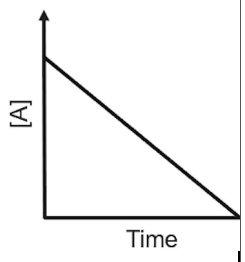
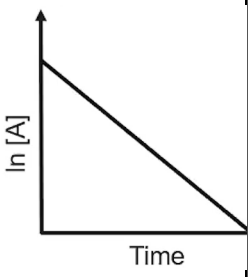
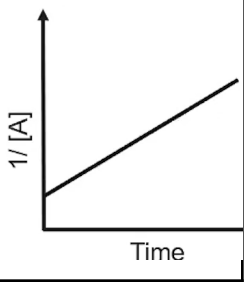
AP Chemistry Daily Videos

5.3 Concentration Changes Over Times

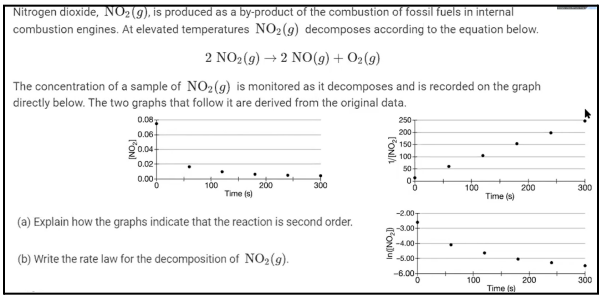
[Video #1]

1. Complete the following table:

Reaction Order	What happens to the rate when the reactant doubles?	Generic Rate Law	Integrated Rate Law	Relationship of k to slope	Graphical representation
Zero					
First					
Second					

2. What is the purpose of the integrated rate law? What does $[A]_t$ and $[A]_0$ represent?

3. Pause the video at 3:16 and attempt the problem, then evaluate how you did and identify any errors.



Nitrogen dioxide, $NO_2(g)$, is produced as a by-product of the combustion of fossil fuels in internal combustion engines. At elevated temperatures $NO_2(g)$ decomposes according to the equation below.

$$2\ NO_2(g) \rightarrow 2\ NO(g) + O_2(g)$$

The concentration of a sample of $NO_2(g)$ is monitored as it decomposes and is recorded on the graph directly below. The two graphs that follow it are derived from the original data.

(a) Explain how the graphs indicate that the reaction is second order.

(b) Write the rate law for the decomposition of $NO_2(g)$.

4. Pause the video at 4:08 and attempt the problem, then evaluate how you did and identify any errors.

$2\,H_2O_2(aq) \rightarrow 2\,H_2O(l) + O_2(g) \qquad \Delta H^\circ = -196\ kJ/mol_{rxn}$

The decomposition of $H_2O_2(aq)$ is represented by the equation above. A student monitored the decomposition of a 1.0 L sample of $H_2O_2(aq)$ at a constant temperature of 300. K and recorded the concentration of H_2O_2 as a function of time. The results are given in the table below.

Which of the following statements is a correct interpretation of the data regarding how the order of the reaction can be determined?

Time (s)	$[H_2O_2]$ (M)
0	2.7
200.	2.1
400.	1.7
600.	1.4

(A) The reaction must be first order because there is only one reactant species.

(B) The reaction is first order if the plot of ln $[H_2O_2]$ versus time is a straight line.

(C) The reaction is first order if the plot of $1/[H_2O_2]$ versus time is a straight line.

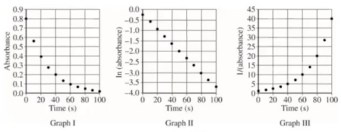
(D) The reaction is second order because 2 is the coefficient of H_2O_2 in the chemical equation.

