

ITA Transcripts

Title: Chemistry Lab 4
Focus: Recitation
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Context: This videotape of a Chemistry recitation was made in September 1989 and is one that I have used repeatedly in my ITA classes. The Chinese TA was an award-winning teacher, one of the most interactive TAs I have observed. Throughout the transcript, one can see the ways in which he encourages student participation, not only having them read out the question in the textbook, asking them to help him plug in numbers as he works an equation, and calling on students for answers, but also in the way that he constantly questions students about the logic behind their answers. He attempts to push them beyond merely rote equation solving to understanding the underlying concepts. In this class period, the TA was reviewing for the first major test of the semester. He gives students a number of hints and pieces of helpful advice about studying for the test. The class occurred early in the semester and the TA did not yet know all the students names, but he expected participation from them during the class and called on individual students as well as addressing his questions to the class at large.

TA: Good afternoon I think we can start . still there should be some more coming in . I gonna pass this name list around so ah . put a date by your name on the appropriate column . okay? Put an date by your name in the appropriate column . I wrote down two important [3 sec] pieces of information here for you for [3 sec] next week's exam? . first is help session . it will be held ah from seven to nine pm . this Sunday night in room 181 Gilman . all right? so if you have any last minute things

1:00

you want to sort out or figure out . clear out of your mind before the exam do come . make good use of those two hours okay? there will be some TA's there help you . with your problems and ah I will be there particularly between eight and nine so you . if you want to talk to me you can come at eight to nine or you can talk to some other ta is fine . and then another thing here on some of the suggestions for you to prepare . for the exam Monday . right? . first thing . you should review the outline . given by Dr. Jacobson in lecture okay? he told us that he [2 sec] gave an outline at the end of each chapter

2:00

. now you should be responsible then for the equations that we give . in those outlines I think he mentioned some equations . maybe the first law and second law equations . so ah in other words you should somehow . Stick that into your mind and ah [2 sec] have that ready for your exam all right? And then the second thing you have to do is to go over the assigned problems once again not to memorize the answer . never never do that okay? but to understand actually how to approach to a similar problem . okay ah your test will most likely will be written in a format similar to what you have done in your homework .

3:00

so try to go over some of the homework problems . but the most important thing is to be able to reproduce the kind of ah methods or approach to solve that kind of problems all right? and ah . don't worry about these drawings . okay? like the plotting to to verify first or second order you know? eh because those things take so much time and you only have fifty minutes for your exam and ah ah I specifically asked Dr. Jacobson and he said that would probably take up too much of your time just do one problem of plotting, so you probably won't have any plotting but the basic concept is what you should know . why you draw a plot and what you should when you draw a plot okay? Read the key terms that's basically for the short answers

4:00

that will be in your test all right? so if you want to prepare for short answers it's a good idea for you to look up the key terms at the end of each chapter . now again you don't have to memorize them right? you should be able . to write them by your own words that's a better way to memorize . you know . if you can write by your own words [3 sec] alright so those are the two pieces of information for you for hopefully you can do well in your first exam are there are any questions . Yes .

S1: how many problems are going to be on the test?

T: on the exam?

S1: Because I was under the impression it was going to be more short answer than problems

T: I have no idea

S2: [unintelligible- said to S1]

S1: [unintelligible-responds to S2]

T: he say two problems in class

S: he said it would be two problems and short answer

T: well then it will be two problems then short answers [*students and TA laugh*]

5:00

[*S1 and S2 say something to each other*]

T: well the short answer could be many forms you know? the way I've been giving you the last quiz . some something like define some term that's one way . He could ask you in another format I may maybe later on I could give you some examples on that okay? but I think to go through the key terms probably help you a lot for the short answers yeah all right? anything else? about the test? Okay now come back to the homework . [*taps book*] any questions on any of the assigned homework problems . Chapter nineteen? . what about chapter nineteen? [4 sec]

6:00

ah basically I think the heavy portion of your exam will be on chapter the first few chapters and ah nineteen yes you will have to be responsible at least for the assigned problems you should know them alright? nineteen any questions on chapter nineteen? anything at all? if you don't have questions I have here for you . if you don't have I have for you . are you ready? Are you ready for my questions then if you have eh if you no questions of your own?=
S: [unintelligible]

T: hmmm?

