How is everyone doing today?

[CHEERING]

You know why there's a lot of excitement, and I saw the silent praise, because I know what this means, recently, and I'm doing more and more.

You guys are excited, because we are celebrating something on Friday.

We are celebrating knowledge, we are celebrating chemistry, and we are celebrating how much we've learned in the last month.

It's called exam three.

Woo.

It's a midterm.

Thank you for that.

What I thought we'd do today instead of-- again, I mentioned this on Monday.

You guys just had Thanksgiving, you're back, and now we've got a test.

And I know you've got a lot of other stuff going on too at this time.

So instead of throwing something in that we're not going to test you on, what I wanted to do with today was just to kind of feel our oneness with the concepts.

All right?

And so I want to go over the concepts that are going to be potentially on the exam on Friday, and I'll talk about those concepts, and we'll do a couple of problems here and there as we go.

OK, so those are the metrics, the specs, for exam three.

But on Monday, I finished with two minutes left, and I said, hey, there's one more kind of acid-base definition.

You won't be tested on it, but it's the most general, and I've got to give Lewis his due.

So I just wanted to just show you like that.

You won't be tested on Lewis acids and bases, but I did throw this in there, and so I want to just, for one or two more minutes, talk about this.

Right?

These are the things you are responsible for knowing.

So an Arrhenius acid-base-- OH, H plus.

Bronsted-Lowry.

It's proton transfer.

And then there's Lewis, who broasted these guys, because he said, uh-uh, and this is the most general way to think about acids and bases.

It is the most general.

It is quite powerful, because you go back to say this one, and so if this is a-- what if we mix this with this?

So here we have H.

Now, remember, Lewis had all the dots all over the place.

He loved dots, and so they're all over the place.

And that's what if you had this, this is a Lewis acid, because it is ready to receive.

What is it ready to receive?

No more atoms, only electrons.

It is the most general way to think about it.

All right?

And this would be a Lewis base, because it is ready to give a pair of electrons and form a bond together.

And that's what they do, or that's what they can do.

So a Lewis acid and a Lewis base is the most general form, and you really get rid of-- so for Lewis, it's all about electron transfer, electron pair transfer, pair transfer, or bonds if you're-- I'm just going to make it as general as possible.

If you're going to mix an acid and a base, which I'll do in a second, it's a pair.

Electron transfer is what it's all about, and what happens here?

Well, you don't have any chemical identity, no more chemical identity.

So it's full.

You don't need the hydrogens anymore.

You don't need the OH's.

It's totally general.

And this really opens it up, because now you can look at gases, liquid, solids, all forms of matter, all elements in the table, and you can think about them as whether they're going to have an acid-like or a base-like character in terms of electron transfer.

So here's the general-- if you had a Lewis acid and a Lewis base, and you mix them together.

Then, you can see that if you got an electron pair that could then go-- that one of them wants it, and the other can give it, and they can form a bond, then that would be how you think about mixing a Lewis acid and a Lewis base.

And again, this won't be on the exam, but I just had to give Lewis his due.

OK, Lewis acids and bases are all about the electrons.

And then the other thing I didn't get to do on Monday was my Why This Matters, and so I want to do that.

Now hair is very much affected by the softness of water.

But instead of me showing you lots of pictures of hair that I found randomly on the internet, googling soft water, hard water, different forms of water, hair, I'm showing you pipes, because that's much more actually relevant in terms of like, for example, whether you can get water into your house at all.

All right?

And this is a real problem.

If you have hard water what it means is you've got minerals in the water.

Right?

Things like magnesium and calcium ions are in the water.

And what happens is, if you run that through pipes, they tend to react and form and deposit.

And you get these deposits of very, very hard mineral deposits around the edges that eventually look like this.

That's not a good thing.

And so you need to soften the water, and that's something you may have heard of.

But now you really know how to think about it, because you can think about it in terms of all of the things that you've learned.

And just as an example, if one of those minerals that's a problem is calcium-- oh, it is, right?

Magnesium is another one that can cause this in pipes.

