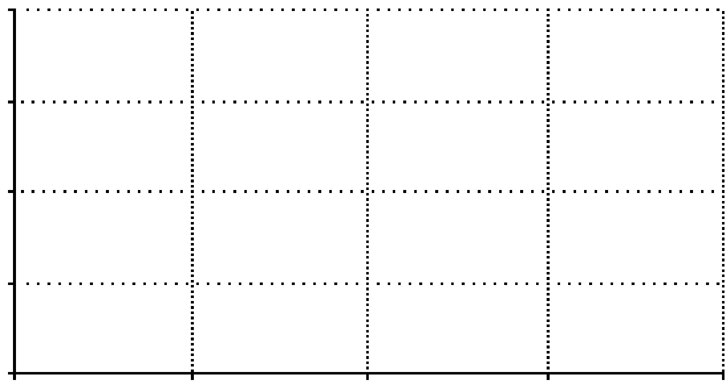
Kinetics
Teacher Answer Key
Section I

Q1. Sketch the graph on the axes provided, labeling all parts as described in the Level I Generic Graph Questions. **See Appendix A.**



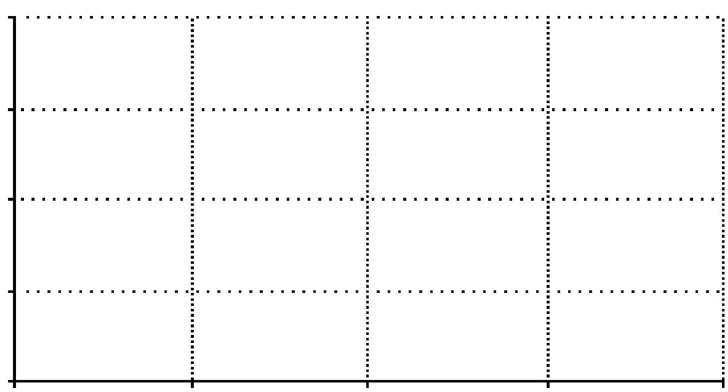
Q2. Referring to your copy of the Graph Interpretation Guidelines, describe in full each curve on the graph.

> **The plot of Rate A Disappears is a horizontal line, showing that the value is constant. The plot of Concentration A is a line with a negative slope. The slope shows that the Concentration A is decreasing at a constant rate equal to the Rate A Disappears.**

Q3. What is the order of this reaction with respect to A? What is your evidence?

> **As shown by the constant Rate A Disappears line, the reaction is zero order.**

Q4. Sketch the graph on the axes provided, labeling all parts as described in the Level I Generic Graph Questions. **See Appendix B.**



Q5. Referring to your copy of the Graph Interpretation Guidelines, describe in full each curve on the graph.

> **The plot of Rate A Disappears is a curve, decreasing at an ever decreasing rate, because its value depends on the decreasing concentration. The plot of Concentration A is curve also decreasing at an ever decreasing rate. The slope of the Concentration A curve is equal to the values plotted on the Rate A Disappears curve.**

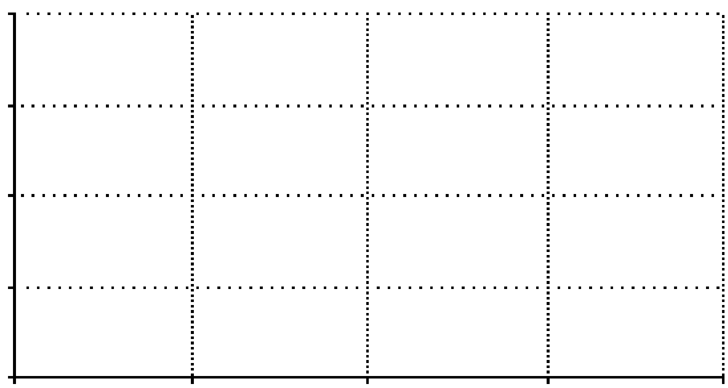
Q6. What is the order of this reaction with respect to A? What is your evidence?

> **This is a first order reaction. The curves on the graph show that the reaction rate depends on the current concentration. As the concentration drops, the reaction rate drops also, which means that the concentration starts dropping at a slower rate.**

Q7. Describe the change you made to the model.

