Announcements – Lecture XVI – Thursday, Oct 31st

1. **Lab 4 – Saturday, November 2nd, 1:00-4:00 pm – ISB 155/160 A-E**
   Lab Owl III – Deadline – Saturday, November 2nd, 11:59 pm

2. **Exam II – Tuesday, November 5th – In Class – 12:45-2:15 pm**
   Sunday, November 3rd – Review , 3:00-5:00pm – ISB 135

3. 

   iClicker:
   Choose any letter: A-E

7.7 What Is Le Chatelier's Principle

Changing the Temperature – Summary

a) Exothermic $R \Leftrightarrow P + heat$

Action	Equilibrium Shift	Why
Add heat (heat the RXN)	Towards Reactants	K↓
Remove heat (cool the RXN)	Towards products	K↑

b) Endothermic $R + heat \Leftrightarrow P$

Action	Equilibrium Shift	Why
Add heat (heat the RXN)	Towards products	K↑
Remove heat (cool the RXN)	Towards Reactants	K↓

7.7 What Is Le Chatelier's Principle

Changing the Temperature

The production of ammonia is an exothermic process –

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

To maximize the $[NH_3]$ at equilibrium it is best to

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

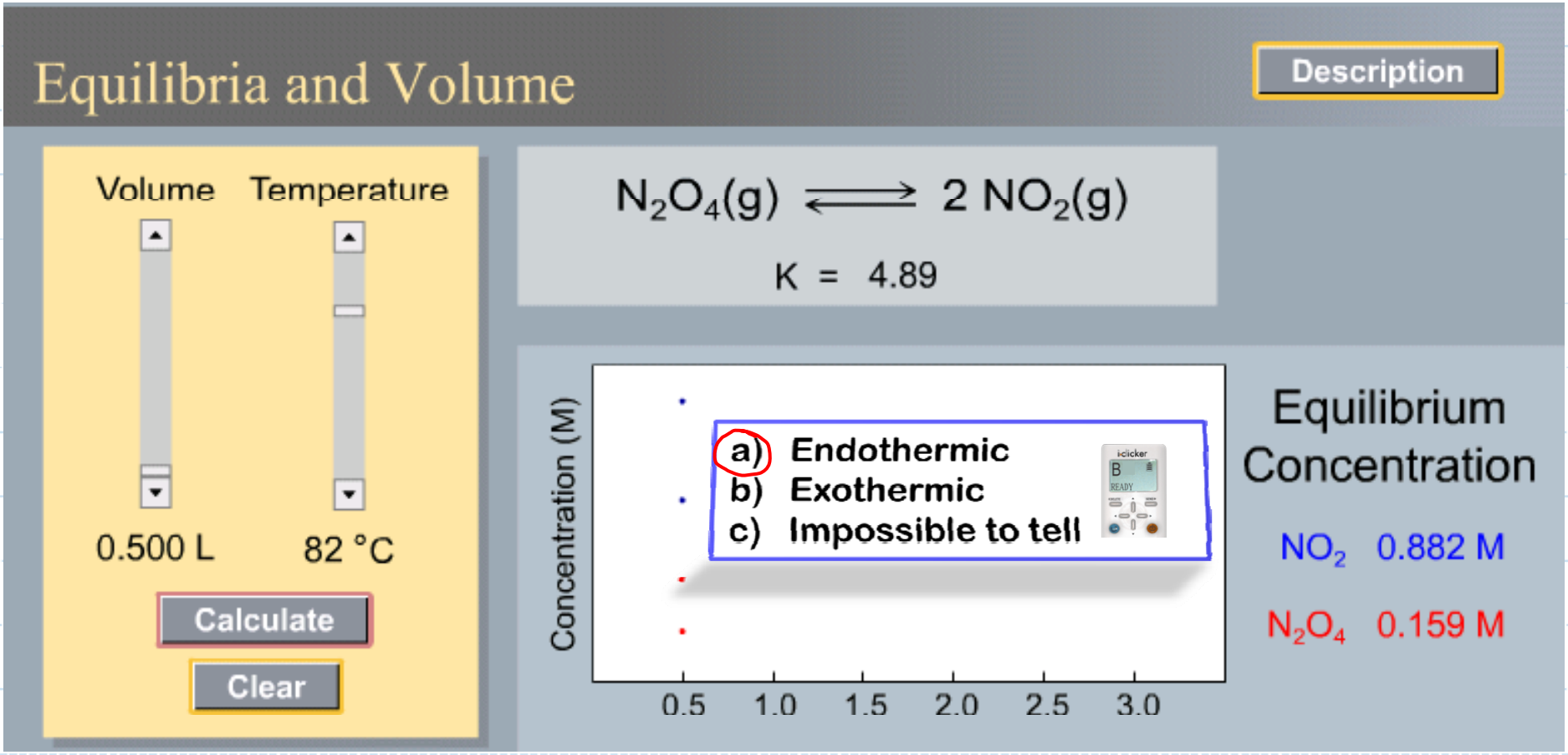
R ⇔ P + heat

↑

Maximize P ... $[NH_3]$ ... you want a shift towards P ... cool the reaction.