You've got to somehow take it out of the water or at least make it into a form that makes it like insoluble, so it'll just flow, and it won't have a chance to come around and deposit on the edge there of the pipe.

And so what do you do?

Well, you add, for example-- oh, we've done this before.

Right?

What if I add soda, something called soda ash?

Oh, we know what that is.

That's Na_2CO_3, and that will give me some ions.

It'll give me some Na pluses, and it'll give me some CO3 2 minuses, and those are in aqueous.

Now, this is all part of the stuff that we've been talking about.

You're dissociating this to get ions in solution, but why do I want these ions?

That's a water softener.

Why?

Because now you can see it.

Right?

Because this one here, this one here is going to remove the calcium.

So if I've got these calcium, these minerals, in the water making it hard water which leads to that and wreaks havoc on your hair, then you get a little of this in there, and you're going to react with the calcium.

Why?

It's because of what we already saw.

If I have this-- this is something we've already looked at-- if I have calcium 2 plus, and I have some bicarbonate in there, CO_3 minus, then we know that I can get precipitates, Ca-- this is just what we looked at in the goody bag, right-- plus CO_2 plus H_2O.

That's the same kind of reaction that we looked at already.

We have calcium carbonate, calcium carbonate.

Why?

Well, because this is going to give me these.

This is a source for those which then eats up some calcium.

And you think, well, now this can take the calcium ions out, so that it runs through.

That's what you want to do here.

That's how you soften water.

Well, you can add lime which gives me a source of OH minus, and that takes out the magnesium.

And these are ways to change the chemistry of water, so that you don't have as many ions, mineral, these calcium and magnesium ions floating around that cause problems.

So that was my Why This Matters, and now we turn to what I started with which is exam three.

Oh, look at that.

I look at that, and that's just happiness.

Look at all those topics-- X-rays XRD, defects, glasses, reaction rates, solubility, aqueous solutions, acids/bases.

It's all there.

It's all there, and it's all there in you, and if not, you've got two days.

So please, make it be there.

Let's go through this.

Let's go through this.

I'm going to go through this topic right there.

So I'm going to tell you the concepts that I want to make sure you know.

OK, so here's the first one.

So it's X-rays, and XRD.

So what do I want you to know?

Well, for example, I want you to know about how you have characteristic, characteristic, characteristic X-rays, and remember this?

This comes from those transitions.

Right?

So you get like the K and the L and the M. We say et cetera.

We never really did et cetera, but we've got a lot of K and L lines we looked at, alpha, beta, but there's also the continuous.

Right?

So this was in-- if you want-- this would be in the topic of X-ray generation, and there's that Bremsstrahlung word that means breaking.

Right?

So if you just want to look at this, you might have a curve that looks-- OK, so we had things like this.

Right?

Oh, I'm going to try to make it not look too bad, and there's another one, and so on.

And remember, so this would be like intensity, intensity, and this would be like maybe a lambda going that way or maybe energy going that way or frequency.

Right?

Those would be like the x-axis, and these are those lines.

Those are the lines, and they come from the transitions that you get from like the K level to the L level to the M level.

Right?

Remember, if you get the energy high enough of an incident electron onto a target, metal, then you can knock out electrons from that 1s shell.

And then something cascades down, and that emits these lines here.

So that'd be like K alpha, K alpha, K beta, et cetera.

But then, you also, even at lower energies, even if you don't have enough energy to knock out a 1s electron, you still can slow an electron down as it goes through a metal atom.

And that's where you get this continuous spectrum and that limit of how much of that type of X-ray you get.

And it just depends on the incident, on the voltage, on the maximum incident electron you fire at it.

So that's those first two topics.

OK?

Well, oh, we also did X-ray diffraction.

Oh, that's fun, diffraction.

OK, and this involves understanding Bragg, the Bragg condition, and also selection rules.

So let's just take a look at an example of the diffraction and selection rules.

OK?

So what would I want?

So these are like the kind of concepts that I want you to know about.

How might it play out?

So like, OK, so here's like an example of a spectrum.

Now, that's an X-ray spectrum for MgFeO4, magnesium ferrite, and it's a kind of steel.