> **Put a second factor of Concentration_A in the formula for Rate A Disappears.**

Q8. Sketch the graph on the axes provided, labeling all parts as described in the Level I Generic Graph Questions. **See Appendix C.**



Q9. Referring to your copy of the Graph Interpretation Guidelines, describe in full each curve on the graph.

> **The plot of Rate A Disappears is a curve, decreasing at an ever decreasing rate, because its value depends on the square of decreasing concentration. The plot of Concentration A is curve also decreasing at an ever decreasing rate. The slope of the Concentration A curve is equal to the values plotted on the Rate A Disappears curve.**

Q10. Referring to the graphs in Questions 1, 4 and 8, which Concentration_A curve is showing the steepest slope during the first 10 seconds? Explain what that means in the context of the problem.

> **The Concentration_A curve for the second order reaction has the steepest slope during the first 10 seconds of the simulation. This means that higher order reactions finish in less time than lower order reactions.**

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Section II

Q1. Predict what will happen to the initial reaction rate if the initial concentration of the reactant is changed from 20 to 10 to 5 {moles per liter} and the reaction is zero order. **(Answers will vary.)**

> **In a zero order reaction, the initial reaction rate should not be affected by the initial concentration of the reactant because the rate is constant.**

Q2. Complete the table provided with the appropriate data from the model.

Run	Initial Concentration A (moles per liter)	Initial Rate A Disappears (moles per liter per second)
1	20	**0.01**
2	10	**0.01**
3	5	**0.01**

Q3. Predict what will happen to the initial reaction rate if the initial concentration of the reactant is changed from 20 to 10 to 5 and the reaction is first order. **(Answers will vary.)**

> **In a first order reaction, each time the initial concentration is halved, the initial reaction rate should also be halved because the rate is proportional to the concentration.**

Q4. Complete the table provided with the appropriate data from the model.

Run	Initial Concentration A (moles per liter)	Initial Rate A Disappears (moles per liter per second)
1	**20**	**0.20**
2	**10**	**0.10**
3	**5**	**0.05**

Q5. Predict what will happen to the initial reaction rate if the initial concentration of the reactant is changed from 20 to 10 to 5 and the reaction is second order. **(Answers will vary.)**

> **In a second order reaction, each time the initial concentration is halved, the initial reaction rate should be quartered because the rate is proportional to the square of the concentration.**

Q6. Complete the table provided with the appropriate data from the model.

Run	Initial Concentration A (moles per liter)	Initial Rate A Disappears (moles per liter per second)
1	**20**	**4**
2	**10**	**1**
3	**5**	**0.25**

Q7. Summarize how the initial reaction rate is affected by the initial concentration of the reactant for:

a) Zero order reactions
The initial reaction rate is not affected by the initial concentration of the reactant.

b) First order reactions
The initial reaction rate is directly proportional to the initial concentration of the reactant.

c) Second order reactions
The initial reaction rate is directly proportional to the square of the initial concentration of the reactant.

Q8. What is the mathematical relationship between the order of the reaction and the reaction rate?

The order of the reaction is the exponent n on the formula:
reaction rate = k * concentration^n

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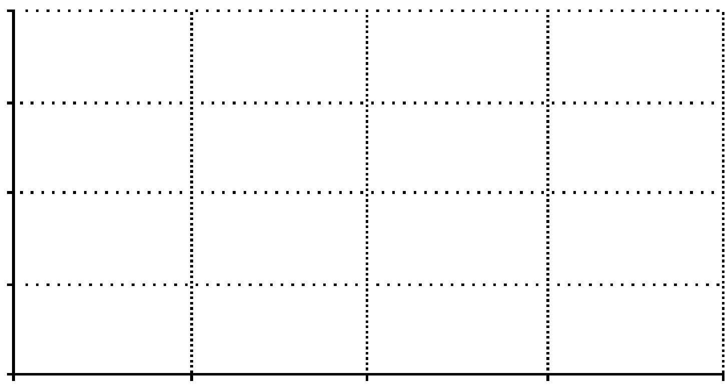
Section III