S: [unintelligible]

T: oh yes why not?

S: but we have a test on Monday . that's not fair

T: well they ah it should be good you should be all ready for now for any quiz [TA laughs]

7:00

[S1 and S2 say something to each other]

T: okay let's ah okay I give you a break . give me some questions first then come on . give me some questions . maybe you'll hit some of those that will be on the quiz . come on 46 sec] what about problem . um [looks through book] what about problem twenty uh twenty nine [3 sec] twenty nine yeah . chapter nineteen right [2 sec] any problem with that one? Okay . you [points at student]. what formula do you use with that that one

S: um

T: [slight chuckle] huhokay why don't you read the question for us?

8:00

S:[reads question]

T: okay . so you are asked to calculate . [writes formula on board] delta g and kp at 298 k for the following reaction so I just picked the first one okay? Let's say the first one . a [writes on board 8 sec] okay? how many of you have done this problem . really . you have done . you don't come up with anything wrong with it?

9:00

S: delta g equals [unintelligible]

T: oh you use this [writes on board] are you telling me this? log kp or something okay that would be for calculating kp . Okay? we will use that later on alright? . just look at this equation . anything wrong with it?

S: [unintelligible]

T: yes what?

S: its not balanced

T: it's not balanced yeah something wrong in that book there . this question it's not balanced there's a typo there you know good . there shouldn't be a two there there shouldn't be a two there . it should be just like this okay? So you have done the homework you [unintelligible] on the spot then alright? that's a good good example

10:00

that ah the book could have something wrong in there and more important is the key . don't trust everything in that key okay? I find that there are several places that have mistakes and don't try to force yourself to accept what the key says you know? it could be a wrong that you force

yourself to to to accept that kind of wrong answer so if you have trouble with any questions in the homework or with the key you should bring it in and we can talk about it you know maybe you are correct the key is wrong alright . back to delta g . somebody help how to find delta g? [4 sec] Yes sir?

S: [unintelligible]

T: okay? the products? [*writes on board*] minus the reaction okay . may be better off to

11:00

say the sum okay the sum of all the products the sum of all the reactions now we don't have to worry about the coefficients here . ah what is it now?

S: multiply?

T: yeah you have to multiply by the coefficients okay? so I will put it this here something like that in somewhere on [*flips through book*] page? . ah this ah formula . where my chapter nineteen you can get this on like page six thirty five? okay six thirty seven . All right? refer k to that equation when you do this . so:0 what do we put in here then . so what do we put in here now . somebody help yes?

12:00

S: [unintelligible]

T: two times the G zero of H I . that's right? that's the product . G zero is the free energy of formation this is the change okay . that's the difference between the two alright and what else?

S: [unintelligible]

T: minus

S:[unintelligible]

T: h two? [*writes on board*]

S:[unintelligible]

T: and the G of zero of I two that's right that's exactly right now where do you get those informations?

S: appendix B=

T: =right you look up in appendix B now I think in the test or in the exam you are either given that appendix B or you will be given the necessary information . all right? you don't need to memorize that alright . can somebody read that out from appendix b for us? what do you use for H I=

13:00

S: one point three

T: one point three thank you? what else? What about

S: [*unintelligible*]

T: H2 is zero [*repeating and writing on board*]

S: negative point three seven

T: three seven for I2 [*writing on board*]. somebody tell me why this is zero . for H2

S: its at equilibrium

T: its at equilibrium?

S: I mean not at equilibrium its at the I don't know what the term is

T: Standard

S: standard yeah=

T: =state yeah right state yeah because the heat of I'm sorry because the free energy of formation are uh referenced to a standard condition . usually it's ah if it's a liquid it will be twenty five degrees Celsius one molar concentration . if its a gas it will be twenty five degrees one atmosphere pressure

13:00

and if it happens . that that things is existing naturally at that particular condition we arbitrarily give it a zero value . and then to make that a a reference for the rest now you can have I 2 . now why I 2 is not zero?