5. Pause the video at 5:11 and attempt the problem, then evaluate how you did and identify any errors.

$Na_2C_{37}H_{34}N_2S_3O_9 + OCl^- \rightarrow products$

blue *colorless*

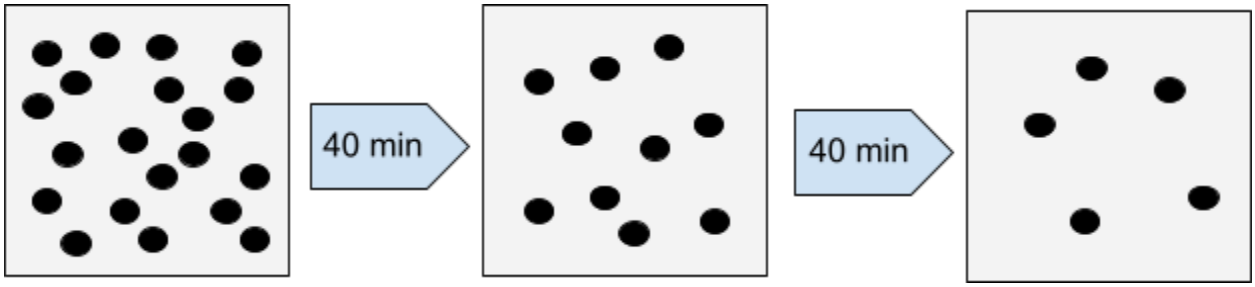
Blue food coloring can be oxidized by household bleach (which contains OCl−) to form colorless products, as represented by the equation above. A student used a spectrophotometer set at a wavelength of 635 nm to study the absorbance of the food coloring over time during the bleaching process. In the study, bleach is present in large excess so that the concentration of OCl− is essentially constant throughout the reaction. The student used data from the study to generate the graphs below.



a. Based on the graphs above, what is the order of the reaction with respect to the blue food coloring?

Video #2

1. Explain in your own words and using this picture what half-life is.

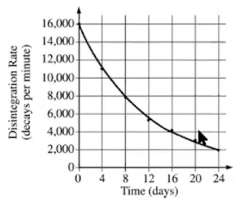


Note that for first order reactions, the concentration of the reactant is decreased by half at a constant rate. You might see this information in a data table or graph. The key is recognizing what is occurring and the rate. The value of $t_{1/2}$ (half-life) can be determined from the graph or data table.

2. Explain how to use this equation to calculate half-life. $t_{1/2} = \dfrac{0.693}{k}$

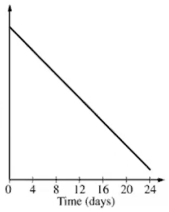
3. Pause the video at 1:20 and attempt the problem, then evaluate how you did and identify any errors.

The radioactivity of a sample of I-131 was measured. The data collected are plotted on the graph below.



c. Determine the half-life, $t_{1/2}$, of I-131 using the graph above.

d. The data can be used to show that the decay of I-131 is a first-order reaction, as indicated on the graph below.



i. Label the vertical axis of the graph above.

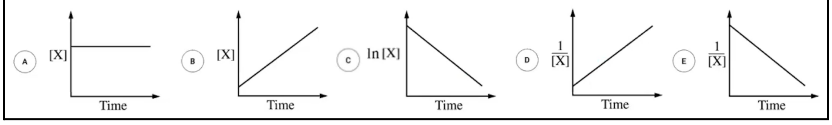
ii. What are the units of the rate constant, *k*, for the decay reaction? .....

iii. Explain how the half-life of I-131 can be calculated using the slope of the line plotted on the graph.

4. Pause the video at 2:52 and attempt the problem, then evaluate how you did and identify any errors.

$X \rightarrow$ products

The rate constant (*k*) for the decay of the radioactive isotope X, according to the equation above, is 2.3×10^{-2} days^{-1}. The slope of which of the following graphs is correct for the decay and could be used to confirm the value of *k*?



5. Pause the video at 3:34 and attempt the problem, then evaluate how you did and identify any errors.

The ammonium salt of isocyanic acid is a product of the decomposition of urea, $CO(NH_2)_2$, represented below.

$$CO(NH_2)_2(aq) \rightleftarrows NH_4^+(aq) + OCN^-(aq)$$

A student studying the decomposition reaction runs the reaction at 90°C. The student collects data on the concentration of urea as a function of time, as shown by the data table and the graph below.

Time (hours)	$[CO(NH_2)_2]$
0	0.1000
5	0.0707
10	0.0500
15	0.0354
20	0.0250
25	0.0177
30	0.0125

e. The student proposes that the rate law is $rate = k[CO(NH_2)_2]$.

i. Explain how the data support the student's proposed rate law.

ii. Using the proposed rate law and the student's results, determine the value of the rate constant, *k*. Include units with your answer.