[SQUEAKING]

[RUSTLING]

[CLICKING]

SARAH HEWETT: All right, let's get started. And if anybody else shows up, then that'll be fine. So today, we are going to talk about how to write a lab report, which is a pretty important part of this course, since it's going to determine a good portion of your grade. And in general, it's good to know how to communicate the science that you do, whether it's in this class or in your research, or in any other context, really.

So I wanted to start just by thinking about these two questions, which is why is it important to write up your results, and then how should you write a lab report? And to help get us thinking about these questions, I printed out on this handout that has a good chunk of text on it. The top part is Ira Remsen's account of his experiment with copper and nitric acid. If you have not read it before, it's a pretty good read. So if you could skim that.

And then at the bottom, there is a shorter description of the same experiment in a way that you may find it written either in a lab report or in a scientific paper if you were going to publish these results. So if you guys want to give those a quick skim through, and then we'll use those to sort of talk about these topics of how do you communicate your science.

And if you've never seen this experiment done before, I have a little bit of video to show what happens when you put nitric acid on a penny. So you can have an even more vivid visual of what Ira Remsen was going through when he decided to pick this up and throw it out a window.

NARRATOR: A few drops of nitric acid are placed on an older copper penny.

SARAH HEWETT: And it goes for a while. So that should give you a little bit of an idea of the situation that he was in. And so having had a chance to skim these two things, does anyone have any answers to these questions about why is it important to write up your results, or how should you communicate your results to other people? Yeah.

AUDIENCE: So it's, like, not ambiguous, so people know what to expect or they know how to handle the situation. [INAUDIBLE] oh, let's see what happens [INAUDIBLE]

SARAH HEWETT: Yeah, using really clear language, so that people know what is going to happen. Like he said, the language acts upon is very vague. And it led to this experiment happening where Ira Remsen burned his hands on some nitric acid. So instead of acts upon, saying things like-- what else could you say instead? What are better words you could use to warn people of what's going to happen? Yeah.

AUDIENCE: Corrosive.

SARAH HEWETT: Yeah, corrosive. Those things that Scott talked about in his safety lecture. So say some of the general terms that we use to describe chemicals. It's corrosive, it will burn, creates toxic gases, is carcinogenic, things like that. What other guidelines should there be for how you want your results written up? Yeah.

AUDIENCE: Indicate amounts, because of the [INAUDIBLE]

SARAH HEWETT: Yeah, yeah, definitely. You want to communicate how much you used. So in that first experiment, he said I put some nitric acid on a penny.

So you don't know what scale that was on or what scale it can be safely done at. So using exact quantities, so that if somebody is going to redo the experiment, they would know exactly how much you used and what they should expect. In terms of the length of these two pieces of writing, which one is easier to read?

AUDIENCE: [INAUDIBLE]

SARAH HEWETT: The bottom one so being clear and concise, using objective, short sentences, so that people can follow what you're writing. And they don't have to read this whole, huge chunk of text in order to get the gist of what's going on. So those are some things to keep in mind while writing up your lab report.

There's a picture of Ira Remsen. He was a chemist in the 1800s. He was born in 1846. And he became the president of Johns Hopkins University, and also is well-known for discovering the sweetener saccharin, which he also discovered by tasting it on his hands as a result of some more poor lab technique. I mean, he became pretty famous. But don't follow his lead necessarily in that way.

So a good lab report starts before the lab even begins. And so here are some things that you should be keeping in mind before you even come into the lab to help set you up to be able to do the experiment successfully, and to be able to have the data that you need to write a lab report. So you want to plan your procedures ahead of time, things that can influence your results, what quantities you need to measure, and what data and results you'll need to collect, so that you can have all of this in your notebook, so that when you go to write up your report you have all of the information that you need.

It's very hard to go back into the lab and write something down that you forgot after you're in your dorm room at 10:00 PM the night before the lab's due, going, oh no. How much did this weigh? So you want to plan out ahead of time what you're going to need to collect.

There are a bunch of parts to the lab report. And this looks slightly overwhelming, but it's actually there to help you organize your thoughts and present things in a format that other people can recognize. So if you've ever written a report for another course, or if you've read scientific articles in the literature, these titles may seem pretty familiar to you.

You guys have written reports for other classes before, yes? Read articles, most of you, maybe? OK, so we're going to go through these parts of the lab report, and talk about in detail what belongs in each section. And we're going to try to do that in the context of the ferrocene experiment to help you guys plan out your report for the one you're going to have to write starting next week. Hopefully, you've already started the little pieces of it.

So the first thing is the title. That's usually pretty boring. Keep it straight to the point. Have something to do with what the experiment that you did is.

And then the first thing that you're going to write after the title is the abstract. And the abstract that you guys are probably pretty familiar with is very short. It's three to four sentences. Keep it in complete sentences, though.

And then you discuss the point of the experiment. You briefly tell what you did and what you found. You can talk about your results-- if you have any yields, melting points, easily digestible results that you can put at the end.