S: [unintelligible]

T: yeah cuz we are looking at a gas state you know? at room temperature what should I 2 be [2 sec]

S: a solid

A solid? or a liquid at twenty five degrees Celsius . so again yeah we got to . but even if you missed that you should be able to tell it from the table right? because the table give you zero . so this would be becomes very simple mathematics and uh you get what you get [writes on board]

14:00

seven . It's not that . sixteen? point seven . [2 sec] kilojoules okay? . don't forget the unit

S: Shouldn't this be negative over the sixteen?

T Oh I'm sorry yes negative thank you . Thank you . yeah who say that was negative . who point that out . Why what's that mean negative? Is there a meaning in that?

S: [unintelligible]

T: hmm . excuse me?

S: [unintelligible]

T: right it it means . it loses the free energy . Yeah . it's not exothermic in this case yeah . If you talk about delta H it's exothermic yes

S: spontaneous

T: right it also means spontaneous . I think that's the most important thing I want to get at there . actually this is a good test . for a reaction that's spontaneous . all right ? if a reaction is spontaneous . it should have a negative delta G . All right? [2 sec]

15:00

okay now . how to find k p? somebody help . well we already have that equation up there [points to equation written on board] so what you need to do now is to plug this results . right?

[writes on board] what is R . somebody . what is R . Yes sir?

S: eight point three oh two

T: eight point three one four something like that .

S: oh yeah, that's right

T: what is that called? Is there a name for that . gas constant right? gas constant . right? then you have a T what is T in this case

S: two ninety eight

T: two ninety eight? right . But always remember to use Kelvin

16:00

if it is given in Celsius in the test you should convert that . K_p is what you look for so now you have to write the equation to get K_p alright? . is there any question on this. so far . yes? .

S: isn't the [unintelligible]. the gas constant . isn't that like that in joules instead of kilojoules?

T: yes that will be in joules yes thank you for pointing that out that's very important because what we have here is kilojoules . so we actually have to put in a conversion factor somewhere here . right . we probably should convert this . into joules right? before we can use this equation . that's right it's a very good point.

17:00

try to remember that now . I almost missed that too thank you for that . make sure you do the conversion get the units right all right? so this this equation got something subtle in there right and you got to use the right R . and the R is eight point three [unintelligible] one point two . anything else? [2 sec] Okay somebody cite this for this problem but this one is actually from a more general equation . can somebody give me the more general equation? [3 sec] It start with ΔG ΔG equals to

S: [unintelligible]

T: something

S: [unintelligible]

T: excuse me?

S: [unintelligible]

T: ah:h okay? you are talking about this one

18:00

ah ah okay this a good this is also important but that's not what I'm . looking at . [acknowledges another student] yes

S: Δ [unintelligible] [*T writes formula on board as student talks*]

T: ΔG equals to ΔG

S: one

T: zero

S: yeah

T: plus two point three o [*S say the formula along with the TA*] three [unintelligible] $\log Q$ something like that . right? Oh sorry [*T corrects something written on board*] $\log Q$

T: now this is a more general equation than that one right? . when we write this equations what sort of assumptions we are making . [2 sec] we are a making a specific condition now . when we use this . what do we mean=

19:00

S: =pressure [unintelligible]

T: pressure ? temperature? constant . um [4 sec] yes in a way but . but the main thing is =

S: at equilibrium

T: at equilibrium right that's right . this is only true when it is at equilibrium . in other words what happens at equilibrium , which of these goes to zero?

S: ΔG =

T: = ΔG goes to zero . now this is a very important piece of information all right? . at equilibrium . there should be no change . of free energy . All right? ΔG means the change of

free energy . and it's equal to zero at equilibrium . so that's very important we have to bear that mind right? and with that . we we can then make this one

20:00

all right . to calculate the delta G zero . all right any questions? [2 sec] Good now somebody mentioned about this one . let's pick out one problem that will use that okay? ah [*flips through book*] let's try to . look at um . what about problem eighteen? [*reads problem out of book silently to himself* 3 sec] oh not eighteen eighteen is the reverse of the question ah twenty two . let's look at twenty two . let's look at twenty two . Ben can you read the question for us? Oh you don't have a book . can somebody read that for us?

21:00

we let the only [2 sec] lady here read that do that for us [S:unintelligible]

T: [*to another student*] well you're a lady too

S: pardon?

