Announcements – Lecture XV – Thursday, Nov 1st

1. Lab 4 … Saturday, November 3rd, 1:00-4:00 pm ISB 155/160 A-E

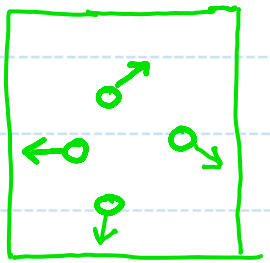
2. Exam II … Thursday, November 8th, In Class, 12:45-2:15pm

3. Final Exam … Wednesday, December 12th, ISB 135, 8:00-10:00am
   Final Review … Sunday, December 9th, ISB 135, 1:00-3:00pm

7.7 What Is Le Chatelier's Principle

Pressure – Gas Phase Equilibria

Pressure : Force per unit area



1. Collisions
2. Momentum.

$$R \Leftrightarrow P$$

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

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

Gas Reactions :

1. $\frac{[P]}{[R]}$ $\quad \bullet \Leftrightarrow \bullet$

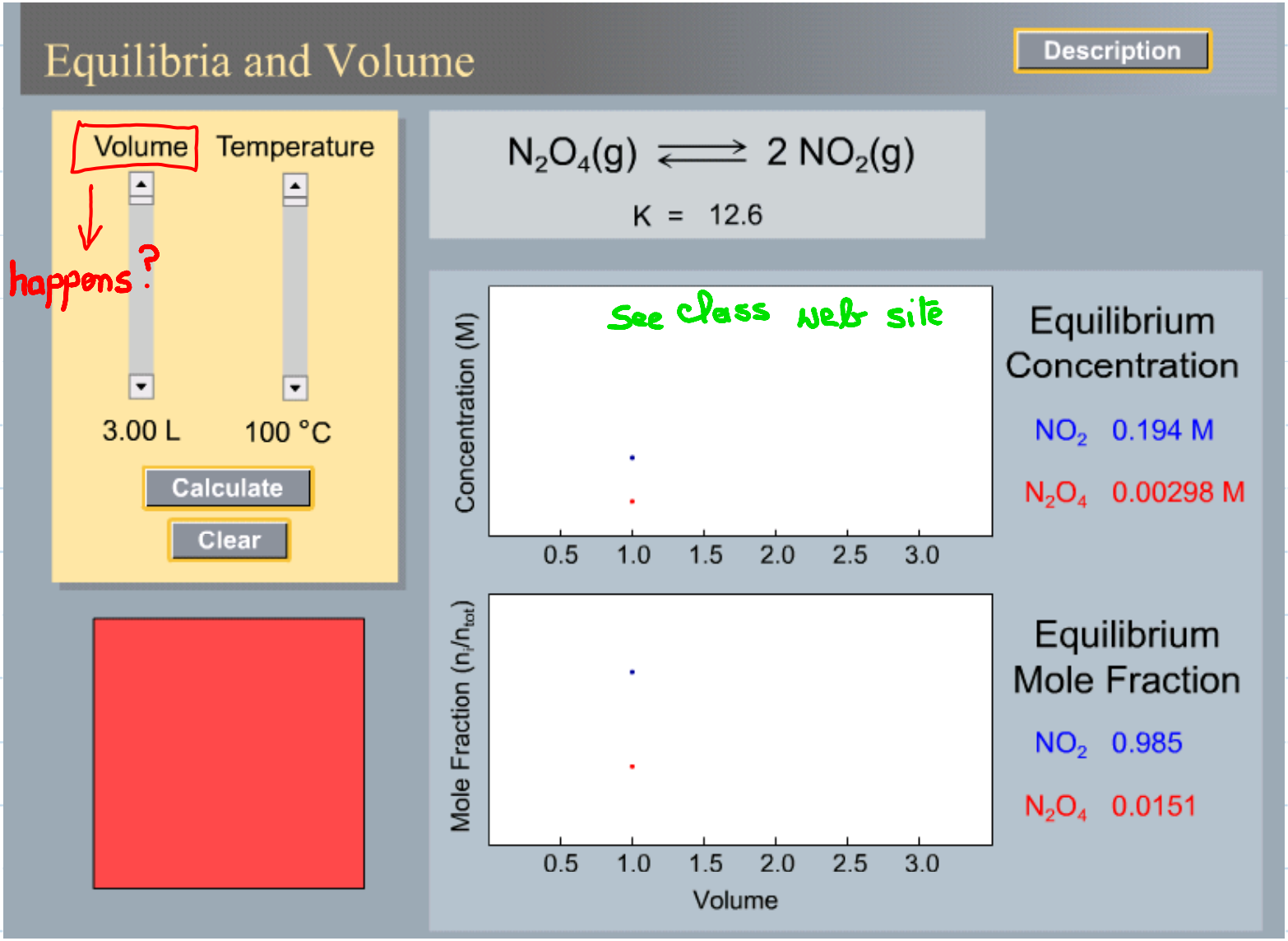
2. $\frac{[P][P]}{[R]}$ $\quad \bullet \Leftrightarrow \bullet + \bullet$