So for your ferrocene, you would say, I synthesized ferrocene this many grams, this was its melting point-- something like that. And the abstract is best written at the end of your report. So after you've done everything else, then you can go back and write the abstract, because the abstract is essentially just a short summary of everything else you've written. So if all the other stuff is there, then you can look at each section, take a sentence out of it, smush it all together, and then you have your abstract.

So then after your abstract, on the start in the guidelines for how to format this and how to write everything are in your lab manuals. So you should definitely look at those while you were preparing your lab report. And it'll tell you that, after the abstract that goes on your first page, the start of the second page of the lab report is going to be your introduction.

And the introduction should probably be about a page or two long give or take, depending on the experiment and how much you need to introduce ahead of time. And you're going to tell the reader what you plan to do and why they should care about it. Give any background that is necessary-- so any historic background, any scientific background, experiments that have come before this one that influenced your work.

Include balanced chemical equations of important reactions. This is very important. So if you're going to be doing some sort of chemical reaction, which in this lab we did-- we did two, then you should include the balanced chemical equation for the work that you're planning to do. And then also, any fundamental mathematical equations that you plan to use to analyze your data. In this case, we don't have so many in this lab. But in future labs, like the catalase lab when you're doing kinetics, you'll have a lot more mathematical equations that you're going to need to use and explain to your reader at the beginning, so that they know what's coming.

And then you want to discuss any important techniques and why you need to use them in the lab-- their relevance to the experiment that you are planning to do. So with this in mind, let's brainstorm what might go in the introduction of your ferrocene reports. So you can think about the ferrocene lecture from Tuesday, stuff you've done in the lab so far. Yeah.

AUDIENCE: Like, how it was discovered, and how it launched the transition metal chemistry.

SARAH HEWETT: Yeah. The discovery and history of ferrocene and other organometallic chemistry. Yeah.

AUDIENCE: Relevant uses of ferrocene.

SARAH HEWETT: Yeah, uses of ferrocene. You guys performed the acetylation of ferrocene. So why do we care that you can add different groups to the ferrocene rings?

It's a good thing to mention. So we've got some historic and scientific background. What else can we put in there?

AUDIENCE: Like, synthesis of ferrocene. So like, the equation's of the organic molecules.

SARAH HEWETT: Yeah.

AUDIENCE: And also the acetylation of ferrocene.

SARAH HEWETT: Yeah, chemical equations for ferrocene and acetylferrocene. We got our balanced chemical equations. Do we have any mathematical equations that we need? No? Now, what techniques might you talk about? Yeah.

AUDIENCE: [INAUDIBLE] sublimation.

SARAH HEWETT: Yeah, sublimation.

AUDIENCE: Inert atmosphere [INAUDIBLE]

SARAH HEWETT: Yeah, inert air-free technique. Yes. You want to talk about that and why we care about that in relation to what could happen to the different components of our ferrocene synthesis. What other techniques?

AUDIENCE: Thin layer chromatography.

SARAH HEWETT: Yeah, TLC. And?

AUDIENCE: Column.

SARAH HEWETT: And the column. Running out of room. Yeah, TLC and column chromatography. So how are you going to purify your products when you're done. Yes, anything else?

AUDIENCE: Filtration?

SARAH HEWETT: Yeah, we can talk about filtration, how you're going to isolate your products during the synthesis.

AUDIENCE: Measuring a melting point calibration [INAUDIBLE]

SARAH HEWETT: Yeah, melting point. Melting point and how you can use the melting point analysis. So what does the melting point tell you? What information are we getting from that? Why are we taking melting points? Yeah.

AUDIENCE: Purity.

SARAH HEWETT: It'll tell you the purity, yeah. So you can compare it to the literature values, and you can look at the width of the melting range to see how pure your compound is. So all of these things are good things that you can discuss in your introduction. And you don't need to go into crazy amounts of detail, but you want to give enough detail that the reader will know why those are important for your particular experiment. Good.

So a note on including equations in a lab report. We said that you need to include any mathematical or chemical equations that are going to be used in the introduction. And the way that you do this is you give each equation a number. And when you write it in your report, you'll write either the chemical equation or a mathematical equation.

And then over to the right in parentheses, you'll number them. And you'll number them in order. And you can either number them both, the chemical and the mathematical equations, sequentially. So any equation, no matter what kind it is, just go one, two, three all the way down.

Or if you want, you can separate and have one of the types of equations be in just regular numbers, and then the other one in Roman numerals. Both formats are acceptable. And if you have any questions about how to do any of the formatting things I'm going to talk to you about, it's all from the *ACS Style Guide.* So we have these books in the lab if you want to borrow one.

There's some information online as well, or you can talk to me or John or the TAs if you have questions and can't find anything. But that's where all of the information for how to format things from this presentation are coming from. So we're going to use ACS formatting for everything.

And then the important thing is that equations and anything else that you add, like tables and figures-- and we'll talk about those in a little bit, they can't stand on their own. You must reference them in the text. So you can't just throw an equation up here and not talk about it. You'll have to throw in a sentence that says, the reaction of copper nitric acid as shown in equation 1.

