Unit 7 Topics 7.1 – 7.14: Equilibrium

Massachusetts InSight

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Equations and Constants

College Board Equation Sheet

EQUILIBRIUM

$$K_c = \frac{[C]^c[D]^d}{[A]^a[B]^b}, \text{ where } a\,A + b\,B \rightleftarrows c\,C + d\,D$$

$$K_p = \frac{(P_C)^c(P_D)^d}{(P_A)^a(P_B)^b}$$

$$K_a = \frac{[H^+][A^-]}{[HA]}$$

$$K_b = \frac{[OH^-][HB^+]}{[B]}$$

$$K_w = [H^+][OH^-] = 1.0 \times 10^{-14} \text{ at } 25°C$$

$$= K_a \times K_b$$

$$pH = -\log[H^+],\ pOH = -\log[OH^-]$$

$$14 = pH + pOH$$

$$pH = pK_a + \log\frac{[A^-]}{[HA]}$$

$$pK_a = -\log K_a,\ pK_b = -\log K_b$$

Equilibrium Constants

K_c (molar concentrations)
K_p (gas pressures)
K_a (weak acid)
K_b (weak base)
K_w (water)

EQUATIONS NOT FOUND ON THE AP EQUATION SHEET

Equilibrium –

$K_{sp} = [A^+]\,[B^-]$ where $AB(s) \rightleftarrows A^+(aq) + B^-(aq)$

Asynchronous Work…BCEs, DCIs and ACAs for Equilibrium

BDA Teacher Web site: Equilibrium is Unit 10

http://genchem1.chem.okstate.edu/BDA/Topics.php

BCE	DCI	ACA		
BCE49	DCI49	ACA55	BCE: Intro to reversible Rxn. ACA: Reversible reactions	Data (Java & video) BCE, ACA
BCE50	DCI50	ACA56	BCE: Macroscopic reversible rxn ACA: using ICE tables to determine K	
BCE51	DCI51	ACA57	BCE: Using ICE tables to calculate $[]_{eq}$. ACA: ICE table practice	
BCE52	DCI52	ACA58	BCE: ICE table practice. ACA: ICE table practice.	
BCE79	DCI78	ACA78	BCE and ACA: Le Chatelier's Principle.	Make video's

Thinking about an introduction to Chemical Equilibrium

Lecture notes on equilibrium constants

Practice calculating equilibrium constants
Practice calculating concentrations of reactants and products at equilibrium

Le Chatelier's Principle **Comparing Q (nonequilibrium reaction quotient) to K.**

2018 and 2019 AP Chemistry Exam Question 2

2019 AP Chemistry Exam **Question 2 parts d, e and f**

- Rubric
- Chief Reader Report

2018 AP Chemistry Exam **Question 2 parts b and c**

- Rubric
- Chief Reader Report

2019 AP Chemistry Exam Question 2

The compound BrCl can decompose into Br_2 and Cl_2, as represented by the balance chemical equation below.

$$2BrCl_{(g)} \rightleftarrows Br_{2(g)} + Cl_{2(g)} \quad \Delta H^\circ = 1.6 \text{ kJ/mol}_{rxn}$$

A 0.100 mol sample of pure $BrCl_{(g)}$ is placed in a previously evacuated, rigid 2.00 L container at 298 K. Eventually the system reaches equilibrium according to the equation above.

(d) Calculate the pressure in the container before equilibrium is established.

(e) Write the expression for the equilibrium constant, K_{eq}, for the decomposition of BrCl.

After the system has reached equilibrium, 42 percent of the original BrCl sample has decomposed.

(f) Determine the value of K_{eq} for the decomposition reaction of BrCl at 298 K.

