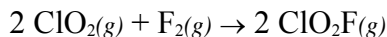
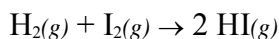


HW-Review-FRQ Practice-Kinetics (Taken from all College Board AP Chem Exams)**1991 B**

The following results were obtained when the reaction represented above was studied at 25°C.

Experiment	Initial $[\text{ClO}_2]$, ($\text{mol}\cdot\text{L}^{-1}$)	Initial $[\text{F}_2]$, ($\text{mol}\cdot\text{L}^{-1}$)	Initial Rate of Increase of $[\text{ClO}_2\text{F}]$, ($\text{mol}\cdot\text{L}^{-1}\cdot\text{sec}^{-1}$)
1	0.010	0.10	2.4×10^{-3}
2	0.010	0.40	9.6×10^{-3}
3	0.020	0.20	9.6×10^{-3}

- (a) Write the rate law expression for the reaction above.
- (b) Calculate the numerical value of the rate constant and specify the units.
- (c) In experiment 2, what is the initial rate of decrease of $[\text{F}_2]$?
- (d) Which of the following reaction mechanisms is consistent with the rate law developed in (a). Justify your choice.
- I. $\text{ClO}_2 + \text{F}_2 \leftrightarrow \text{ClO}_2\text{F}_2$ (fast)
 $\text{ClO}_2\text{F}_2 \rightarrow \text{ClO}_2\text{F} + \text{F}$ (slow)
 $\text{ClO}_2 + \text{F} \rightarrow \text{ClO}_2\text{F}$ (fast)
- II. $\text{F}_2 \rightarrow 2 \text{F}$ (slow)
 $2 (\text{ClO}_2 + \text{F} \rightarrow \text{ClO}_2\text{F})$ (fast)

1992 D

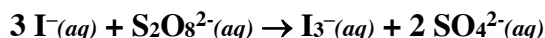
For the exothermic reaction represented above, carried out at 298K, the rate law is as follows.

$$\text{Rate} = k[\text{H}_2][\text{I}_2]$$

Predict the effect of each of the following changes on the initial rate of the reaction and explain your prediction.

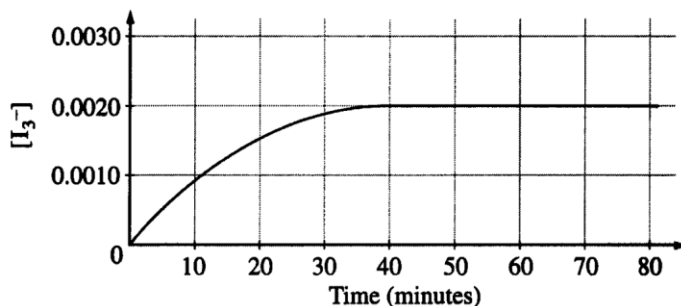
- (a) Addition of hydrogen gas at constant temperature and volume
- (b) Increase in volume of the reaction vessel at constant temperature
- (c) Addition of catalyst. In your explanation, include a diagram of potential energy versus reaction coordinate.
- (d) Increase in temperature. In your explanation, include a diagram showing the number of molecules as a function of energy.

2001 D

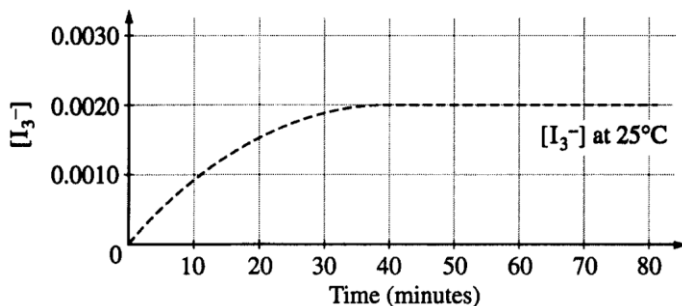


Iodide ion, $\text{I}^{-}(aq)$, reacts with peroxydisulfate ion, $\text{S}_2\text{O}_8^{2-}(aq)$, according to the equation above. Assume that the reaction goes to completion.