And you put it in, you make a powder of it, and and you throw some X-rays on it.

Oh no, you throw just one type of X-ray on it.

All right?

So for these X-ray spectra, what happened?

I threw some K alpha on it, I showed right there, you got to say what you got.

All right?

You've got to know at least the source of X-rays has this wavelength.

Good.

And if I have that spectrum, and say, what's the lattice constant?

What's the structure?

I can get that.

How would I get that?

How would I get that?

So I would take this spectrum, and notice something is very much pointed out to me, a peak and a number, 35.5.

Right?

That's the 2 theta value for the 311 peak.

Well, I think I'll take that as a hint.

Maybe I should think about that number, and OK, so let's see.

From Bragg, so from Bragg, you know that you got n lambda equals 2d sine theta, and remember that had to do with constructive and destructive interference of waves, the waves being the X-rays.

And then we said, well, n is 1 in our class, so that's just 1 in 3,091.

It doesn't have to be.

You could have interference off of two planes down, three planes down, but in this class, we're just doing the two planes next to each other.

So n is 1.

OK?

Now, I'll take that angle, and I'll round it to 18 degrees.

So I'm going to say for theta equals 18 degrees, then-- oh, wait, why is it 18?

Because that's 2 theta.

Right?

Because remember, we take spectra in 2 theta, but the theta in Bragg is 1 theta.

OK, that wasn't too hard.

But now, I've got, let's see, sine theta is around 0.3, and oh, I got lambda.

Lambda equals 1.54 nanometers, and so I can actually plug in now.

I didn't even need the peak.

I'm just plugging in the Bragg condition, and I've got d.

d equals 2.52 Angstroms, so I'm done.

No.

No, I'm not done, because the question says, what's the lattice constant?

What's the lattice constant?

This d, I didn't say-- I did something very bad-- I didn't say what d-- d is in hkl.

That's what an XRD does.

XRD, that's a different than diffraction, but the d, in Bragg, is the distance between the mirror planes that are scattering.

All right?

And so that's some cuts in the crystal.

That's some hkl, and we know from that era that there is an equation for cubic crystals that gives us hkl which is a divided by the square root of h squared plus k squared plus l squared.

And that is the lattice constant of the crystal, and that would be the distance between any planes, any set of planes, in the crystal, and that's what we need.

Now, I can use that, combine it with the d, and I can get that the lattice constant is 8.38 Angstroms.

Good.

But the second question is-- you don't even need to do any math to answer that-- what is the lattice structure?

Here, we simply go to our selection rules, and we know from before if they're all even or all odd-- so here we have, let's see, all these peaks-- 220, 311, 400.

You can see, they're always all even, or they're always all odd.

From our selection rules, what kind of crystal is that?

It's got to be FCC.

All right?

It's got to be FCC.

So that's the answer to that question, just from looking at the peaks that you get and matching them with the selection rules that you know, that we've already talked about.

You could also, if you didn't have the planes-- so this is an example, where you're given all these planes.

You're given all these hkls, but what if instead it's like the one we had in class?

We went through this in class.

Here, I'm not given the planes.

I'm given instead just two theta values.

Well now, you've got to go and use the procedure of XRD, and I'm not going to do that again.

We've already done that pretty thoroughly, but that's what you would have to do here, where you create your columns.

Remember the columns?

All right?

So you would simply make your columns, you make your sign, your thetas, your 2 theta theta sine squared thetas.

And then you normalize, you take the lowest one, and you normalize to 1.

Clear fractions, and then find the hkl combinations, and that's how you would go from this to getting, for example, the planes.

So those are some examples of things I want you to be able to do with X-rays and XRD.

Let's move on.

Let's go to the next topic.

Let's do defects.

How about this, defects, because as we said, it's just like life, crystals, defects are what make them interesting.

It's the same.

Everything, it's all about defects, imperfections, those are the interesting and exciting things, so we've got to know about them in chemistry, of course.

So we've talked about a bunch of different kinds of defects.

The first one that we talked about were vacancies, vacancies, and these could be interstitial.

These fall into the category of point defects, point defects, right?

You could also have interstitial point defects, interstitial or substitutional.