Thinking about an equilibrium problems

In the graph below the endothermic reaction

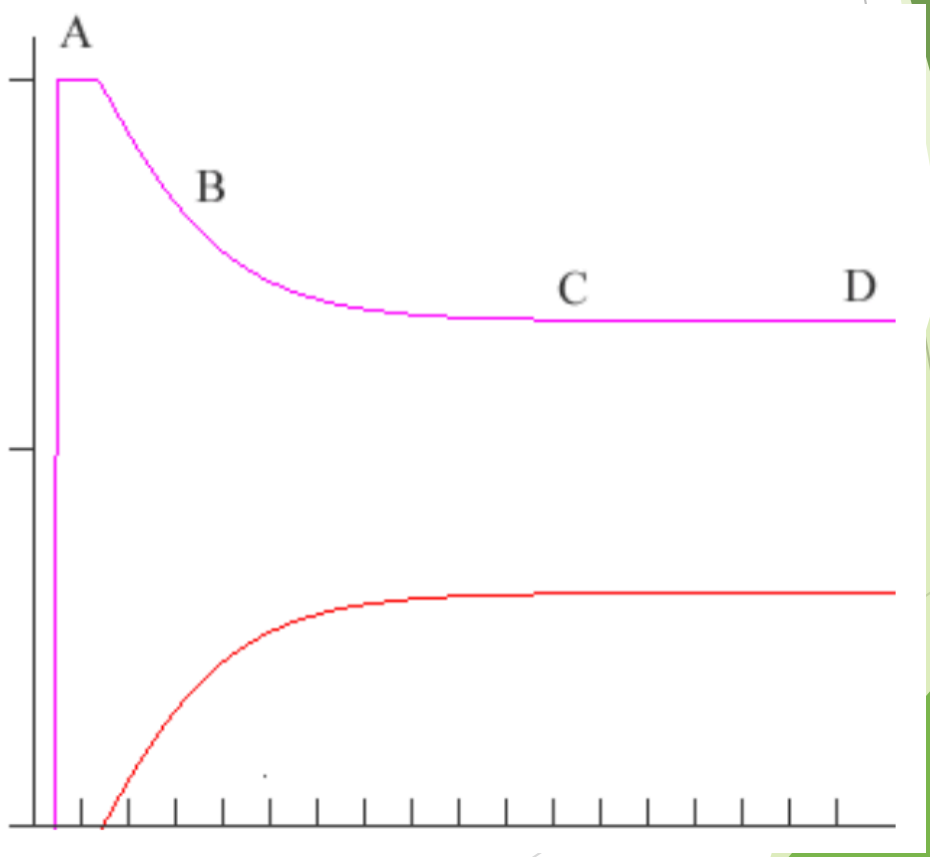
$$BR_{(g)} \rightleftarrows B_{(g)} + R_{(g)}$$

is represented. Initially only $BR_{(g)}$ is present in the reaction vessel. The marks along the x-axis are in 1 minute increments. The initial [BR] (y-axis) is 2.0 M. The reaction begins about 1.5 minutes in this case.

(a) At what point (indicate a letter) does the reaction attain equilibrium?

(b) Indicate whether K for the reaction is greater than 1, less than 1 or equal to 1. Explain.

(c) At point 'B' indicate how Q compares to K. Explain.