7.7 What Is Le Chatelier's Principle

Changing the Temperature



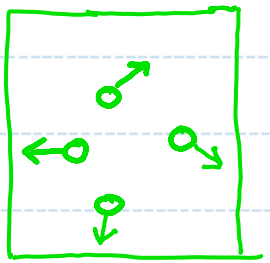
? What is happening to K as I increase the temperature

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.

$$R \Leftrightarrow P$$

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

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

Gas Reactions :

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

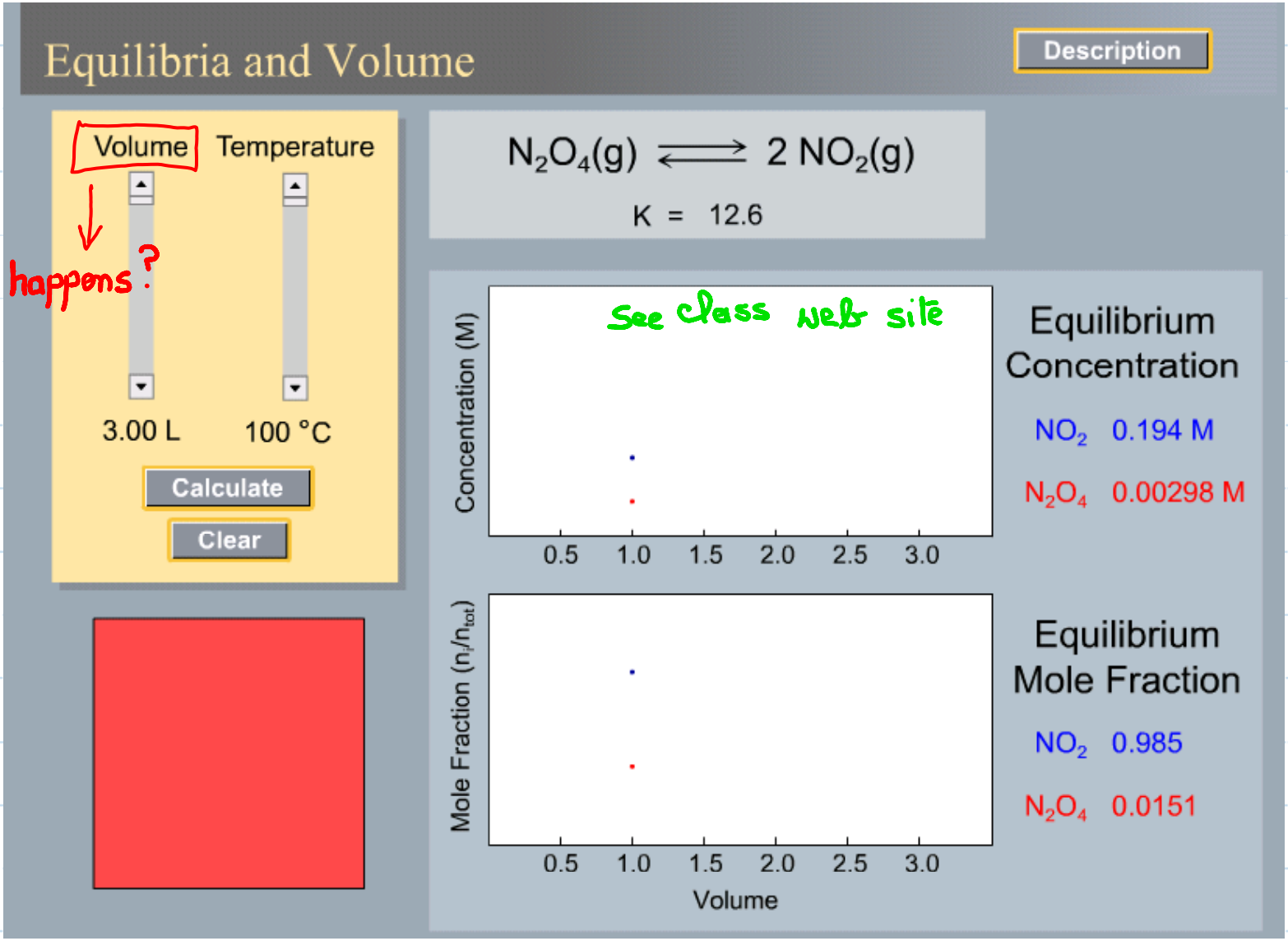
2. $\frac{[P][P]}{[R]}$ $\quad \bullet \Leftrightarrow \bullet + \bullet$

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

• = 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) ⇔ 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

$Hb + O_2 \Leftrightarrow HbO_2(g)$