Those are the different kinds of defects we've talked about for point defects.

Also, by the way, if it's an ionic point defect, ionic point defect, you need to make sure you have charge neutrality, charge neutrality, plus two types.

There's Frenkel, and there's Schottky.

You can think about Schottky, you remove, but you've got to remove them in a way that's charge-balanced.

Right?

So in Schottky, you remove.

In an ionic crystal, you've got to keep charge.

That's a new thing you've got to keep track of.

And so if we had-- I'll go to this picture.

Well, you should know this picture.

This is an important picture.

We showed it a lot-- vacancy, interstitial, self-interstitial, substitutional.

And then if it's ionic, now all of a sudden, you've got charges in there, and so you've just got to make sure things remain neutral.

Right?

In Schottky, you would remove atoms to balance the charge, and in Frenkel, you move an atom.

Schottky remove, Frenkel move.

That just occurred to me, that that's the same word with just re in front of it.

That's exciting.

Well, so if I were to ask you, for example, if I were to ask you this.

You diffuse chromium into one side of the ionic crystal alumina to make it red and titanium on the other.

Would you expect oxygen vacancies, aluminum vacancies, or no vacancies in each case?

Just follow the charge, follow the charge.

So for example, if I had alumina, O3.

Well, if I were Lewis, if I were Lewis I would see this as 2Al3 plus.

Right?

This is how he saw ionic bonds.

Ah, I want to make sure this is clear.

I'm going to start over.

So I would have 2Al3 plus, and then I would have a 3O2 minus.

Remember, O likes to be 2 minus, and so if I were to introduce something like Cr2O3, well, this is 2Cr3 plus, so this is 2Cr3 plus, and 3O2 minus.

So if I substitute aluminum with chromium, then I'm charge-balanced.

Right?

I'm OK.

But if I substitute titanium, TiO2 is Ti4 plus and 2O2 minus, you know this just from the formula.

Because if oxygen is 2 minus, this thing's got to be neutral, and so that's Ti4 plus.

But now, if I put a Ti in there, and I get one in for an aluminum, I've knocked the charge by 1.

Right?

So this gives us an extra charge, and that means you've got to create vacancies, create aluminum vacancies.

It's the only way to do it.

So for every three titanium atoms that I put in, I've got to take an aluminum one out.

Right?

Otherwise, I'm not going to have charge balance, not going to have charge balance.

Right?

So that would be an example of playing with an ionic crystal, but remember, we also had stress-strain curves.

Because when we talked about line defects, we talked about how that's a way for metals and other materials to undergo deformation.

And then we said, well, how are we going to conceptualize these things happening, and we did it with the stress-strain curve and the mechanical response of materials.

So we learned about stress-strain curves and fracture points, fracture and plastic versus elastic regimes.

OK, I'll give an example in a sec.

OK?

And finally, the last thing we did with defects is we talked about their activation.

And so we know if something is thermally activated, as are point defects, vacancies are thermally activated, so are other types of point defects.

And we said that we need an Arrhenius relationship, and that requires knowledge of an activation energy for the defect to form.

So that was another really important concept that we covered.

Right?

So for example, here is like a defect formation energy question.

So let me go over here, stay with this side, where I've got some defects.

So one thing I want to make clear, the fraction of vacancies.

We talked about this.

We talked about an Arrhenius behavior, Arrhenius-like behavior, and the fraction of vacancies was the number of vacancies over the number of possible sites.

That makes a lot of sense.

Now, if it's Arrhenius, then this is some constant times e to the minus activation energy divided by KBT, where we use the Boltzmann constant if it's per atom.

Right?

So per vacancy, that activation energy would be per vacancy.

But when I first introduced this, I simply let a be 1, but a is a constant.

This is a constant, and it can be whatever.

It's a constant.

It's called the anthropic factor, and it's a constant related to as you would have in any Arrhenius-like behavior.

Right?

Remember how it's like a frequency factor, this is related to all sorts of complexities that we don't need to know about related to how vacancies form.

It's a constant that's in there, and I let it be 1, but I want to make sure we put it in explicitly.