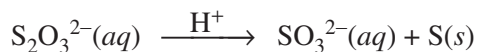
- (a) Identify the type of reaction (combustion, disproportionation, neutralization, oxidation-reduction, precipitation, etc.) represented by the equation above. _____
- (b) In an experiment, equal volumes of $0.0120 \text{ M } \text{I}^{-}(aq)$ and $0.0040 \text{ M } \text{S}_2\text{O}_8^{2-}(aq)$ are mixed at 25°C . The concentration of $\text{I}_3^{-}(aq)$ over the following 80 minutes is shown in the graph below.



- (i) Indicate the time at which the reaction first reaches completion by marking an "X" on the curve above at the point that corresponds to this time. Explain your reasoning.
- (ii) Explain how to determine the instantaneous rate of formation of $\text{I}_3^{-}(aq)$ at exactly 20 minutes. Draw on the graph above as part of your explanation.
- (c) Describe how to change the conditions of the experiment in part (b) to determine the order of the reaction with respect to $\text{I}^{-}(aq)$ and with respect to $\text{S}_2\text{O}_8^{2-}(aq)$.
- (d) State clearly how to use the information from the results of the experiments in part (c) to determine the value of the rate constant, k , for the reaction.
- (e) On the graph below (which shows the results of the initial experiment as a dashed curve), draw in a curve for the results you would predict if the initial experiment were to be carried out at 35°C rather than at 25°C .

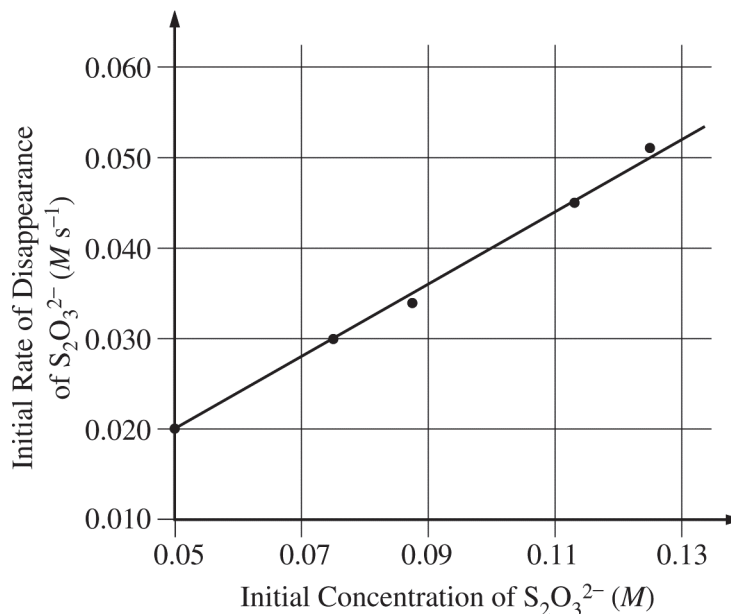


2009 AP[®] CHEMISTRY FREE-RESPONSE QUESTIONS (Form B)



2. A student performed an experiment to investigate the decomposition of sodium thiosulfate, $\text{Na}_2\text{S}_2\text{O}_3$, in acidic solution, as represented by the equation above. In each trial the student mixed a different concentration of sodium thiosulfate with hydrochloric acid at constant temperature and determined the rate of disappearance of $\text{S}_2\text{O}_3^{2-}(\text{aq})$. Data from five trials are given below in the table on the left and are plotted in the graph on the right.

