

Announcements – Lecture XVI – Thursday, Oct 30th

1. **Fourth Lab – Saturday, November 1st ... 1-4pm ... ISB 155/160 (A-E)**

a) Print lab prior to coming to lab -- use the 'Print Friendly Version' located on the top left hand side of the page – this is the version that contains the 'Data Sheet' that you will hand in upon completing the lab.

b) Third set of Lab Owls will appear in Owl after this lab. There are a total of 4 sets of Lab Owls and they are worth 25% of the Lab Grade.

2. **Second Exam – Tuesday November 4th – 1:00-2:15pm – In Class**

3.

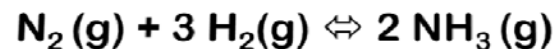


iClicker:

Choose any letter: A-E

7.7 What Is Le Chatelier's Principle Changing the Temperature

The production of ammonia is an exothermic process –



To maximize the $[\text{NH}_3]$ at equilibrium it is best to

- a) Heat the reaction
- b) Cool the reaction**
- c) Leave it as is!



Maximize P ... $[\text{NH}_3]$... you want a shift towards P ...
cool the reaction.

7.7 What Is Le Chatelier's Principle Changing the Temperature

Equilibria and Volume

Description

Volume Temperature

0.500 L 82 °C

Calculate

Clear

$$\text{N}_2\text{O}_4(\text{g}) \rightleftharpoons 2 \text{NO}_2(\text{g})$$

$K = 4.89$

Concentration (M)

a) Endothermic
b) Exothermic
c) Impossible to tell

Equilibrium Concentration

NO_2 0.882 M

N_2O_4 0.159 M

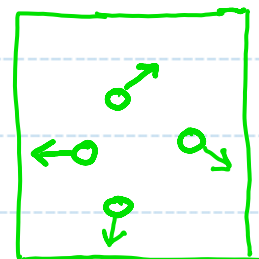
? What is happening to K as I increase the temperature

K is increasing ... shift towards products ... must be endothermic

7.7 What Is Le Chatelier's Principle

Pressure – Gas Phase Equilibria

Pressure : Force per unit area



1. Collisions
2. Momentum.



$$K = \frac{[P]}{[R]}$$

$$[] = \# \text{ mol} / \text{V (L)}$$

Gas Reactions :



$\bullet =$ Gas molecule



7.7 What Is Le Chatelier's Principle Changing the Pressure – Gas Phase Equilibria

Equilibria and Volume Description

Volume Temperature

3.00 L 100 °C

Calculate Clear

What happens?

$$\text{N}_2\text{O}_4(\text{g}) \rightleftharpoons 2 \text{NO}_2(\text{g})$$
$$K = 12.6$$

Concentration (M)

See class web site

Equilibrium Concentration

NO_2 0.194 M

N_2O_4 0.00298 M

Mole Fraction (n_i/n_{tot})

Equilibrium Mole Fraction

NO_2 0.985

N_2O_4 0.0151

Volume



7.7 What Is Le Chatelier's Principle

Changing the Pressure – Gas Phase Equilibria



ACTION

Volume \uparrow , pressure decrease:

EQUILIBRIUM SHIFT

Towards the side with the greater
NUMBER of gas molecules ... **trying**
to restore the pressure ... if it can.

Volume \downarrow , pressure increase:

Towards the side with the fewest
NUMBER of gas molecules ... **trying to**
reduce the pressure ... if it can.



7.7 What Is Le Chatelier's Principle

Changing the Pressure – Summary

- | | | |
|----|--|--|
| 1. | $O_3(g) + NO(g) \rightleftharpoons O_2(g) + NO_2(g)$ | $\bullet + \bullet \rightleftharpoons \bullet + \bullet$ |
| | Action | Why |
| | $V \uparrow, P \downarrow$ | No shift |
| | $V \downarrow, P \uparrow$ | No shift |
| | | K is unaffected |
| 2. | $2 NOCl(g) \rightleftharpoons 2 NO(g) + Cl_2(g)$ | $\bullet + \bullet \rightleftharpoons \bullet + \bullet + \bullet$ |
| | Action | Why |
| | $V \uparrow, P \downarrow$ | Towards products |
| | $V \downarrow, P \uparrow$ | Towards reactants |
| | | $K \uparrow$ |
| | | $K \downarrow$ |
| 3. | $N_2(g) + 3 H_2(g) \rightleftharpoons 2 NH_3(g)$ | $\bullet + \bullet + \bullet + \bullet \rightleftharpoons \bullet + \bullet$ |
| | Action | Why |
| | $V \uparrow, P \downarrow$ | Towards reactants |
| | $V \downarrow, P \uparrow$ | Towards products |
| | | $K \downarrow$ |
| | | $K \uparrow$ |

7.7 Le Chatelier's and Hemoglobin