This n is the number of possible sites.

Right?

So maybe it's the number of lattice sites in the crystal, number of possible sites.

But you might get this could be related to, for example, or to or from, things like the grams that you have of something or maybe the volume or the moles, et cetera.

Right?

So these are the kinds of problems we've done.

That gives you a sense of how many sites did you have.

Right?

It could be per centimeter cubed.

It could be per moles.

You go back and forth.

How much stuff do I have?

It's that kind of back and forth.

If I had a problem like this, then I know I can set it up, because I've got two temperatures.

You see the key here, the concentration of 10 to the cubed per centimeter cubed, so don't let that throw you off.

It's simply two equations, where a bunch of stuff cancels.

Right?

So the fraction of vacancies, fv1, would be 10 to the 3rd divided by fv2, and that's going to be 10 to the 3rd over 10 to the 16th, because the number of stuff cancels.

Right?

I didn't change that.

But this pre-factor cancels too.

You can put it there, A times e to the minus ea divided by KB times 300 Kelvin-- remember, so it was Kelvin-- divided by A times to the minus ea divided by KB times the other temperature, 900 Kelvin.

Right?

And so those cancel, the stuff related to n cancels, and I can just take the number of vacancies.

Right?

So that's what's nice about having something like this.

You have two temperatures and a whole bunch of stuff can cancel, and you can figure out then the activation energy which doesn't change.

The activation energy is simply the energy that you need, so you can now solve for ea, and I think you get something like 2.3 electron volts.

Remember that you could also have plotted it.

You'd know that in this equation, in the Arrhenius relationship, if you take the log, then you have the minus 1 over T relationship.

So remember that?

So if you take the T versus the log, then you're going to get that.

Right?

We like plots, when we think about Arrhenius, because it makes it easier.

We can make it linear, where the slope of this is minus ea, the slope, minus ea over KB, in this case.

Right?

So we talked about these are all kinds of things that we talked about.

And finally, getting to this stress-strain, what if we looked at this?

This is the stress-strain, so now we're here.

We just did this.

We talked about that.

We talked about this, so stress-strain.

So if you were to be given plots like this, you should know which one is most brittle, which one is the stiffest, the most resistant to changing elastically, and which one is the most ductile?

You can see that the stiffest one is going to be the one that's the most resistant to elastic deformation.

That's that linear part, that first part.

So there, it's going to be material A. It's going to be A, because it's got the highest slope.

Right?

OK.

How about the most brittle?

Well, that's the one that's going to break.

So it sort of looks like-- without deforming, without being able to undergo defamation, that's brittleness.

It's going to crack before doing anything.

So that's B, right?

That's B.

And then the most ductile will be the one that has the most plastic deformation, because that's what ductility is, so that's going to be C. OK?

So remember stress-strain curves.

You've got this elastic part here, that's linear, and then if it's a material-- not all materials have plastic defamation.

Some are going to break before they start deforming plastically, but if it can deform plastically, then it's going to have that yield point.

Right?

The yield stress, where then it starts becoming non-linear, and then finally, it fractures somewhere else.

OK?

So those are stress-strain curves.

OK, let's move on.

Now, oh, with the next topic-- oh boy, I'm going to run out of real estate-- we've got glasses, and here, the most important thing to know about is the curve.

That's how it all started.

Right?

I'm calling it The Curve.

Let's go all caps, because it's The Curve, and what I mean by The Curve is the volume per mole versus temperature.

We also talked about the effects of cooling rate, and we also talked about the effects of modifiers, and in particular how the modifier changes the viscosity because it cuts the pasta.

OK, so but the framing of these concepts was in The Curve, and that's this one.

Oh, I have a picture of it.

There it is.

OK, they did specific-- we do volume per mole is how we're looking at it in this class, so volume per mole versus temperature.

Now remember, if it's a crystal, where am I going to go?

Let's go here.

If it's a crystal, then you've got one melting point that only depends on the material.

It only depends on the material, so that melting point is Tm, and it's going to have a big volume change as it goes from liquid to crystal solid.

OK?