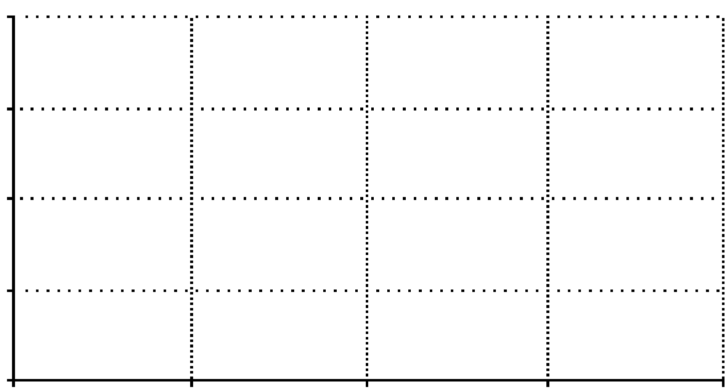
Q1. Sketch the graph on the axes provided, labeling all parts as described in the Level I Generic Graph Questions. **See Appendix D.**



Q2. Referring to your copy of the Graph Interpretation Guidelines, describe the effect that doubling the rate constant has on the lines you see on the graph.

> **Doubling the rate constant on a second order reaction makes the Rate_A_Disappears start twice as high as before, but it quickly drops to the same low level as the original because there is little concentration left.**

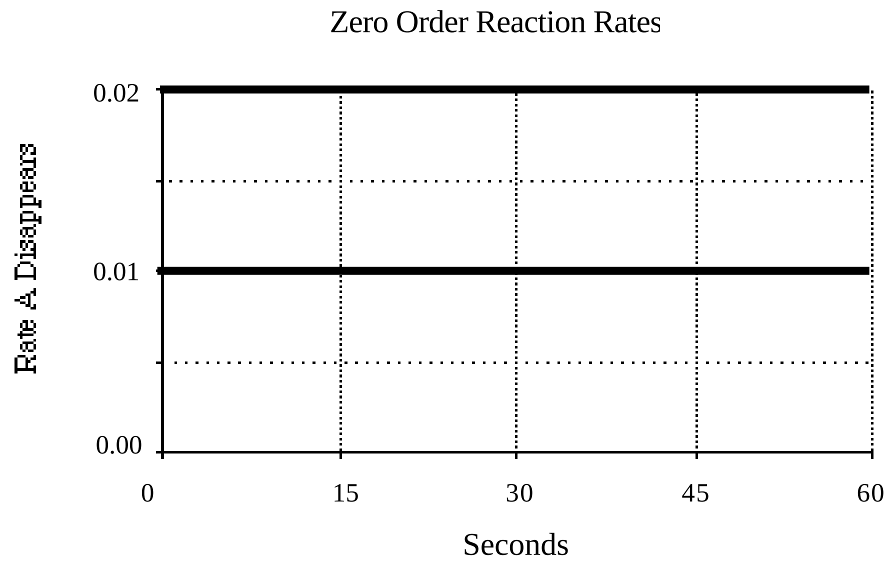
Q3. Sketch the graph on the axes provided, labeling all parts as described in the Level I Generic Graph Questions. **See Appendix E.**



Q4. Referring to your copy of the Graph Interpretation Guidelines, describe the effect that doubling the rate constant has on the curves you see on the graph.

> **Doubling the rate constant on a first order reaction makes the Rate_A_Disappears start twice as high as before, and it slowly drops to about the same low level as the original because there is eventually little concentration left.**

Q5. Without returning the model to a zero order reaction, predict what the comparative graph should look like if the first run has **Rate A Disappears** set to **0.01 {moles per liter per second}** and the second run has **Rate A Disappears** set to **0.02.** Sketch your prediction on the axes provided, labeling all parts as described in the Level I Generic Graph Questions.



Q6. Referring to your copy of the Graph Interpretation Guidelines, describe the effect that doubling the rate constant has on the curves you see on the graph.

Doubling the rate constant on a zero order reaction makes the Rate_A_Disappears start twice as high as before, and it stays at that level because the rate is constant.

