HOMEWORK #6

CHMY 361 **HANDOUT #9**
Nov. 15Nov, 2016

Due Tue. Nov 22, 9 am

1. For the reaction A + 2B --> C, the following data is collected:

Initial Concentrations (M)

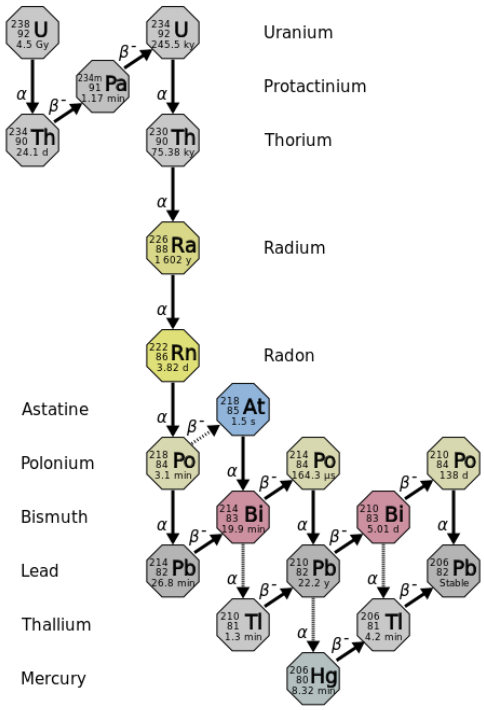
A	B	Initial Rate
0.2	0.1	8.0 Ms^{-1}
0.1	0.1	2.0 Ms^{-1}
0.1	0.2	4.0 Ms^{-1}

(a) What are the orders of this reaction with respect to [A] and [B] and the overall order?

(b) What is the numerical value and units of the rate constant from the above data if the rate is defined as: rate = rate of disappearance of B?

(c) If we define the rate as = appearance of the product C, what will be the numerical value of the rate constant?

2. Radon (an extremely radioactive noble gas) has a **half-life of 3.8 days**, and is continually rising from the ground as the result of much slower decay of Uranium. It is the number one cause of lung cancer among non-smokers.



The so-called Watras incident (named after the American construction engineer Stanley Watras), in which an employee at a U.S. nuclear plant triggered radiation monitors while leaving work over several days—despite the fact that the plant had yet to be fueled, and despite the employee being decontaminated and sent home "clean" each evening, dramatized that **radon** levels in particular dwellings can occasionally be orders of magnitude higher than typical. This implied a source of contamination outside the plant, which turned out to be radon levels of 100,000 disintegrations (Bq)/m^3 in the worker's basement.[20] Radon soon became a standard homeowner concern.

Calculate the number of disintegrations per second (=becquerels, or Bq) per atom of Radon from its half-life.

User:Tosaka - File:Decay chain(4n+2, Uranium series).PNG

3. For the reaction A + 2B ---> C (stoichiometric), the following mechanism is proposed:

Step 1: A + B <---> D (forward rate constant = k_1, back rate constant = k_{-1}, where (importantly) *if* D is formed, it cannot be observed experimentally (and therefore cannot appear in a proposed rate law).

Step 2: B + D ---> C (forward rate constant = k_2, back rate constant is negligible).

(a)What is the rate law predicted if Step 1 is the rate determining step?
(b) What is the rate law predicted if Step 2 is the rate determining step?

4. The uncatalyzed rate of hydrolysis of certain gluconpyranosides at room temperature can be estimated by observing the rate at very high temperatures and using the Arrhenius equation to extrapolate to room temperature (300 K). At 250 ^oC the rate constant = 10^{-5} s^{-1} and at 200 ^oC the rate constant = 10^{-6} s^{-1}. What is the expected rate at room temperature? (The same reaction in the presence of an enzyme proceeds at a rate that is $\mathbf{10^{16}}$ times faster at room temperature!

5. On a summer day the UV flux at 300 nm can be 200 x 10^{-5} Js^{-1} on an area the size of a human face. At this wavelength, DNA absorbs most of this light. If the quantum yield for causing thymine dimers is 0.001, how many moles of thymine dimers will be formed in 5 hours?

6. If one journal article states that for a certain enzyme, K_M = 1 x 10^{-5} M and that k_2 (i.e., k_{cat}) =2 x 10^6 s^{-1}, and another states for the same enzyme that K_M = 1 x 10^{-4} M and that k_2 =2 x 10^4 s^{-1}, is there any way to tell whether one, both or neither are credible values? State the basis for your conclusion.

7. Given 3 charges, A, B, C in a straight line, in which the charges shown are in units of elementary charge, the distance between A ($^{+2}$A) and B ($^{-1}$B) = 2.0 Angstrom, and the distance between B and C ($^{+2}$C) = 1.0 Angstroms. Calculate the electrostatic potential energy of interaction in kJ/mole of this charge distribution. Use the form of Coulomb's Law given in lecture and in the text with units kJ/mol in which the charges are in units of elementary charge, and distances are in units of Angstroms.

8. (a) Show that Boltzmann's constant at 300 K = 0.697 cm^{-1} by dividing k_B in $JK^{-1}molecule^{-1}$ by hc, where c is the speed of light in cm s^{-1} and h is Planck's constant in J s.

(b) Show that k_BT at 300 K = 209 cm^{-1}.

(c) What is the name of the electromagnetic radiation for which the minimum energy to put a molecule into the first excited state = $\mathbf{2k_BT}$ at 300 K? (***thermal*** energy is constantly exciting everything, with no need of a beam of light, but will less successful the larger the energy jump).

(d) What type of energy of the molecule is being excited, (e.g., translational, rotational, vibrational, electronic, nuclear spin)?
(For the next exam you will be asked to do this for *any* wavelength of light.)