3. $\frac{[P]}{[R][R]}$ $\quad \bullet + \bullet \Leftrightarrow \bullet$

$\bullet$ = Gas molecule

7.7 What Is Le Chatelier's Principle

Changing the Pressure – Gas Phase Equilibria



7.7 What Is Le Chatelier's Principle

Changing the Pressure – Gas Phase Equilibria

Reactants (g) $\Leftrightarrow$ Products (g)

Action	Equilibrium Shift
Volume ↑, pressure decrease:	Towards the side with the greater number of gas molecules ... trying to restore the pressure ... if it can.
Volume ↓, 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. $O_3(g) + NO(g) \Leftrightarrow O_2(g) + NO_2(g)$ ● + ● ⇔ ● + ●

Action	Equilibrium shift.	Why
V↑, P↓	No shift	K is unaffected
V↓, P↑	No shift	

2. $2\ NOCl(g) \Leftrightarrow 2\ NO(g) + Cl_2(g)$ ● + ● ⇔ ● + ● + ●

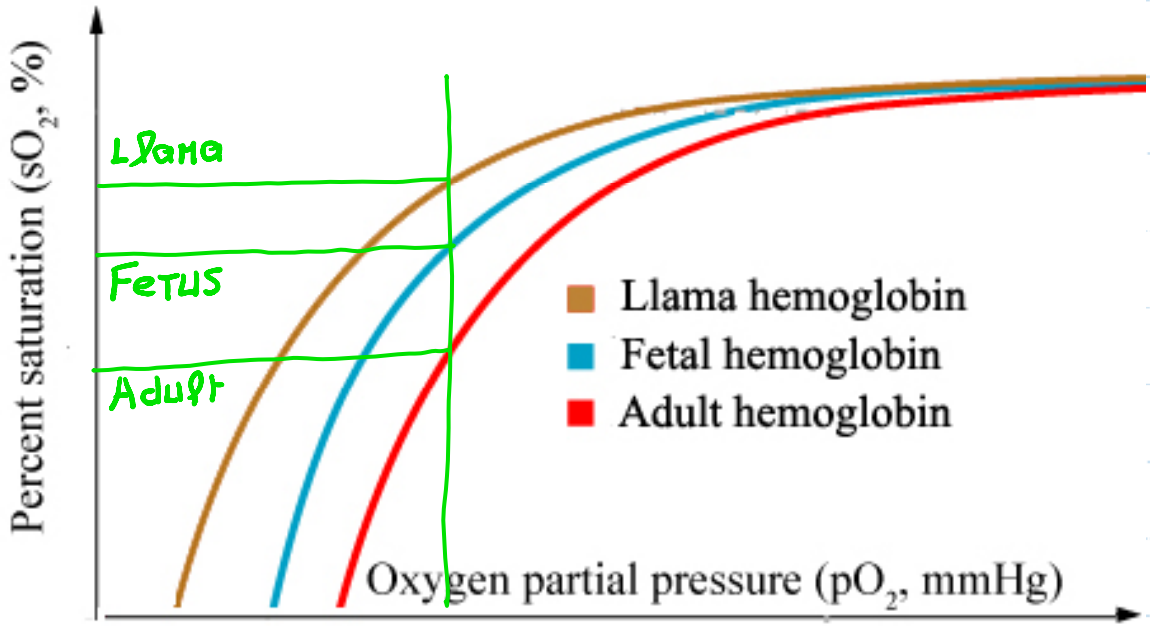
Action	Equilibrium shift	Why
V↑, P↓	Towards products	K↑
V↓, P↑	Towards Reactants	K↓