Q7. Summarize how the initial reaction rate is affected by doubling the rate constant for:

a) Zero order reactions
The initial reaction rate is doubled when the rate constant is doubled.

b) First order reactions
The initial reaction rate is doubled when the rate constant is doubled.

c) Second order reactions
The initial reaction rate is doubled when the rate constant is doubled.

Q8. Summarize how the reaction rate graph is affected by doubling the rate constant for:

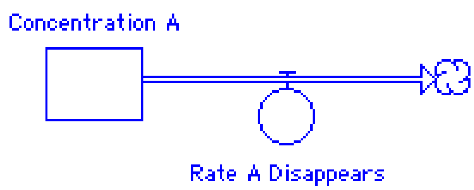
a) Zero order reactions
There are two parallel horizontal lines, one twice as high as the other.

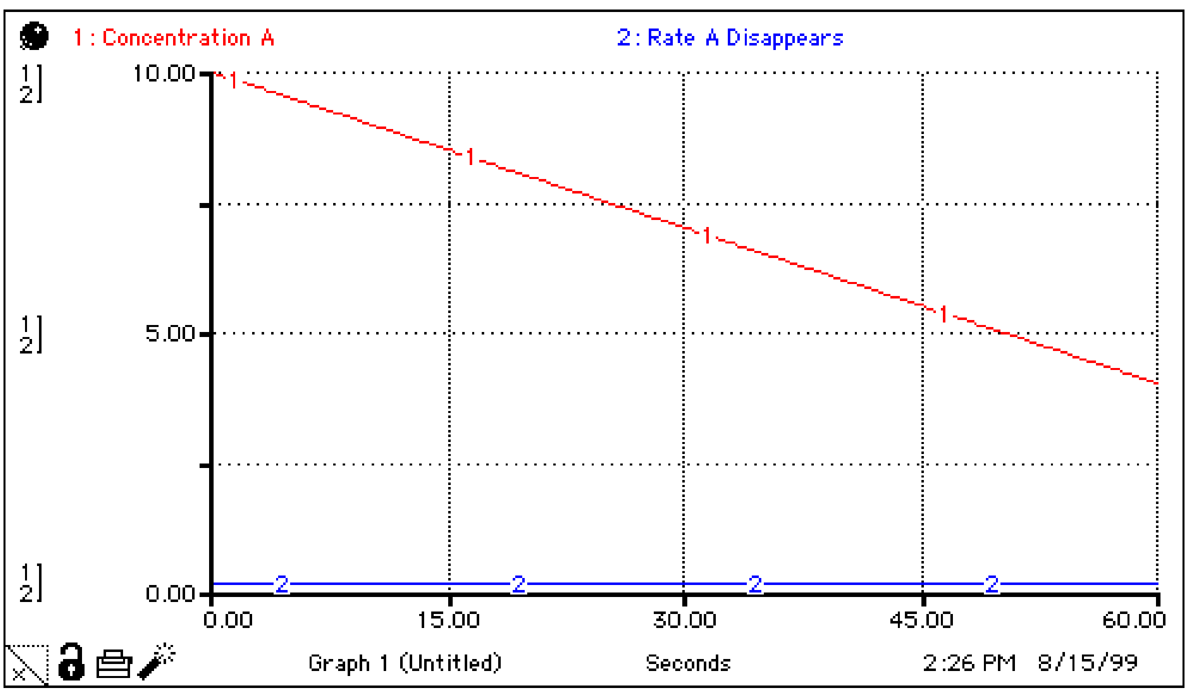
b) First order reactions
There are two curves, each decreasing at an ever decreasing rate. One starts twice as high as the other. They slowly get closer in value as time goes on.

c) Second order reactions
There are two curves, each decreasing at an ever decreasing rate. One starts twice as high as the other. They quickly get close in value.

