## Chapter 13: Solutions and Colligative Properties

1) A 10.5-gram sample of Jamesonnium is dissolved in 125 mL of water. The resulting solution boils 103.5 deg C.

a) What is the molar mass of Jamesonnium?

b) Consider a sample of Jamesonnium at 0.0 ºC.

Sketch the temperature curve for Jamesonnium based on the following heating treatment:

Jamesonnium is solid at 0.0 deg C

Jamesonnium is heated to 5.0 deg C and melted

Jamesonnium is heated to 85.0 deg C

2) Calculate the heat added to 5.58 g of Jamesonnium from 0.0ºC to 85.0 ºC. Some of the info may not be needed.

$C_{(s)}$ = 32.6 J/g C  $\Delta H_{fus}$ = 99.0 J/g  melting point = 5.0 deg C

$C_{(l)}$ = 134.8 J/g C  $\Delta H_{vap}$ =339 J/g  boiling point = 80.1 deg C

$C_{(g)}$ = 15.9 J/g C

## Vapor Pressure

1) Calculate the vapor pressure of a solution at 25 deg C containing 99.5 g of galactose (molar mass = 180.156) and 400 ml of water. The vapor pressure of pure water at 25 deg C is 27 torr. Assume 1.00 g/ml for density of water.

2) A solution composed of two volatile liquids, A and B, has a vapor pressure of 369 torr at 0ºC. Pure A and pure B have vapor pressures of 252 torr and 417 torr respectively at 0ºC. What is the mole fraction of A in the solution?

3) A mixture of volatile Jamesonnium and ethyl ether are in a beaker at room temperature. It is well mixed and has a vapor pressure of 330 torr. At room temperature, pure Jamesonnium and ethyl ether has a vapor pressure of 420 torr and 520 torr, respectively. What is the mole fraction of Jamesonnium in the mixture?

4) The osmotic pressure of a solution containing 6.69 mg of Jamesonite per 50.0 ml of solution is 4.55 torr and 45 deg C. What is Jamesonite's molar mass?

**Boiling Point Elevation and Freezing Point Depression**

1) What is the boiling point of a solution made by dissolving 10.21 g of ethylene glycol, $C_2H_6O_2$, in 71.3 mL of ethanol, $C_2H_6O$?

2) What is the boiling point of an aqueous solution whose vapor pressure is 20.5 torr at 25 °C? Assume the solute is nonvolatile and that the vapor pressure of pure water at 25 °C is 23.76 torr.

3) What is the freezing point of a solution comprised of 47.4 g $CaCl_2$ dissolved in 359.5 g water? Kf=1.86 C/m

4) Is it possible to have an aqueous solution with a boiling point of 2.1 degrees C?

5) Rank the following by lowest freezing point, and then highest boiling point

0.10 m KI  0.05 m $MgCl_2$  0.25 m $C_6H_{12}O_6$  .05M HCl

## Chapter 14: Chemical Kinetics

1) A reaction is first order with respect to [X] and second order with respect to [Y]. When [X] is 0.20 M and [Y] = 0.20 M the rate is 8.00 × 10-3 M/min. The value of the rate constant, including correct units is?
2) James is trying to synthesize Jamesonnium (J) via the following reaction:

$$3A_{(s)} + 4B_{(aq)} \rightarrow C_{(g)} + 7J_{(s)}$$

   a) Assume Product $J_{(g)}$ is shown to be forming at a rate of .0072 M/s. What are the rates of change for A, B and C?

   b) Assume the rate of disappearance for A is 1.2M/min, what is the rate of appearance of C?

3) Sean said that after concentration of A tripled and B halved, the rate changed by a factor of 16. Sean got a gold sticker. What was the rate law that Sean was seeing?

4) James wants to experimentally determine the order and rate constant for each. What is the rate law? Determine the rate constant and the overall order. Remember units and to assume constant temperature.

| Trial | [A] | [B] | Initial Rate M/s |
|---|---|---|---|
| 1 | 0.100 | 0.100 | 0.028 |
| 2 | 0.200 | 0.100 | 0.058 |
| 3 | 0.200 | 0.200 | 0.082 |
| 4 | 0.400 | 0.400 | 0.23 |

5) Using your rate from part above, how would the ratio of rate change if:

   - A is tripled

   - A and B are both halved

## Integrated Rate Laws and Half-Lives

1) The half-life for a second order reaction is 231 seconds. What percent remains after 10 minutes?

2) Jamesonnium has a half-life of 12 seconds. What percentage of Jamesonnium has been consumed after 1.8 minutes?
3) Mark is getting high. Some THC metabolites have a half-life of 20 hour and follow first order kinetics. If Mark is getting high midnight on Sunday, how much THC is still in his system by his next chemistry lecture? (12pm Tuesday)

4) Radioactive Iodine can be used in cancer treatment in the thyroids. If Iodine normally has a half-life of 8.07 days, and today, your thyroid absorbed 15 microcuries during treatment, how much would remain after 45 days?

5) For a reaction of Jamesonnium, $2J \rightarrow A$, find k.

| Time (s) | Ln[A] |
|---|---|
| 8 | 1.61 |
| 16 | 1.43 |
| 24 | 1.27 |
| 32 | 1.14 |
| 40 | 1.02 |
| 48 | 0.92 |
| 56 | 0.82 |

**Reaction Mechanisms**

1) A proposed mechanism for an unknown exothermic reaction is shown below. Write the overall reaction, and identify the intermediates, the rate-determining step, and the rate law predicted by this mechanism.

Step 1: $A_2 \rightleftharpoons 2A$ fast

Step 2: $A + AB \rightarrow C + D$ slow

Step 3: $A + D \rightarrow E$ fast

2) For the question above, draw a possible potential energy diagram

3) Are the valid mechanisms for their overall respective reactions?