And so for example, I'm just basically replotting it, but you would have something like this and something like this and something like this, and that's your melting point.

This would be the liquid, and this would be the solid, and you know that, if it's going to undergo this big volume change.

Then, it's the melting point and it's a crystal.

But then we say, well, but if it can't find-- by crystal I mean in opposition to glass, which we know doesn't just mean your windows.

It means any amorphous material, meaning it's not crystalline.

It didn't find the lattice structure.

Remember those three reasons, the musical chairs?

Whatever you're trying to crystallize, atoms or molecules, they weren't able to find all the lattice sites, not even withstanding some defects here.

They simply couldn't do it, and so it's amorphous, and it's a glass.

And in that case, what happens is it super cools and then becomes a solid at something called the glass transition temperature.

Which unlike the crystal can have different values, and those values can depend on things like the cooling rate.

So if I cool it slower, if I cool it slower-- remember this is faster, faster, slower, and please, do not confuse time with this axis.

This is just temperature.

So we can use the same-- this is volume per mole-- we can use the same The Plot to think about modifiers as well.

Because it's not-- this is just one plot, one curve and another.

This happened to be cooled slower, so it was able to super cool more, before it locked in the disorder, and the other one's faster.

You could also imagine if you cut the pasta, you change the viscosity.

And so now you're changing something else about the glass using chemistry, and you're allowing it to find those lattice sites more easily.

You're allowing it to try to become crystalline, to try to close pack just a little bit more.

So you can also get this, by cutting the pasta you can get these kinds of changes.

So those are the things we talked about with glass.

Now, next, we talked about reactions.

OK.

What do we need to know about reactions, reaction rates?

So we want to know the order of some general reaction, like aA plus bB-- remember this-- goes to cC plus dD.

And we want to know the rate from-- basically, it's the mass conservation, so from the coefficients.

OK, so that would be, for example, like minus 1 over a, d(A), dt-- that's a rate-- equals minus 1 over b d(B), dt, et cetera.

Now, those come from the coefficients, but the rate law does not, the rate law does not.

So these are simply instantaneous rates, but now I say, no, I want a rate law that gives me the dependence on these concentrations at any time.

So the rate law would be, for example, like rate equals k times A to the m, B to the n.

Now, here's the thing.

These come from experiments.

Very important distinction, right?

Those come from experiments, and so you could get the rate with respect to A which would be-- I'm sorry.

The order with respect to A would be m, the order with respect to B would be n, and the overall order of the reaction is m plus n, the overall order.

And then, we had one more item here of conceptually what I want you to know about, which is that the rate also depends on temperature.

Sorry, the rate constant, rate constant depends on temperature.

So if I were to now say, well, OK, I want to know something about the order of a reaction, you might get a table like this, and we did this in class.

You might get a table just like this.

Here's a reaction.

It's W and X and Y, and it goes to Z.

Don't let the fact that you have three reactants throw you off.

You've got a certain number of reactants, they've got their coefficients, and they go to some product.

And now, you're given experimental data, so from this data, you can get the order of the reaction with respect to each one of these.

Right?

And that would then give you, of course, the overall order.

So let's see.

If we were to look at that data, then what would we get?

So what you want to do in these kinds of situations is, first of all, don't panic.

By the way, on an exam, in general, don't panic, and if you have a question, you can ask a question, but also show us what you know.

We will give you-- as you I hope have seen already-- we will give you as much credit as we can for sharing what you know.

You don't have to get everything right to get a lot of points.

Please share your knowledge.

So in this case, what would the knowledge be?

Well, it would be that I want to compare stuff, like trial 1 and 2.

And if I do that, you see, OK, trial 1, trial 2, then two of them stay constant, but W doubles.

OK?

So comparing 1 versus 2, you got W goes to 2 two times, but the rate is same, so you know the order is 0 with respect to W. But if I compare 1 versus 3, then you know that, let's see, x goes to 3x and the rate goes to 3x, and so the order is 1.

And then finally, for Y-- I will just jump to it-- the order is 2, and you can do that just by find one where only Y changes.

You don't have to necessarily find one where just one changes.

Right?