Trial	Initial Concentration of $\text{S}_2\text{O}_3^{2-}(\text{aq})$ (M)	Initial Rate of Disappearance of $\text{S}_2\text{O}_3^{2-}(\text{aq})$ (M s^{-1})
1	0.050	0.020
2	0.075	0.030
3	0.088	0.034
4	0.112	0.045
5	0.125	0.051



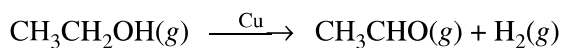
- Identify the independent variable in the experiment.
- Determine the order of the reaction with respect to $\text{S}_2\text{O}_3^{2-}$. Justify your answer by using the information above.
- Determine the value of the rate constant, k , for the reaction. Include units in your answer. Show how you arrived at your answer.
- In another trial the student mixed $0.10 \text{ M Na}_2\text{S}_2\text{O}_3$ with hydrochloric acid. Calculate the amount of time it would take for the concentration of $\text{S}_2\text{O}_3^{2-}$ to drop to 0.020 M .
- On the graph above, sketch the line that shows the results that would be expected if the student repeated the five trials at a temperature lower than that during the first set of trials.

2011 AP[®] CHEMISTRY FREE-RESPONSE QUESTIONS

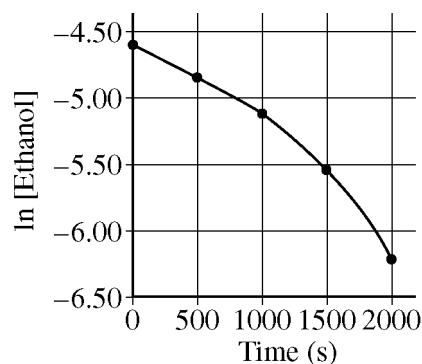
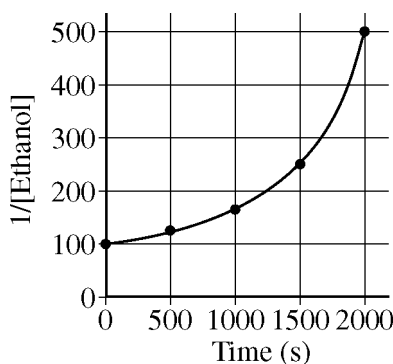
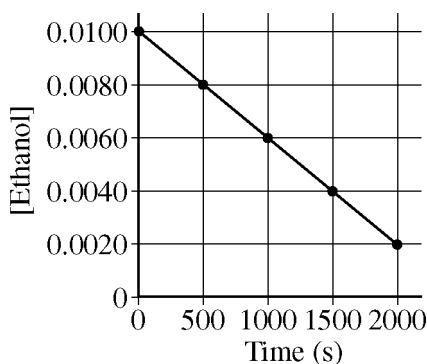
6. In an experiment, all the air in a rigid 2.0 L flask is pumped out. Then some liquid ethanol is injected into the sealed flask, which is held at 35°C. The amount of liquid ethanol initially decreases, but after five minutes the amount of liquid ethanol in the flask remains constant. Ethanol has a boiling point of 78.5°C and an equilibrium vapor pressure of 100 torr at 35°C.

- (a) When the amount of liquid ethanol in the flask is constant, is the pressure in the flask greater than, less than, or equal to 100 torr? Justify your answer.
- (b) The flask is then heated to 45°C, and the pressure in the flask increases. In terms of kinetic molecular theory, provide TWO reasons that the pressure in the flask is greater at 45°C than at 35°C.

In a second experiment, which is performed at a much higher temperature, a sample of ethanol gas and a copper catalyst are placed in a rigid, empty 1.0 L flask. The temperature of the flask is held constant, and the initial concentration of the ethanol gas is 0.0100 M. The ethanol begins to decompose according to the chemical reaction represented below.



The concentration of ethanol gas over time is used to create the three graphs below.



- (c) Given that the reaction order is zero, one, or two, use the information in the graphs to respond to the following.
- (i) Determine the order of the reaction with respect to ethanol. Justify your answer.
- (ii) Write the rate law for the reaction.
- (iii) Determine the rate constant for the reaction, including units.
- (d) The pressure in the flask at the beginning of the experiment is 0.40 atm. If the ethanol completely decomposes, what is the final pressure in the flask?

STOP

END OF EXAM