Mechanism I

Step 1: $J + J \rightarrow A + C$ slow

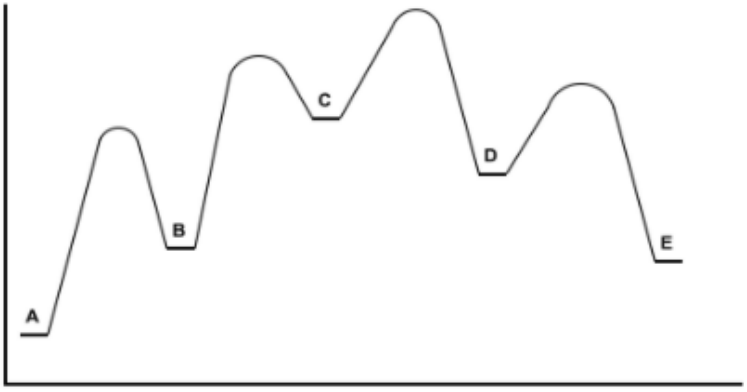
Step 2: $C \rightarrow A + B_2$ fast

| | | |
|---|---|---|
| Step 1: | $C_4H_9Br \rightarrow C_4H_9^+ + Br^-$ | Slow |
| Step 2: | $C_4H_9 + H_2O \rightarrow C_4H_9OH_2^+$ | Fast |
| Step 3: | $C_4H_9OH_2^+ + H_2O \rightarrow C_4H_9OH + H_3O^+$ | Fast |

**Activation Energy**

1) Write 3 forms of the Arrhenius equation.

2) A graph is shown for a particular reaction.




   a) Label the axis, the reactants, and products.
   b) Label the transition states, where intermediates could be found and show the activation energies.
   c) How many steps would this mechanism have? Which step is rate-determining?
   d) Which step is the fast step?
   e) Which step has the smallest rate constant?
   f) Show the effects of a catalyst being introduced in the first step of the mechanism.
   g) Is this reaction overall endothermic or exothermic?

3) For an unknown reaction,
   a) find the activation energy required to have a reaction with a rate of $2.5 \times 10^{-4}$ $M^{-1}s^{-1}$ at 327 deg C to transition to a rate of $3.5 \times 10^{-3}$ $M^{-1}s^{-1}$ at 377 deg C.

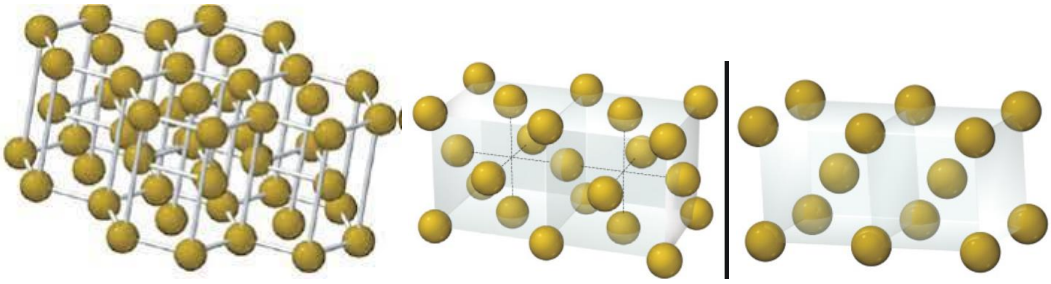
   b) Determine the rate constant at 700K

4) In a certain solvent is first order with respect to (CH3)3CBr and zero order with respect to OH- . In several experiments the rate constant k was determined at different temperatures. A plot of ln k versus 1/T was constructed resulting in a straight line with a slope value of -1.10×104 K and y-intercept of 33.5. Assume k has units of s-1.

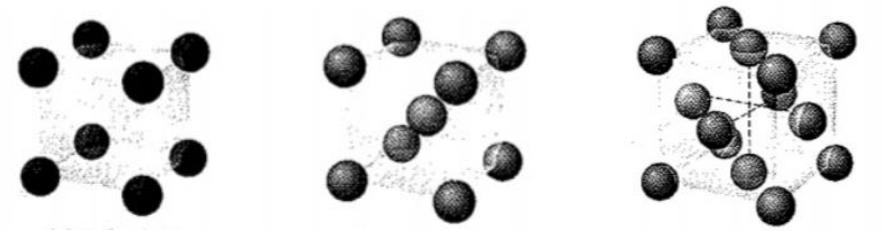
Determine the activation energy, the frequency factor, and the k value.

## Chapter 12: Solid State Chemistry

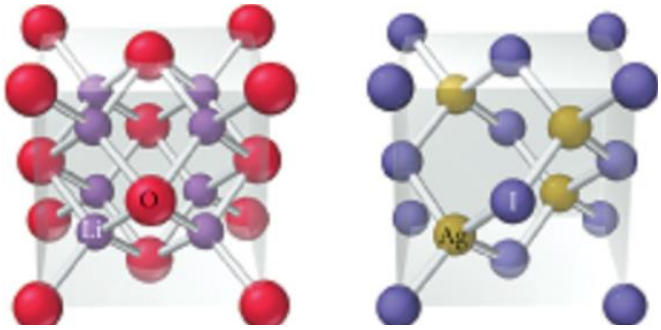
1) For each of the structures below, determine the coordination number



2) Determine the number of atoms per unit cell



3) Based on the structure, name these two molecules



4) Are the following n-type or p-type indicator?
a) Silicon doped with Gallium
b) Germanium doped with antimony

5) For a body-centered cubic unit cell, derive the length of the edge of the cube in terms of atomic radius.