T: oh go ahead

S: from the values given for delta H and delta X um calculate the value of delta G initial [unintelligible] if the reaction is not spontaneous under static conditions at 298 K at what temperature does the reaction become spontaneous [*T erases board as student reads the problem*]

T: okay thank you that's ah that's um so in this case you want to find delta G . and what ah what other information given . let's say part b okay? we look at part b [*writes on board* 6 sec] all right? you are given

22:00

in this case delta H . 572 kilojoules and you are also given delta S . 179 KJ per K . and you are asked to find this . so what do we start where do we start

S: [unintelligible]

T: that's right you have to use that equation now delta g . delta H zero minus T delta S . in this case . you want to know what's delta g and you are given those two. What about the temperature . is it given anywhere? Is it given anywhere? . well its given in two ninety eight right? . even if it is not given .

23:00

you know it is two ninety eight because this is . standard condition . right? Standard condition is always two ninety eight so all you need now is to put the numbers in there [*writes on board*]

okay so you put . so you put 572 KJ and you put 298 K . And then you put 179 joules per K . all right? is that all? [2 sec] anything missing there? Yes?

S: [unintelligible]

T: yeah again you got to be careful with the units here right? So we have to either convert this to joules or kilojoules to joules so let's convert this to kilojoules this time so what do I put here?

S: one over a thousand=

T: =one over a thousand

24:00

[TA writes as the student talks] that's right so I have the joules down there and the kilojoules up here and that's what I end up . kilojoules right then I can add them . So that give the answer okay? that ah somebody got a calculator can do this real fast maybe? [5 sec] make sure you bring your calculators to the exam okay ? [5 sec] what do you get
S: [unintelligible]

25:00

T: five eighteen is the total is after subtraction . okay what about this? Well you can figure that okay . you can figure that out . save time . so that is your answer . so what do you conclude from here . is is this reaction spontaneous or not no . yeah . not a spontaneous reaction because delta G is . positive . now a short question could be something simple like this . what is the uh criteria for a spontaneous reaction . So what would you say?

S: [unintelligible]

T: right delta G of the equation is negative or negative delta g zero

26:00

so short answers could be something like that . ah now the next part of the question asks you . if you want to make this spontaneous . maybe you can do something . to to make that happen and you would suggest? what can you do? What can you do to make this . negative=

S: =raise the temperature

T: raise the temperature here right because this is negative so ah . now how high is the temperature . how high do we need in order to make this reaction spontaneous . how high . Can somebody tell me?

S: [unintelligible]

T: hmmm . excuse me?

S:[unintelligible]

solve when this is zero . ah when this is zero is ah equilibrium is not spontaneous . it should be less than zero . you want delta g less than zero

S: [unintelligible]

T: yeah right but in mathematics so what do we do now so in terms of mathematics what do we say we set up what would you set up . you want this to be some negative number . so what happens to those two numbers . Yes .

S: [unintelligible]

T: the subtraction must be less than zero so what does that tell you . how how what happen to the values of those two numbers . which one has to be bigger

27:00

T: t delta s has to be bigger . so you get an overall minus right . okay now we can set this I'm going to set this this is bigger than that . if this is bigger than that I'm going to get a negative number so now put the t you want to find and then put down 179 . I'm going to divide it by a thousand because that will give you kilojoules and that will be five seventy two so what you get is t must be bigger than five seventy two [*writing on board*]. as long as you are multiplying by a positive number . the sign doesn't change it's all mathematics you can check that that's all it is you multiply a positive number to both sides

28:00

the sign doesn't change . okay now if somebody quickly do me a favor what does this come out to=

S: [unintelligible]

T: three thousand one hundred something right ninety five K right . is that a common situation do you usually get that kind of temperature in nature? [1 sec] well there is one place in nature where you can get that kind of temperature it's the surface of the sun maybe . but now actually we have an instrument that can give you a temperature above five thousand K . we can get that really easy nowadays . all you need is a half a million dollars instrument all right? [*students laugh*] yeah and that's easy right? . okay so you see that it requires a really high temperature to do the job .