3. $N_2(g) + 3\,H_2(g) \Leftrightarrow 2\ NH_3(g)$ ● + ● + ● + ● ⇔ ● + ●

Action	Equilibrium shift	Why
V↑, P↓	Towards Reactants	K↓
V↓, P↑	Towards products	K↑

7.7 Le Chatelier's and Hemoglobin

$Hb + O_2 \Leftrightarrow HbO_2(g)$



8.1 What Are Acids and Bases?

Acid: A substance that produces H_3O^+ ions in aqueous solution.

$$HA(aq) + H_2O(l) \xrightarrow[OR]{} H_3O^+ + A^-$$

Base: A substance that produces OH^- ions in aqueous solution.

$$B(aq) + H_2O(l) \xrightarrow[OR]{} BH^+ + OH^-$$

8.2 How Do We Define the Strength of Acids and Bases?

Acids:

Strong: $HA(aq) + H_2O(l) \longrightarrow H_3O^+ + A^-$ ~100% ... only 6

HCl, HBr, HI, HNO_3, H_2SO_4, $HClO_4$

Weak: $HA(aq) + H_2O(l) \Leftrightarrow H_3O^+ + A^-$ $K_a = \dfrac{[H_3O^+][A^-]}{[HA]}$

8.2 How Do We Define the Strength of Acids and Bases?

K_a Values			K_a Values		
Name of Acid	**Acid**	**K_a**	**Name of Acid**	**Acid**	**K_a**
Sulfuric acid	H_2SO_4	large	Hexaaquaaluminum ion	$Al(H_2O)_6^{3+}$	7.9×10^{-6}
Hydrochloric acid	HCl	large	Carbonic acid	H_2CO_3	4.2×10^{-7}
Nitric acid	HNO_3	large	Hydrogen sulfide	H_2S	1×10^{-7}
Hydronium ion	H_3O^+	1.0	Dihydrogen phosphate ion	$H_2PO_4^-$	6.2×10^{-8}
Hydrogen sulfate ion	HSO_4^-	1.2×10^{-2}	Hypochlorous acid	HClO	3.5×10^{-8}
Phosphoric acid	H_3PO_4	7.5×10^{-3}	Ammonium ion	NH_4^+	5.6×10^{-10}
Hexaaquairon(III) ion	$Fe(H_2O)_6^{3+}$	6.3×10^{-3}	Hydrocyanic acid	HCN	4.0×10^{-10}
Hydrofluoric acid	HF	7.4×10^{-4}	Hexaaquairon(II) ion	$Fe(H_2O)_6^{2+}$	3.2×10^{-10}
Formic acid	HCO_2H	1.8×10^{-4}	Hydrogen carbonate ion	HCO_3^-	4.8×10^{-11}
Benzoic acid	$C_6H_5CO_2H$	6.3×10^{-5}	Hydrogen phosphate ion	HPO_4^{2-}	3.6×10^{-13}
Acetic acid	CH_3CO_2H	1.8×10^{-5}	Water	H_2O	1.0×10^{-14}
			Hydrogen sulfide ion	HS^-	1×10^{-19}