

CHEM 113C, Spring 2009, Problem Set 1

DUE: Friday, April 10

Hand in during class or e-mail before class to 113C@chem.ucsb.edu

TABLE III  
Sodium Iodide Catalysis of Hydrogen Peroxide in Water  
1. NaI = 0.02053 mols per liter  
Bar. = 738 mm Temp. = 25° C  $a = 36.28$

$t$ (Minutes)	Observed volume (cc)	Milligrams of dry O <sub>2</sub>	$x$	$a-x$
0	4.00	4.90	—	—
5	8.05	9.87	4.97	31.31
9	10.90	13.36	8.46	27.82
17	15.75	19.30	14.40	21.88
27	20.40	25.00	20.10	16.18
38	24.00	29.42	24.52	11.76
60	28.65	35.12	30.22	6.06
79	30.83	37.79	32.89	3.39
Final reading 3 hrs. later	33.60	41.18	36.28	—
1 cc O <sub>2</sub> over water at 738 mm and 25° C = 1.2257				Average Duplicates, Mean.

**Problem 1.** V. L. Bohnson in *J. Phys. Chem.* 24, 677 (1920) studied the rate of the irreversible reaction



in water, catalyzed by NaI. The data he obtained are given in the table above.  $x$  represents the amount of H<sub>2</sub>O<sub>2</sub> decomposed and  $a$  is the initial amount.

**(1a) (20 points)** Explain why the author does not give the units of  $x$  and  $a$ , nor does he tell us the volume of solution.

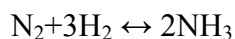
**(1b) (20 points)** How did he convert the volume of oxygen into milligrams of dry oxygen? Use a few of the volumes given by him and calculate the milligrams of oxygen.

**(1c) (20 points)** Knowing how many milligrams of oxygen were produced, calculate how much  $\text{H}_2\text{O}_2$  was consumed and compare to  $x$  given in the table.

**(1d) (60 points)** Guess a rate equation and calculate the rate constant. If you do not use Mathematica, use the simple method given in class. If you use Mathematica, perform a least-squares fitting. Test the quality of your result (i.e. see if you get a good fit of the data)

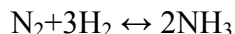
**(1e) (20 points)** Calculate at what time you consume half of the  $\text{H}_2\text{O}_2$ . (If you use Mathematica you have a model of such a calculation in Ch. 2 Workbook.)

**Problem 2. (20 points)** Prove that if the reaction



goes from right to left then the extent of reaction decreases in time or is constant and it is negative.

**Problem 3.** You perform the reaction



with 0.3 mole of  $\text{N}_2$  and 0.4 moles of  $\text{H}_2$  in a container of 20 liters.

**(3a) (30 points)** What is the maximum value that the extent of reaction  $\eta$  can take?

**(3b) (20 points)** If at a given time the extent of reaction  $\eta$  is 0.1 mole/liter, calculate the concentration of  $\text{H}_2$ ,  $\text{N}_2$  and  $\text{NH}_3$  at that time.