29:00

now today we have reviewed several equations we have reviewed this one right? . we reviewed the delta G obtained from the products and the reactions . and then we also reviewed the delta G with the K constant . those are the important equations . last week we were kind of rushed so we didn't go over the quiz I want to go over that with you because I find that there are some problems in some of you so why don't you take that piece of quiz out from last week and ah [*erases board*]

30:00

I made the question one up by myself I just ah . so [*writes on board*] ah as you can see there are some mistakes in there . part a . I strike that one completely out because its mainly my fault that I forgot to put something in there . part A I asked you to write an expression r in terms of x . now actually it's not just x it should be in terms of x and t and time okay? .all right now if this is given to you does that give you enough clue then to give you the correct answer? write an expression for r in terms of x and t

31:00

so what's that look like r equals to [*writes what students are saying*] delta x over delta t . to that's what I want but since I didn't include the t in there you think of all sorts of answers . so I just simply strike that out except . I honored those people that give me the correct answer so I think that one of you got twenty out of 19 or something like that so you got an extra point all right? . b write the rate law . so what do I want here . the rate law . what do I want

S: [unintelligible]

T: yeah what do I want here rate law . how how do you commonly express a rate law [2 sec] somebody?

32:00

someone? yes sir.

S: [unintelligible][*writes on board as student talks*] [T: x in this case x...a whatever...b yeah right]

T: so you want something like this . of course you want to know what is a and b in your answer so now what do you do . What do you get for a and b . Let's put down some numbers here okay? So you have that in the equation okay . you can look that up [*writes on board 6 sec*] okay so what do you now [2 sec]

33:00

so what is a? obviously one . right? . So what you do is take this one and take that one like this and compare the ratios right? now actually there are there is a simple way of doing this is by looking at this you can divide those . so it ends up you can either this divide by that [*points at equations on board*] or that divide by that . doesn't matter . so let's say . this divide by that so you end up one half . So one half a should equals to one half . very plain [*unintelligible*] one right? you can use this method . right if you have trouble you should try to use this method I think it's quite easy this a . look at a so a has to be a one .

34:00

what about b [2 sec] which sets of experiments do you choose

S: [*unintelligible*]

T: hmm?

S: two and three

T: two and three and so what do you get? You got one half right . again b this time equals . equals what . [2 sec] depends on how you divide it right? the way I write it . this divided by that become two two to the b equals to what

S: one eighth

T: right one eighth . so what is b?

S: negative three

T: right b is negative three .

35:00

now many of you give me b is 3 . some of you say b is one third . it shows me that you get the idea that 3 involved in there except that you are not ready for any negative numbers up there . so do do pay attention to that all right? you could have negative numbers you could have it could be a fraction now . how how do you get that as 3 [*taps equation on board*] by just looking at it your math is too good for this class [laughs 2 sec] is there a way you can do that let's say I can't tell it . some of your classmates cannot tell if right away by inspection=

S: =the negative tells you that it's reciprocal [*unintelligible*]

36:00

T: okay and that is one way of looking at it . because you see there is a reciprocal relationship here right? It's not two to eight . if this is an eight then this would be a three right but this is one eighth so it becomes a minus three that is one way . or you could actually make use of your calculator and try to do this . you could say log of q . bring the power down and take the log of this number . for the log of the other number . now all we need to do now is to punch that into your calculator and do a division . .you should get b . it should come out like this now okay? . that is one other way of solving it but I think on your test you will probably see something more uh uh by inspection

37:00

more you can just look at it and you can tell . do pay attention to things like you know . unexpected things so ah the correct answer for b therefore should be R equals k x y-3 . now part c what is the overall reaction rate . Somebody tell me . what is the overall reaction rate?

S: negative two=

T: negative two right you add those two numbers ah b? calculate the rate constant in b . how do you calculate the rate constant . well you dump the numbers back in there right? so for b you are to find k . the rate constant is k

38:00

so what you need to do is you pick up one of these right . and then solve it . so we have one point four equals to k . equals to [writes on board] point oh three eight power one and then a point five minus three . right? is it right? Yes . How many of you think this is right . show hands if you think this is correct put your hand up . wo:w . now you're used to me already. when I ask something like that there's supposed to be something wrong right? . okay who think this is correct nothing wrong with it . o:h now even those two [laughs] give up . Yes there is something wrong . somebody tell me what's wrong . yes?

