TI-nspire™

Grade level: 9-12
Subject: Chemistry
Time required: 45 to 90 minutes

Kinetic

by – Todd Morstein

Study of Chemical Rates of Reaction

An introductory lesson on determining the differential rate law and rate constant

Concepts

Chemical kinetics, order of reactions, differential rate law, rate constants

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Teacher preparation

The kinetics one document must be loaded on all handhelds.

Classroom management tips

If multiple classes are using the activity have the students open a new document at the end of class and don't save the kinetics document

TI-Nspire Applications

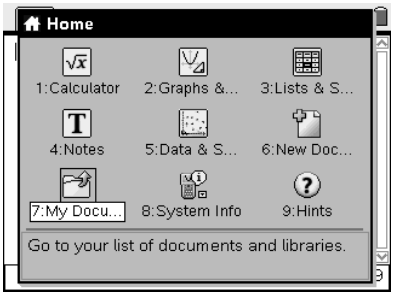
Kinetics introduction.tns

Step-by-step directions

Kinetics Activity 1

Objective

- Determine rate of reaction
- Understand orders
- Determine the differential rate law
- Determine the integrated rate law



Open the kinetics introduction activity on the TI-Nspires.

1. Press (home).
2. Arrow down to 7:My Documents and press (enter).
3. Select Kinetics Introduction.
4. Read the introduction page of the kinetics activity.

Questions

What is Rate? _____
How can rate be determined? _____
_____

5. Press the (ctrl) ▸ to move to page 1.2.
6. Determine the slope of the line between the two points.
    a. In the bottom screen determine the change in concentration [A].
    b. Determine the change in time.
    c. Calculate the rate of reaction between these two points.

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Subject: chemistry

Question

What was the Δ[A]? _____
What was the Δt? _____
What was the Rate? _____

7. Construct a line between the two points.
    a. Press Menu.
    b. From the 7:Points & Lines menu select 4: Lines.
    c. Place the cursor on the first point and press ctrl.
    d. Move the cursor to the second point and press ctrl to finish the line.
8. Measure the slope of the line.
    a. Press Menu
    b. From the 7:Measurement menu select 3:Slope.
    c. Move the cursor to the line and press ctrl.
    d. Move the value to a clean spot on the graph and press ctrl to drop the value.

Question

What is the slope of the line generated? _____
How does this value compare to the slope calculated earlier? _____

The slope between two points on a time concentration graph represents the **average rate** between the two points.

Reactions don't tend to follow a perfectly straight line though. The reactants tend to decay in a curved shape. What was done on the page 1.2 is finding the average rate.
On the following page 1.3 you will look at **instantaneous rates** for the reaction.

$A \rightarrow B + C$

The decay of the graph represents what happens to A over time. To determine the instantaneous rate of the reaction a **tangent** is needed. A tangent is a line that touches the graph at one point and represents the slope of the curve at that one point.

9. Press Menu.
10. From the 6: Points& Lines menu select 7: Tangent.
11. Move the cursor to the curve and press ctrl to attach the tangent.
12. Press esc.
13. Measure the slope of the tangent.
    a. Press menu
    b. From the 7: Measurement menu select 3:Slope
    c. Move the cursor to the tangent and press ctrl to select the tangent.
    d. Move the cursor to an empty space on the graph and press ctrl to drop the measurement.
14. Press esc to get out of measurement mode.
15. Move the cursor to the tangent point. Press and hold the ctrl to grab the point.
16. Move the point up and down the graph paying attention to the slope value.

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Questions

What happens to the slope near the y-axis? _____
What happens to the slopes as you move down the graph to the right? _____
Where is the greatest rate for the reaction? _____
Where is the smallest rate? _____

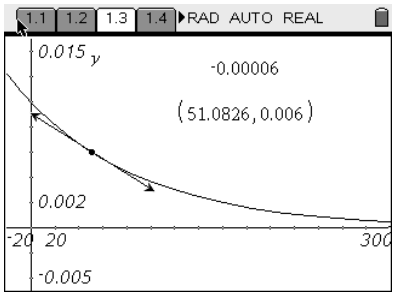
The rate law is an equation that represents the rates at each concentration. This law incorporates what is called a rate constant and an order of reaction. The order of reaction is the affect the concentration has on the rate. The rate constant is the conversion between concentration and rate. For the reaction below

$A \rightarrow B + C$

The general Rate law would be $Rate = k [A]^n$

k is the rate constant, *n* is the exponent or described as the order of reaction. Given the graph previously the order can be determined by looking at the concentration and the rate.