Thinking about an equilibrium problems

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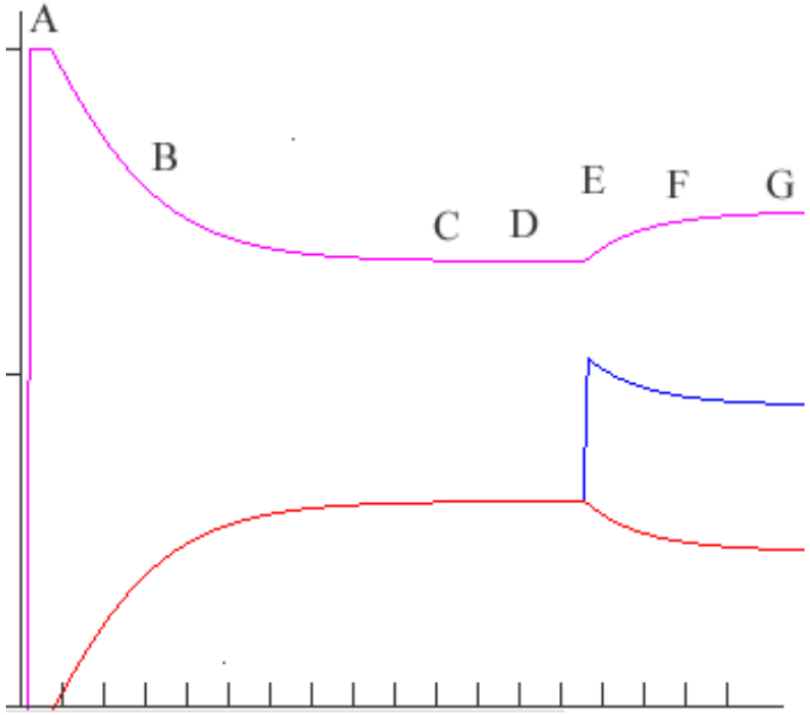
(d) In this new view the same reaction has occurred. Indicate the stress (at point E) that was imposed on the system, and explain how the system changed as a response to the stress.



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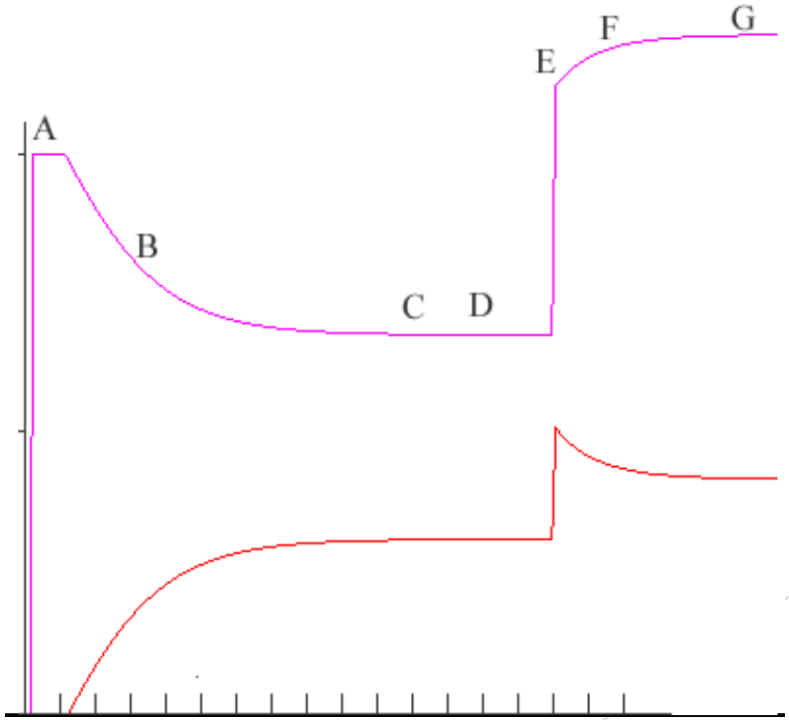

QUESTIONS?

Talk/chat to John Gelder

or

john.gelder@okstate.edu

Thinking about an introduction to Chemical Equilibrium

Introducing reversible and irreversible reactions using a particulate level followed by a macroscopic approach approach.

- Inquiry Activity
- Particulate level (.jnlp file)
- Particulate level (video)
- Macroscopic level

Getting students to invent Le Chatelier's Principle

- Guided Inquiry Activity
- Following a reversible reaction with chart recordings (.jnlp file)
- Following a reversible reaction with chart recordings (video)

Inventing the Equilibrium Constant

- Guided Inquiry Activity
- Chart Recording (.jnlp file)
- Chart Recording (video files….not prepared yet)

Lecture notes on equilibrium constants

Practice calculating equilibrium constants

Practice calculating concentrations of reactants and products at equilibrium