S: [unintelligible]

39:00

T: right . don't forget this . a lot of time we because save that space on the table . we do that . if you look at your homework problems we do that too you know sometimes so don't forget those small things here . You know? so you shouldn't put one point four you should put ten to the minus five that makes a whole lot different in your answer okay? As a matter of fact, some of you did that you know? you just simply forget to put in the minus five . so you should get the k from here . one last things . just to jump a little ahead . the last problem . question one asks you what is the rate of appearance of [] alright? so what I'm really getting at is a ratio

40:00

all right between the two different rates . I want to put something on the board and I want you to fill in the blank for me ok? . just to save time . I'm going to say [writes on board] I want to put some kind of numbers here so that all of these will be equal all right? so what do I put here . what do I put for this one?

S: three halves

T: what is it now . three? three halves? . are you sure? okay? three halves or two thirds . all right . I give you a choice again multiple choice. how many of you think it's three halves . How many of you think it's two thirds [2 sec] only one? sometimes the majority doesn't win. Okay I'll tell you . in this case the majority is wrong . I don't think it's three halves . what makes you think it's three halves

S: for every two . there's three Y

T: yeah because you look at it this is the three here it goes with the Y so you bring the two across . it becomes three halves right? . just . now there are two ways of doing this . so your answer is this you are saying this okay? if this is true can you tell which one is bigger? in terms of number

41:00

which one is bigger . is this one a bigger number or this one is bigger number

S: the second one

T: this one is bigger number? are you sure? So you are saying that ten times three halves equals to eight?

S: there's a negative there

T: uh that is also negative . the negative . Now don't confuse yourself with the negative . the negative only means it's disappearing . it really has nothing to . you know don't confuse yourself with the mathematics with the negative . the negative is more a sign here telling you that this is being disappeared when the reaction goes . and the positive means that it appears . okay . there are two ways of solving this problem okay? One way is asking yourself which one disappear faster X or Y . just tell me which one disappear faster

S: Y

T: Y disappear faster

42:00

right? so Y must the rate of Y must be quicker than the rate of X . all right? so the rate of Y must be quicker than rate of X . so if I want to multiply a number here to make them equal . this number has to be smaller than one . if this is quicker than that I have to multiply a number smaller than one to make them equal . So it has to be two thirds . if three halves is the other way around that means this is bigger than that one . Now that's a one way of looking at it . now that requires some logical thinking . but in exam probably you got so so tense up . you know . you don't think clearly . so let me teach you another mathematical way you know . it's just simple mathematics . if you put down X and Y here and two and three here . if I want to put them equals then what do I do . in mathematics

S: two X equals three Y

T: two X equals to three Y . you multiply like that? . no you never multiply like that . you always cross multiply . we call it cross multiplications . if the ratio is like this . X to Y is two to three . if I want to put an equals between them . I have to cross multiply . I have to say that 3 x equals two y . all right? so x is two half y uh two third Y . that's exactly this answer here Okay? so you always cross multiply all right? when you have two ratios you cross multiply them to make them equal

S: how do you know that X disappears faster than Y

T: how do I know? Okay simply by looking at the ratio here

43:00

here it tells me that when I lost two X at the same time I lost three Y so Y must be losing faster than X Okay?

S: [unintelligible]

T: the con . ah the concentration? no it doesn't it doesn't work that way . you can look at it from the equation now just to go to make things faster so what what what else do I put here . What else do I put .

S: two thirds?

T: also two thirds . what about here . Huh?

S: two

T: two . Yeah . Right that's a two there . Okay . So that's the way to compare . Now what about it . Can I compare those two? If I want to write the rate of B in terms of uh Y

44:00

ah can I write tha?t so I can write like this what do I put here? Yes?

S: one third

T: one third all right . exactly . one third . if you cannot see that try the mathematics again Y and B that's a three and a one there so cross multiply . y equals to three B so if I want to set B equals to some Y I have to say B equal to one third of Y. now make sure you have this clearly from your mind because its quite important I think uh on your next exam you need to know this all right so I particularly want to go this go back with you . now I have the question ready here for you so you can pick that up . we are running out of time so I will do this I will give you this quiz as a practice at home . you can get ready yourself ready for the exam . it will be graded so don't don't you know if you have any you can stay and ask me or ask Dr. Jacobson for help