17. Press Menu
18. From the 1: Actions menu select 6: Coordinates and Equations.
19. Place your cursor on the tangent point and press ⏺.
20. Move off of the tangent and drop the coordinates in an empty space and press ⏺.
21. Y is the concentration, x is the time and the slope is rate.
22. Set the concentration to 0.006
    a. Press esc.
    b. Cursor over the y-value and press ⏺ to change the value.
    c. Enter the concentration and the rate in the table below.



Data

Concentration (M)	Rate M/s
0.006	
0.003	
0.0015	

Questions

As the concentration is doubled from 0.003 – 0.006, by what multiple does the rate increase by? _____

How many times greater is the 0.006 than 0.003? _____ Concentration change
How many time greater is the rate for 0.006 then 0.003? _____ rate change
What power would the concentration change have to be raised to, to equal the rate change? _____

The power is called the order. What is the order of this reaction? _____
If the reaction is $A \rightarrow B+C$, write the rate law for the reaction. _____

Determine k by substituting a concentration and a Rate into the rate law and solving for k. _____

Write the rate law including k. _____
What is the rate if the concentration were 0.0023 M, using the rate law? _____

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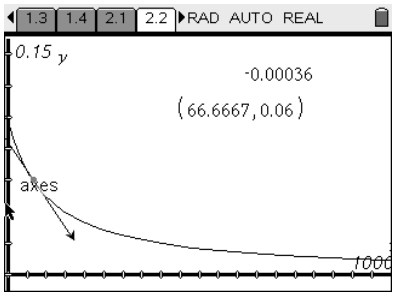
Move to page 2.2

23. Press ctrl ▶ until you are on page 2.2.
24. Add a tangent to the curve.
    a. Press Menu
    b. From the 6: Points & Lines menu select 7: Tangent
    c. Move the cursor the curve and press ⬭ to attach the tangent.
25. Measure the rate.
    a. Press menu
    b. From the 7: Measurement menu select 3:Slope.
    c. Cursor over the tangent and press ⬭.
    d. Move to an empty spot on the graph screen and press ⬭ to drop the value.
26. Determine the coordinates of the tangent.
    a. Press menu
    b. From the 1: Actions menu select 6: coordinates
    c. Cursor over the tangent point and press ⬭.
    d. Move to and empty spot on the graph screen and press ⬭ to drop the value.
27. Change the y value and record the rates.

Concentration		Rate	
0.06			
0.03			
0.02			
0.01			



Questions

As the concentration is doubled from 0.03 – 0.06, by what multiple does the rate increase by? _____
How many times greater is the 0.006 than 0.003? _____ Concentration change
How many time greater is the rate for 0.006 then 0.003? _____ rate change
What power would the concentration change have to be raised to, to equal the rate change? _____
The power is called the order. What is the order of this reaction? _____
If the reaction is A → B+C , write the rate law for the reaction. _____
Determine k by substituting a concentration and a Rate into the rate law and solving for k. _____
Write the rate law including k. _____

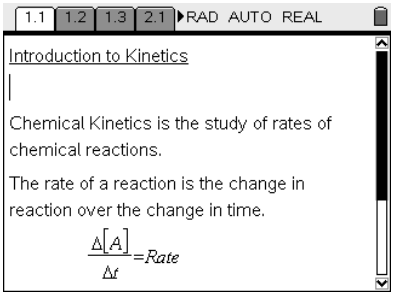
Assessment and evaluation

- *Students should be answering the questions throughout the activity.*
- *Presenting this activity to the class after they have explored gives the teacher the opportunity for clarification.*
- *Students should have an idea of rate, order and rate law.*

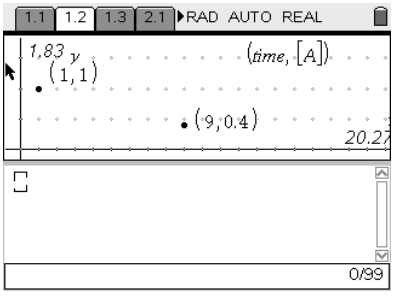
Student TI-Nspire Document

Kinetics introduction.tns

Screenshot #1



Screenshot #2



Screenshot #3