

SCH 4U

PREDICTING DIRECTION OF REACTION

$$K_c = \frac{[Products]^x}{[Reactants]^y}$$

1. If Reactants \rightleftharpoons Products, then $[P] \gg [R] \quad \therefore K_c \gg 1$
2. If Reactants \rightleftharpoons Products, then $[P] \approx [R] \quad \therefore K_c \approx 1$
3. If Reactants \rightleftharpoons Products, then $[P] \ll [R] \quad \therefore K_c \ll 1$

To Check if a Reaction has reached Equilibrium,

1. Use reaction quotient, Q_c , (same as K_c , but used to test an equilibrium system).
2. Substitute values into Q_c .
3. If $Q_c = K_c$, system is at equilibrium.

If $Q_c > K_c$, too many products, so reaction will reach equilibrium by going to the LEFT.

If $Q_c < K_c$, too few products, so reaction will reach equilibrium by going to the RIGHT.

Eg. At 500°C, $K_c = 0.40$ for $N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)}$

In a container, $[N_{2(g)}] = 0.10 \text{ mol/L}$, $[H_{2(g)}] = 0.30 \text{ mol/L}$, and $[NH_3] = 0.20 \text{ mol/L}$.

- A) Is this reaction at equilibrium?
- B) If not, which direction will it go to reach equilibrium?

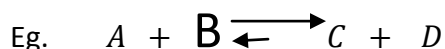
$$Q_c = \frac{[NH_3]^2}{[N_2][H_2]^3} \qquad K_c = 0.40$$

Le Chatelier's Principle

"If a system at equilibrium is subjected to an external stress, the equilibrium will shift so as to minimize the stress."

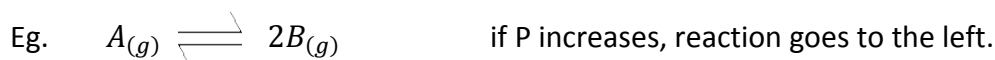
(A) CHANGES IN [R] & [P]

- If [R] increases or [P] decreases, $Q_c < K_c$, therefore reaction goes to the right.
- If [R] decreases or [P] increases, $Q_c > K_c$, therefore reaction goes to the left.



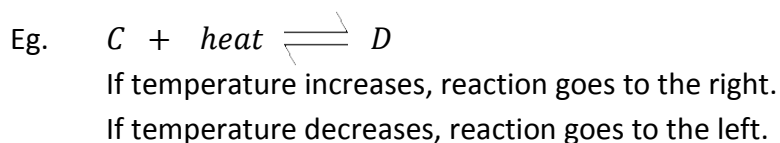
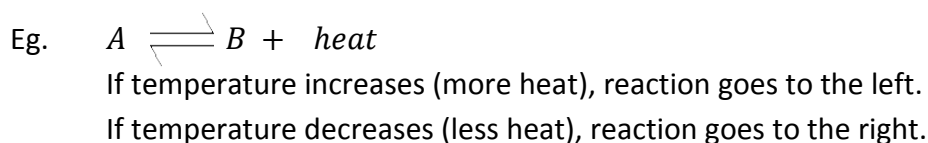
(B) CHANGES IN VOLUME OR PRESSURE (OF GASES)

- If V decreases or P increases, reaction goes to side with fewer moles
- If V increases or P decreases, reaction goes to side with more moles



(C) CHANGES IN TEMPERATURE

- If exothermic, treat NRG as a product
- If endothermic, treat NRG as a reactant



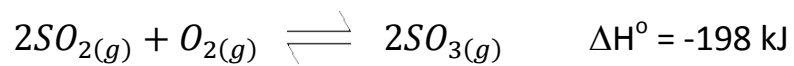
(D) EFFECT OF A CATALYST

- No effect on equilibrium (would only get there faster)

(E) ADDITION OF A NON-REACTANT/PRODUCT

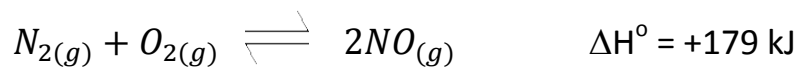
- Not part of reaction, so it does not affect equilibrium

Eg. How can you shift equilibrium to the right?



- A) Temperature –
- B) $[SO_2]$ –
- C) $[O_2]$ –
- D) $[SO_3]$ –
- E) Pressure –
- F) Volume –

Eg. Which direction will equilibrium shift for ...



- A) add N_2 –
- B) remove O_2 –
- C) add catalyst –
- D) add He –
- E) reduce volume to half –