Lecture 42: Equilibrium 3

**Read:** BLB 15.6–15.7

**HW:** BLB 15:51, 53, 70
       Sup 15:11–13

**Know:**
- LeChatelier’s principle
- catalysts
- **math refresher** in BLB Appendix A

**FINAL SKILL CHECK TEST DEADLINE:** **TODAY!!!**
**MONDAY, APRIL 27**

**Need help?? Get help!!** TAs in CRC (211 Whitmore) and SI—hours on Chem 110 website; my office hours (Mon 12:30-2 & Tues 10:30-12 in 324 Chem Bldg [or 326 Chem]). **THIS week is last week for SI, CRC and Sheets Office Hours**

**Final Exam:** **MONDAY, May 4, 12:20 pm.** locations under “exam schedule”; no pds, ipods, graphing calculators, etc. Only non-text programmable calculators allowed. Bring PSU ID and pencils

**Concept Final review session with Sheets:** Thursday 4/30 @ 6pm in 108 Forum. Please work through the Concept Exam (on lecture note page) before the review session & bring it with you, along with any questions you may have. This review is meant to complement to the review sessions that your TAs will be holding in which they will go over the practice exams.
Predicting the direction of a reaction that has not reached equilibrium yet

\[ aA + bB \rightleftharpoons cC + dD \]

- if the system is **NOT** at equilibrium, then

\[ Q = \frac{[C]^c[D]^d}{[A]^a[B]^b} \]

**NOTE:** the concentrations used here are **NOT** equilibrium concentrations!!! Beware!

- **Q** = reaction quotient

- when \( Q = K_c \) system is at equilibrium; **no change**

- when \( Q > K_c \) reaction **shifts to left** producing more

- when \( Q < K_c \) reaction **shifts to right** to produce more
Procedure to determine equilibrium concentrations

1. as always, write the balanced chemical reaction

2. write the equilibrium constant expression

3. list the initial concentrations

4. calculate Q & determine the direction of the shift need to reach equilibrium

5. define the change needed to reach equilibrium for each species

6. define the equilibrium concentrations for each species (initial + or – change)

7. substitute equilibrium concentrations into the equilibrium expression & solve for the unknown

8. always check equilibrium concentrations found by substituting them back into the equilibrium expression
Example

\[ 2 \text{HI}(g) \rightleftharpoons \text{H}_2(g) + \text{I}_2(g) \]

\[ K_c = \frac{[\text{H}_2][\text{I}_2]}{[\text{HI}]^2} = 1.25 \times 10^{-3} \]

A. If we add 0.1 mole of HI in a 1L container that is already at equilibrium, what will happen?

1. reaction shifts to the right
2. reaction shifts to the left
3. no change occurs

B. If the concentrations of all three gases in the vessel are 0.1 mol/L, what will happen?

1. reaction shifts to the right
2. reaction shifts to the left
3. no change occurs
**Example**

Using $K_{eq}$ to obtain equilibrium concentrations of reactants and products. Initially $[\text{IBr}] = [\text{I}_2] = [\text{Br}_2] = 0.05 \text{ M}$ in a 1.0 \text{ L} volume. What are the final concentrations of reactants and products?

$$2\text{IBr}(g) \rightleftharpoons \text{Br}_2(g) + \text{I}_2(g) \quad K_c = \frac{[\text{Br}_2][\text{I}_2]}{[\text{IBr}]} = 2.5 \times 10^{-3}$$

$Q = \underline{}$

So, which direction does system move to establish equilibrium??

**bold** = given

<table>
<thead>
<tr>
<th></th>
<th>IBr</th>
<th>Br$_2$</th>
<th>I$_2$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>initial</strong></td>
<td>0.05 mol</td>
<td>0.05 mol</td>
<td>0.05 mol</td>
</tr>
<tr>
<td><strong>change</strong></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td><strong>at equilibrium</strong></td>
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<td></td>
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<tr>
<td><strong>[final]</strong></td>
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</tbody>
</table>
Always double check that your answer makes sense. Does it go in the expect direction?? Does the $K_c$ (or $K_p$) equal its value after you have solved for the unknown???
LeChatelier’s principle

• a *dynamic equilibrium* tends to oppose any change in conditions (touched on this in Chap 13 when we talked about solubility!)

• what happens to a system at equilibrium when the system is disturbed by changing

  concentration
  volume
  pressure
  temperature

• *so…*

if a system at equilibrium is disturbed, the concentrations of reactants and products will **shift to minimize** the effect of the disturbance

that is \[ Q \rightarrow K \]
Before next class:

Read: BLB 15.6–7
HW: BLB 15:51,52,53,69; Sup 15:11–13

Know:
• LeChatelier’s principle
• catalysts
• math refresher in BLB Appendix A

Work through the concept final (on lecture notes website).

Good luck studying for finals! Please start now.

Answers:
p. 4 A: 1; B: 2
p. 5: [IBr] = 0.136 M; [Br₂] = [I₂] = 0.0068 M