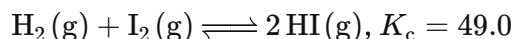
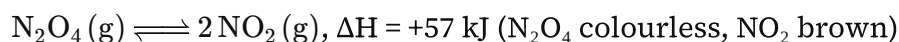
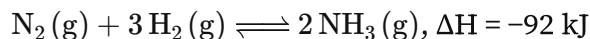


Le Chatelier's Principle

Effects of concentration, pressure, temperature and catalysts on equilibria

Name _____ Class _____ Date _____

REACTIONS USED



For each change, state the direction of shift and whether K changes.

A. Understanding

1. State Le Chatelier's principle.

B. The Haber process

2. For $\text{N}_2 + 3\text{H}_2 \rightleftharpoons 2\text{NH}_3$, predict the effect on the amount of NH_3 at equilibrium, and on K, of: (a) adding H_2 (b) removing NH_3 (c) increasing the pressure by reducing the volume (d) increasing the temperature (e) adding an iron catalyst.

3. Industrial ammonia plants run at about 450 °C, although a lower temperature would give a higher equilibrium yield. Explain why a lower temperature is not used.

C. Colour and temperature

4. A sealed tube of N_2O_4 and NO_2 is placed in ice water. Predict and explain the colour change.

5. The same tube is quickly compressed to half its volume at constant temperature. The colour first darkens, then becomes slightly paler (but stays darker than at the start). Explain both observations.

D. Special cases

6. Explain why changing the pressure does not shift $\text{H}_2 + \text{I}_2 \rightleftharpoons 2\text{HI}$.

7. More solid CaCO_3 is added to $\text{CaCO}_3(\text{s}) \rightleftharpoons \text{CaO}(\text{s}) + \text{CO}_2(\text{g})$ at equilibrium. What happens? Explain.

E. Using Q

8. An equilibrium mixture of $\text{H}_2 + \text{I}_2 \rightleftharpoons 2\text{HI}$ contains 0.0222 M H_2 , 0.0222 M I_2 and 0.156 M HI . 0.100 M H_2 is added. Calculate Q immediately after the addition and predict the direction of shift.

F. Challenge

9. For the change in question 8, calculate the new equilibrium concentrations. (Let x be the decrease in $[I_2]$; you will need to solve a quadratic equation. Use the unrounded starting values 0.02222 M, 0.12222 M and 0.15556 M.)