catalyst (equilibrium is reached faster).

Note that Le Châtelier’s principle does not explain why the shift occurs.

The principle is only a guide for predicting the effect of changing conditions on the equilibrium position.

$Fe^{3+}(aq)$ + $SCN^{-}(aq)$ $\rightleftharpoons$ $FeSCN^{2+}(aq)$ + heat

faint yellow — colourless — dark red



Disturbance	Observation
add Fe^{3+}	darker red
add SCN^{-}	darker red
remove Fe^{3+}	lighter red
remove SCN^{-}	lighter red
increase temperature	lighter red
decrease temperature	darker red

When heated, the following system becomes darker brown.
Is the forward reaction exothermic or endothermic?

$$\text{heat} + \underset{\text{colourless}}{N_2O_4(g)} \rightleftharpoons 2\,\underset{\text{brown}}{NO_2(g)}$$

endothermic ⇨

Success Criteria

- ❑ I can apply Le Châtelier's principle to predict how various factors would affect a chemical system at equilibrium.

PRACTICE:

- Page 446 #1, 2, 3, 4