Physical Chemistry (Chem 132A)

Lecture 20
Monday, November 20

Midterm 2

1. Second Midterm exam: Wednesday, November 22
   second midterm will cover Chapters 1—6, 19

   - there will be a seating chart
   - same procedures as midterm 1
     - 1 page notes allowed
     - bring calculator
   - arrive early if possible

Important Topics Since Midterm 1 (slide 1)

- **Mixtures: Limited to Binary mixtures**

  Phase rule: F = C–P+2

  partial molar quantities:

$$V_j = \left(\frac{\partial V}{\partial n_j}\right)_{p,T,n'}$$

Gibbs-Duhem equation: $$d\mu_B = -\frac{n_A}{n_B}\,d\mu_A$$

Mixing (for an ideal gas mixing is driven by delta S_{mix})

for non-Ideal systems enthalpy may play a role

Roult's Law: $p_A = x_A p_A^*$

Non-ideal behavior: Henry's Law: $p_B = x_B K_B$ B is solute

Important Topics Since Midterm 1 (slide 2)

Mixtures (continued)

- **Colligative Properties**
  - **freezing point depression**
  - **boiling point elevation**
- **Phase Diagrams for Binary Mixtures**
  - **distallations**
  - **azeotropes**

Liquid-solid phase diagrams

- **cooling curves**
- **eutectic mixtures**

Non-ideal behavior

- **fugacity**
- **activities:**

$$a_A = \gamma_A x_A$$

$$\mu_A = \mu_A^* + RT \ln x_A + RT \ln \gamma_A$$

Important Topics Since Midterm 1 (slide 3)

- **Ionic Solutions**

  Debye-Huckel Law

$$\log \gamma_\pm = -0.509 \left| z_+ z_- \right| I^{1/2}$$

$$I = \frac{1}{2} \sum_i z_i^2 \left(\frac{b_i}{b^0} \right)$$

I is the Ionic Strength

- **Equilibrium Constants and Reaction Quotients**

$$\Delta_r G = \Delta_r G^0 + RT \ln(Q)$$

$$\mathbf{\Delta G^0 = -RT\ln K}$$

$$K = \frac{a_C a_D}{a_A a_B}$$

$$a_A = \gamma_A x_A$$

$$K = K_\gamma K_b$$

Important Topics Since Midterm 1 (slide 4)

- **Electrochemical Cells**
  - **Half reactions**
  - **Balancing Redox reactions**
  - **Standard cell potentials**

- **Nernst Equation:**

$$E_{cell} = E^0_{cell} - \frac{RT}{\nu F} \ln Q$$

$$E^0_{cell} = \frac{RT}{\nu F} \ln K$$

Important Topics Since Midterm 1 (slide 5)

- **Temperature Dependence of K**

$$\ln K_2 - \ln K_1 = -\frac{\Delta_r H^0}{R}\left(\frac{1}{T_2} - \frac{1}{T_1}\right)$$

$$\ln\frac{K_2}{K_1} = -\frac{\Delta_r H^0}{R}\left(\frac{1}{T_2} - \frac{1}{T_1}\right)$$

- **Le Chatelier's Principle**

- **Boltzmann Speed Distribution**

$$\left\langle v^n \right\rangle = \int_0^\infty v^n f(v)\,dv$$

$$v_{mean} = \int_0^\infty v f(v)\,dv = \left(\frac{8RT}{\pi M}\right)^{1/2}$$

$$v_{rms} = \left(\int_0^\infty v^2 f(v)\,dv\right)^{1/2} = \left(\frac{3RT}{M}\right)^{1/2}$$

Important Topics Since Midterm 1 (slide 6)

- **Collision cross sections**
- **Mean free path**

- **Flux**

$$J(matter) = -D\frac{dN}{dz}$$

$$J(thermalenergy) = -\kappa\frac{dT}{dz}$$

Important Topics Since Midterm 1 (slide 7)

$D = (1/3)\lambda v_{mean}$ **Diffusion coefficient**

$\kappa = (1/3)\nu v_{mean}\,\lambda N k$ **Thermal conductivity**

$\eta = (1/3)v_{mean}\,\lambda m N$ **Viscosity**

These expressions provide reasonable approximations for the transport coefficients.

Important Topics Since Midterm 1 (slide 8)

- **Ion Mobilities**

  S = uE

  E = applied field

  u is the mobility

- **Diffusion Equation**

$$F = -\left(\frac{\partial \mu}{\partial x}\right)_{T,p}$$

$$F = -RT\left(\frac{\partial \ln a}{\partial x}\right)_{T,p} = -RT\left(\frac{\partial \ln c}{\partial x}\right)_{T,p} = -\frac{RT}{c}\left(\frac{\partial c}{\partial x}\right)_{T,p}$$

In One dimension:

$$\frac{\partial c(x,t)}{\partial t} = D\frac{\partial^2 c(x,t)}{\partial^2 x}$$

Things to Review Prior to Midterm 2

Everything prior to the first midterm

Review the first midterm (answers are on the canvas site)

Discussion Section Problems

WebAssign Homework Problems

SEE YOU AT THE EXAM

WEDNESDAY, NOVEMBER 22