

Show work where possible

1. (6 Pts) What is the rate law that corresponds to the data shown for the reaction $2A + B \rightarrow C$? (Determine the order with respect to each reactant)

Exp.	Initial [A]	Initial [B]	Initial rate
1	0.015	0.022	0.125
2	0.030	0.044	0.500
3	0.060	0.044	0.500
4	0.060	0.066	1.125

*A - [

*A: Since there is no rate change for 2 & 3, the order of A is 0.

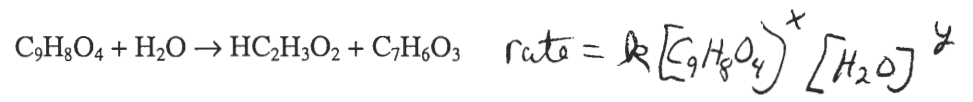
B: picking any pair where B changes, i.e. 2 over 1.

$$\frac{0.500}{0.125} = \left(\frac{0.044}{0.022}\right)^x$$

$$4 = 2^x \quad x = 2$$

rate = $k[B]^2$

2. (11 Pts) Aspirin, $C_9H_8O_4$, slowly decomposes at room temperature by reacting with water in the atmosphere to produce acetic acid, $HC_2H_3O_2$, and 2-hydroxybenzoic acid, $C_7H_6O_3$ (this is why old bottles of aspirin often smell like vinegar):



Concentration and rate data for this reaction are given below.

Exp	$[C_9H_8O_4]$ (M)	$[H_2O]$ (M)	Rate (M/s)
1	0.0100	0.0200	2.4×10^{-13}
2	0.0100	0.0800	9.6×10^{-13}
3	0.0200	0.0200	4.8×10^{-13}

Determine the rate law for this reaction and calculate k (be sure to include the correct units).

for $C_9H_8O_4$ use $\frac{\text{Exp 3}}{\text{Exp 2}}$: $\frac{4.8 \times 10^{-13}}{9.6 \times 10^{-13}} = \left(\frac{0.0200}{0.0100}\right)^x \quad x = 1$

for H_2O use $\frac{\text{Exp 2}}{\text{Exp 1}}$: $\frac{9.6 \times 10^{-13}}{2.4 \times 10^{-13}} = \left(\frac{0.0800}{0.0200}\right)^y \quad y = 1$

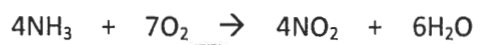
$$\text{rate} = k[C_9H_8O_4][H_2O]$$

$$k = \frac{2.4 \times 10^{-13}}{[0.0100][0.0200]} = 1.2 \times 10^{-9} \text{ M}^{-1} \cdot \text{s}^{-1}$$

3 (4 Pts) Given the rate law for a reaction, $\text{rate} = k[A][B]^2$, where rate is measured in units of $M s^{-1}$, what are the units for the rate constant k?

$$k = \frac{\text{rate}}{[A][B]^2} = \frac{M s^{-1}}{M \cdot M^2} = s^{-1} M^{-2}$$

4. (4 Pts) Which one of the following is not a valid expression for the of the reaction below? Explain your answer.



- a. $-\frac{\Delta[O_2]}{7\Delta t}$ b. $-\frac{\Delta[NO_2]}{4\Delta t}$ c. $\frac{\Delta[H_2O]}{6\Delta t}$ d. $-\frac{\Delta[NH_3]}{4\Delta t}$ e. $\text{rate} = k[NH_3]^x [O_2]^y$

NO_2 is a product, should be positive.