Because if you knew one is first order-- if you knew one, and then you had another one, and they both changed.

But maybe the rate didn't change, then you know they must have both the same order, if they change in opposite ways.

Right?

So you can get into this in different ways, just looking at these changes from one to another and thinking about what must happen in terms of the rate law, in terms of what you wrote out here.

But you could also ask questions like with reactions, OK, this is first order.

What's the dependence of the concentration over time as a function of the rate constant?

Well, that just goes back to our understanding of the integrated rate equation.

Right?

And so let's see, oh boy, now I need to find-- I'm going to go-- I hate to do this, XRD.

I hate to do this, but sometimes being first carries a consequence.

OK.

So in this case-- first of all, by the way, you look at reaction like that, you're like, well OK, from the coefficients and the mass balance stuff, you know that the change in oxygen, for example, with time, the instantaneous rate would equal minus the change in MO2 with time.

Well, that's not what the question asked.

The question says it's first order.

So that's enough, because this means that if I integrate the rate law then-- first of all, if it's first order-- then d of MO2 with respect to time must equal some constant times the concentration of MO2 to the 1, first order.

And so now, if I integrate this, I take this concentration over here, I put the dt over there.

You integrate it.

You've got all the integrated rate laws.

We've gone through this already.

You know that you get that the log-- oh, we do logs-- are this MO2 equals the log of some starting concentration minus Kt.

OK?

Why do we do that?

Because we like plotting things, linear things.

We love linear.

So remember, we did this.

We went from these integrated rate laws to plots and back and forth, and so that's also very important.

OK.

Now finally, so the last couple of things.

And I'm purposely giving these last ones a little less time, because they're the ones that we've seen very recently, and these are the ones that we haven't seen for almost a month.

Right?

Yeah, but you still gotta know about solubility, and so for solubility, remember what we did is we did equilibrium and Le Chatelier, and we did the equilibrium constants, the K's.

Like for example, Ksp is the solubility product, solubility product constant.

Right?

And then we also did ice tables, and then we talked about the common ion.

And so as an example, if I were to tell you, well, OK, I'm going to take BaCl2.

I might have done this one in class already.

If I add BaCl2 to a saturated solution of BaSO4, why does it cause precipitation?

Answer-- because of the common ion effect, but you could write these out.

So you write out your saturated solution, so you write out your BaSO4, and you see that BaSO4 solid will go to Ba2 plus in solution plus SO4 2 minus in solution.

And so the common ion effect tells you that if I now add something else that has something in common with one of these, that gives me an ion in common, then because of Le Chatelier, you're going to drive the reaction the other way.

That precipitates, because it forms a solid BaSO4.

So I've just done that.

Right?

I've given you BaCl2 which gives you a source of Ba2 plus, and how do you figure out if you were given amounts what happens, what the new equilibrium is?

You use ICE.

Right?

You use the ICE tables.

OK.

And then finally, we talked about acids and bases.

Oh, I really hate to erase defects, but here we go.

Defects are gone.

Arrhenius, I'm so sorry.

That was painful.

And the last topic here is acids and bases, and this is the most recent one, and so what do we have?

Well, got the acid equilibrium constant, the base.

We did water.

We did pH.

Oh, we did p anything.

Right?

p equals negative log of the thing, pKa, pKb.

OK, and then we did, like for example, the definitions, so Arrhenius versus Bronsted-Lowry definitions.

And so for example, if you're given a solution-- this is one, just a simple example of an acid-- and it's HOCN, and you're given the acid.

And you know the pH, so you're given that.

Then the pH from that information you can get that the concentration of H plus-- which is also a H3O plus-- is 1.7 times 10 to the minus 3 moles per liter.

That's from the pH, and if you have that, then you can go to the Ka definition, which is H plus concentration OCN minus divided by the acid HOCN concentration, and you've got it all.

Because if you're right the equilibrium equation, which is what Ka describes, the equilibrium of this acid dissociating into ions, dissociating into H plus and OCN minus, and so you can get Ka.

OK.

So what I hope is that this got us in the mood, that this got us all kind of on the right page with respect to these topics.

You've got two days.