Appendix A

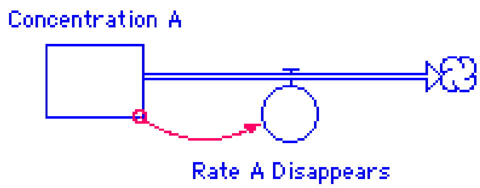
Zero Order Reaction
Concentration A = 10 moles per liter
Rate A Disappears = 0.1 moles per liter per second

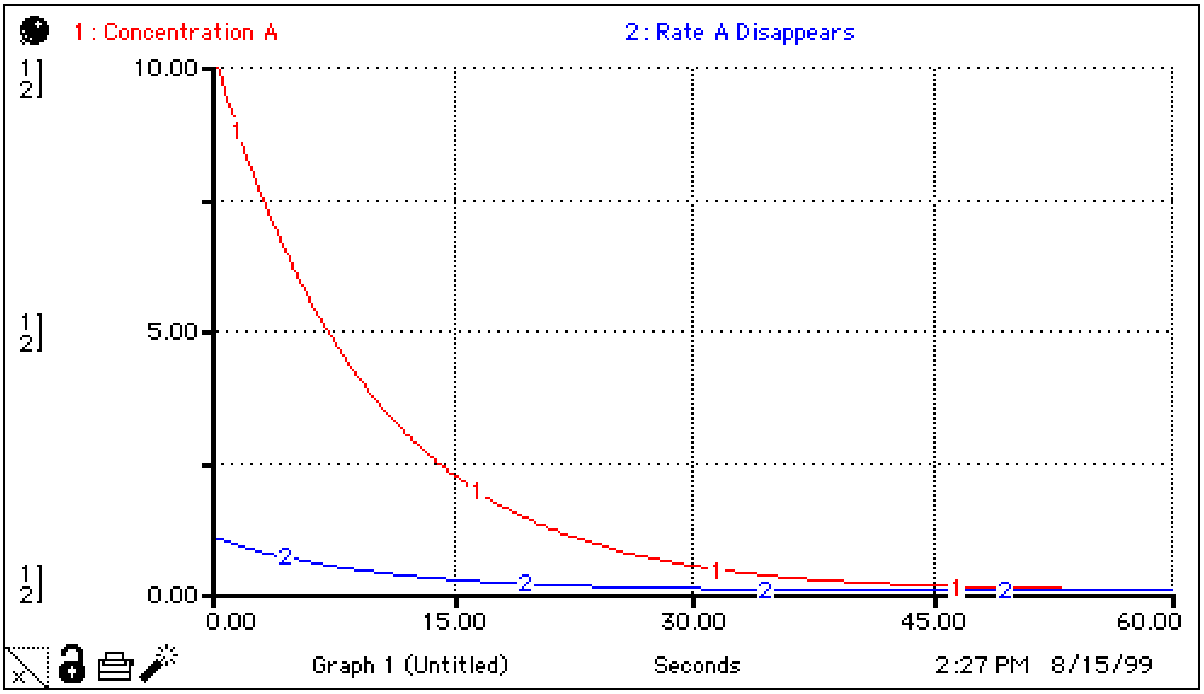




Appendix B

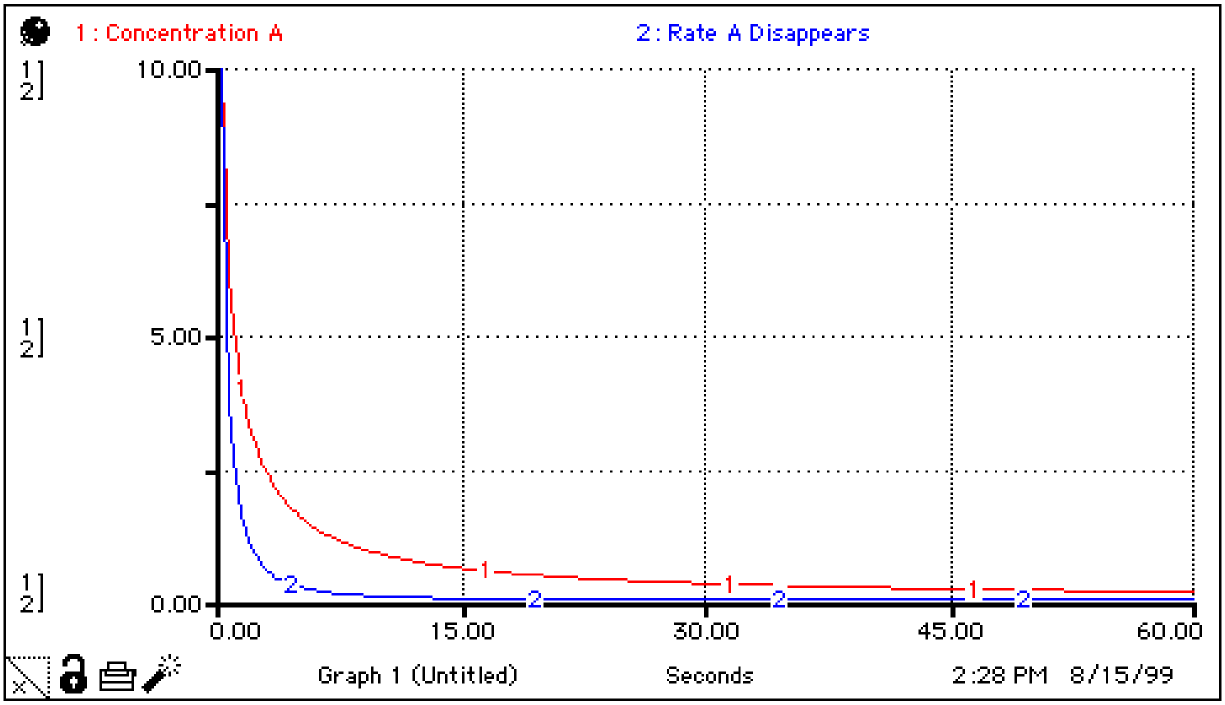
First Order Reaction
