



Experiment 10

Chemical Kinetics Discovery Lab

CH 204

Fall 2006

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Last week in lab

Titration curves

Changing composition of a weak acid solution as strong base is added

pH meters, pH standards

Witnessed the awesome power of a buffer solution to resist changes in pH

Thermo vs Kinetics

Thermodynamics is concerned only with where you start and where you finish.

Kinetics is all about how you get there:
reaction rates and reaction mechanisms
(the individual steps of a reaction).

Reaction rate

How quickly a reactant disappears, or how quickly a product forms.

$$\text{Rate} = -\frac{\Delta[A]}{\Delta t} = -\frac{d[A]}{dt}$$

The relationship between concentration and reaction rate is expressed in the form of a *rate law*.

Rate Laws

Rate laws tell you how the rate of a reaction depends on the concentrations.

For the reaction $A + B \rightarrow C + D$,
a typical rate law is

$$\text{Rate} = k[A][B]$$

Most rate laws are 1st or 2nd order. (Sum of the exponents equals 1 or 2.) This example is 1st order in A and B, and 2nd order overall.

Reaction Mechanisms

The actual step-by-step chemical pathways that reactions take.

These often include intermediaries and catalysts that don't appear in the overall equation - but they might appear in the rate law.

Catalysts and Intermediaries

catalysts - consumed early in a reaction and regenerated in the same amount later. No net change in concentration.

intermediaries - produced early in a reaction and consumed later. Doesn't show up as either a reactant or a product in the overall reaction.

In the reaction



A might not necessarily react directly with B, because the mechanism might be something like



Elementary Reactions

Each individual step in a reaction mechanism is called an *elementary reaction*.

There are no “hidden participants” in an elementary reaction, and the rate law is exactly what you would expect:

For $aA + bB \rightarrow cC + dD$, the rate law is
Rate = $k[A]^a[B]^b$

Rate Laws for overall reactions

Generally speaking they are often exactly what you would expect, but there are enough exceptions out there that that's not a safe bet.

Rate laws can't be predicted from overall reaction equations, and are determined empirically.

“All right, men...

...here's what we're gonna take and do.”

150 mL of unknown solution

2.5 g of unknown solid

1 or 2 drops of methylene blue indicator

Mix 'em up and watch the reaction go.

Your mission, if you decide to accept it...

Determine the mechanism of the reaction.

Break the overall reaction into individual elementary reactions.

Identify the role of the unknown solid and any other reactants, catalysts, and intermediaries in the system. (The unknown liquid does NOT play a role.)

Things to watch for

Rates of reactions - what happens quickly?
What happens slowly?

How does doubling the concentration of a reactant affect the rate of reaction?

Which changes in the reactants result in the formation of more product? How do you know?

What is the limiting reagent in the reaction?

"My brain hurts!"

The answers aren't in the lab manual, and your TA won't hand them to you either.

You've got to noodle your way through to the answer on this one.

Make sure you *understand* the mechanism before you leave the lab. Your TA will not answer questions about the mechanism once lab is over.

In your notebook

Record all your data and observations.

Part 15 - simple graphs. Two or three points is enough. No need for Excel, just draw a simple graph in your lab notebook.

Record all observations directly into your lab notebook.



Before you leave the lab

Look over the discussion questions
and make sure you know the
answers.

Well, that lecture wasn't
very helpful, was it?

No, it wasn't.

Special Announcements

NO LECTURE NEXT WEEK

Experiment 10 reports are due by the beginning of lab time next week.

NO QUIZ NEXT WEEK

Check out of your drawer at the end of lab today.

More Special Announcements

IF YOU HAVE A MAKE-UP LAB

Go directly to lab at your normal lab time next week. I will post make-up lab room assignments on the web page and on signs posted outside the labs. You may end up working in another lab or with another TA.

IF YOU HAVE MORE THAN ONE MAKE-UP LAB

See me immediately if you have not already so we can schedule which lab you will do when.

One Final Special Announcement

IF YOU ARE NOT HERE TODAY

Let me know right away so we can get you
on the make-up schedule for next week.