Key for Take-Home Assignment 08

The table below shows the results for an initial rate analysis of the reaction

$$\mathrm{A} + \mathrm{B} \longrightarrow \text{Products}$$

carried out in the presence of a potential catalyst, C. The general rate law for the reaction is

$$R = k[\mathrm{A}]^{\alpha}[\mathrm{B}]^{\beta}[\mathrm{C}]^{\gamma}$$

where k is the rate constant, and α, β, and γ are the reaction orders for A, B, and C. Use this data to answer the following questions:

What are the values for α, β, and γ? Using experiments 1 and 2, we see that doubling the initial concentration of A increases the rate by a factor of 2; thus, we know that $\alpha = 1$. Using experiments 2 and 3, we see that tripling the initial concentration of B increases the rate by a factor of 3; thus, we know that $\beta = 1$. Finally, sing experiments 3 and 4, we see that quadrupling the initial concentration of C increases the rate by a factor of 1; thus, we know that $\gamma = 0$.

What is the value of the reaction's rate constant, with units? To find the value of the rate constant we use any of the experiments to calculate k given the rate, R, and the concentrations and reaction orders for A, B, and C; thus, using the data from the first experiment

$$k = \frac{\text{Rate}}{[A]^{\alpha}[B]^{\beta}[C]^{\gamma}} = 99.2$$

with units on the rate constant of $\mathrm{mM}^{-1}\ \mathrm{s}^{-1}$.

Is C acting as a catalyst in this reaction? To determine if C is acting as a catalyst, we need to decide if its concentration affects the reaction's rate. If γ is 0, then C is not a catalyst, but if γ is 1 or 2, then C is a catalyst. For this problem, C is not a catalyst.

Be sure to fully document how you arrive at answers to all three questions. Your sample number is 105.

$[\mathrm{A}]_0$ (mM)	$[\mathrm{B}]_0$ (mM)	$[\mathrm{C}]_0$ (mM)	Rate (mM/s)
0.11	0.11	0.11	1.1999
0.22	0.11	0.11	2.4159
0.22	0.33	0.11	7.2626
0.22	0.33	0.44	7.2548