Concentration A = 10 moles per liter
Rate A Disappears = 0.1*Concentration_A moles per liter per second





Appendix C

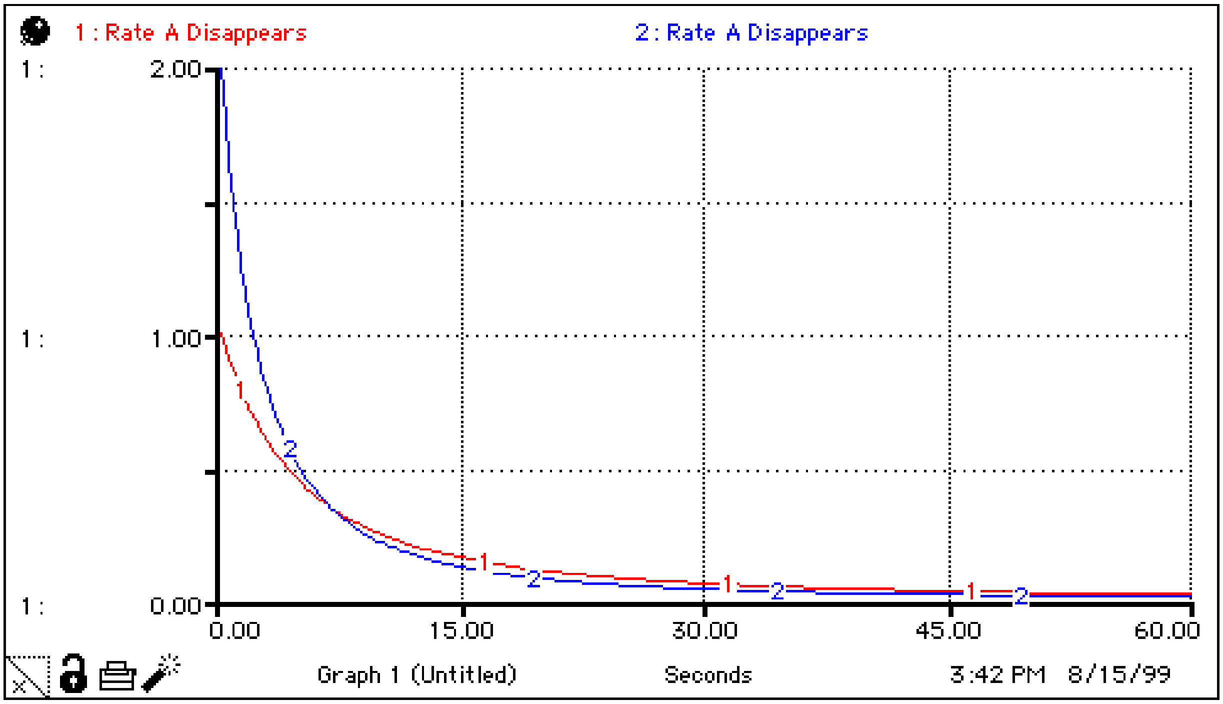
Second Order Reaction
Concentration A = 10 moles per liter
Rate A Disappears = 0.1*Concentration_A^2 moles per liter per second



Appendix D

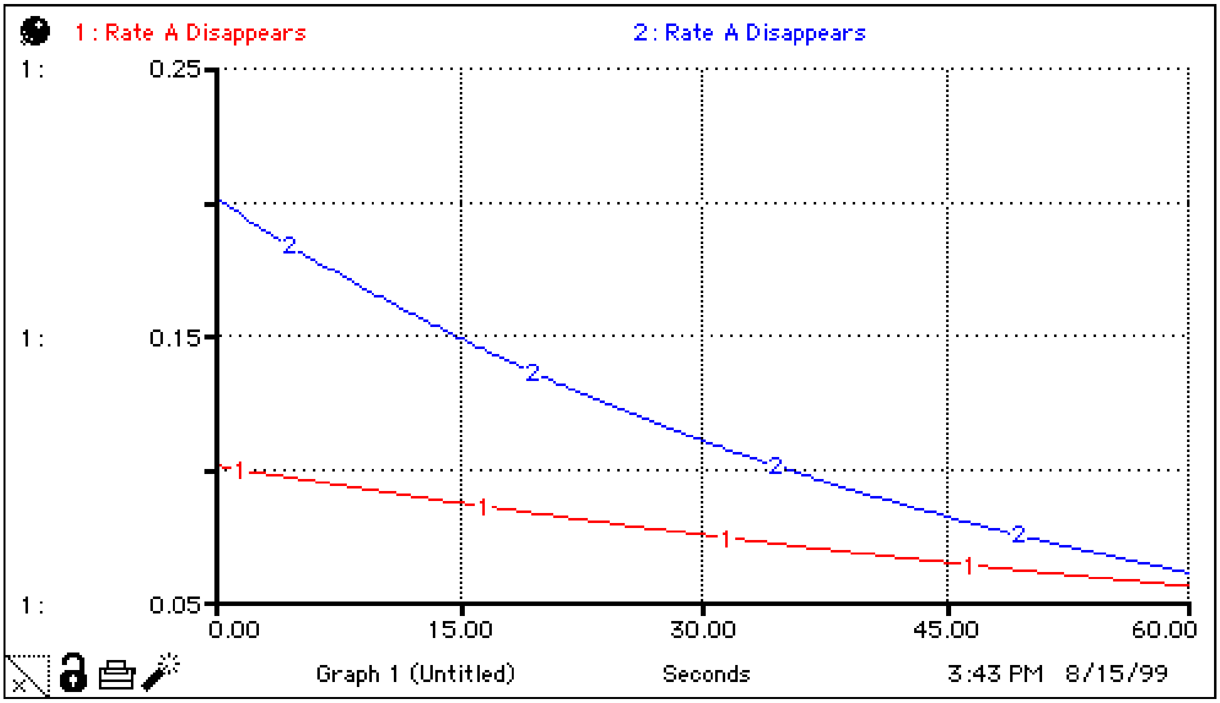
Second Order Reaction

Concentration A = 10 moles per liter
Rate A Disappears = 0.01*Concentration_A^2 moles per liter per second



Appendix E

First Order Reaction
Concentration A = 10 moles per liter
Rate A Disappears = 0.01*Concentration_A per liter per second


1 : Rate A Disappears
2 : Rate A Disappears
1 :
0.25
1 :
0.15
1 :
0.05
0.00
15.00
30.00
45.00
60.00
Graph 1 (Untitled)
Seconds
3:43 PM 8/15/99