So the next part is procedures and observations. So this includes what you actually did in the lab. And the really important thing about this is that it has to match what is in your lab notebook.

So we already gave you an idealized version of the procedure-- an idea of how you're supposed to be doing it. But we want to know what actually happened when you did the experiment. So if you accidentally added twice as much cyclopentodiene as you were supposed to, write that in your procedure. Don't just re-copy what is in the lab notebook. Draw a diagram of any specialty glassware that you used.

So you don't need to tell us piece by piece how you assembled your glassware. You can just draw a picture and say, I set up a distillation as shown in figure 1. And that's all you need to do.

Then you need to give enough information for one of your classmates to recreate the procedure. So again, you don't need to go into excruciating detail about how you injected things out of a syringe. Assume that one of your classmates is reading this, and they have the same knowledge that you do. So if you say, I used a syringe to measure this, or a syringe was used, because you're not supposed to use pronouns, then that would be enough information for one of us to recreate the experiment.

Include all the information about a chemical with the correct precision. So when you're measuring-- and we'll talk about this next week in our lecture, about the different precision of glassware, you want to include all relevant significant figures. So if you're measuring something that has more than one decimal place, include all of the decimal places.

So 5.2 milliliters of 8 molar nitric acid was added, not just 5 milliliters of added in-- if there's any specific way that you added things-- like when you guys added your aliquots, you did 0.25 milliliters at a time, you want to include that so that people don't add it all at once-- something like that. Or if you add something drop-wise, make sure that's included.

And then you want to give brief observations about the color, texture, and state of matter of your product. So you can say, I formed 5 grams of a white powder-- something like that, just so that, again, when the reader's are doing the lab, if they get a white powder, they want to know is this correct? Yes. And then if there are any safety concerns that are relevant or unusual, those can also go in your procedure and observation section.

So again, thinking about ferrocene, what are you going to write out the procedures of? What was the first thing that we did? I guess not even that you guys did.

Cracking the cyclopentodiene. So even though you guys didn't do that necessarily yourselves, that was an important part of the procedure. So you should include cracking the cyclopentodiene monomer.

AUDIENCE: I have a question.

SARAH HEWETT: Yeah.

AUDIENCE: Like with the examples where we draw the figures. So if we're drawing the chemical equation for the [INAUDIBLE] or drawing sublimation, do we just scan those into the lab report?

SARAH HEWETT: Yeah, so if you're going to be drawing any pictures of glassware or chemical equations, you can handwrite them and scan them in, and insert them as pictures into your lab report if that's easier. You can also use, for chemical equations especially, ChemDraw if you have access to that on a lab computer. Or there's some free versions, like MarvinSketch or ChemDoodle that you can find online that will give you the actual chemical structures that you can draw. And then you can just copy and paste those into your lab report.

And also, if you have ChemDraw, it has a glassware feature, where you can actually build different glassware setups. So you can build the distillation in there if you wanted do. But yeah, if you handwrite anything, like equations or pictures, you can scan those in and insert them as a picture.

So once you crack the Cp, what was the next big part of the procedure. First thing you made. We'll just call it synthesis of ferrocene-- of ferrocene.

So that would be, yeah, preparing the KOH. Preparing the iron chloride. Mixing them together. Shaking for who knows how long. And then your filtration and your isolation of the ferrocene.

Then the next thing was the synthesis of acetylferrocene, which some of you have done, and some of you will do today. And then what are we doing next week, in the last day? TLC. The important parts of that are running the TLC, and also choosing your solvent. So you want to make sure that you include both of those things in there.

And then what's the last thing we're going to do to purify the product? Column chromatography. So you'll have a bunch of different parts to the procedure for this lab, and for most of the labs that we do, especially since they're all multiple day labs. So you will have a lot of things to write about in the procedure. And so you want to keep those straight between your days.

And this is where your lab notebook and the notes that you take in the lab are going to be super-important and helpful in writing up what is happening in this section of the lab. The way that you write the whole lab report, but especially the procedure and observation section, is in the third-person passive voice. And this feels awkward for a lot of people at first. But instead of writing something like, I added 5 milliliters of nitric acid to the copper, it took this long, and I used 6.2 molar nitric acid and copper shavings, you would write it in the passive voice.

So, to a round bottom flask containing copper metal shavings was added 5 milliliters of nitric acid. The acid was added drop-wise over the course of 15 minutes. So there are no real actors in your lab report, except for the chemicals themselves.

So the chemical was added. By who, we don't care. You want to write in the passive voice.

And as an example, here is an article that was recently published in *JACS,* the *Journal of the American Chemical Society.* And you can see that this is how a procedural section is written for something that's going to be published. And one of the ways that you can do it-- you can either say in the sentences, like, 10 millimoles of 2,4-Dibromobutyryl chloride was added, or you can put the quantities in parentheses.

And in this case, they've chosen to do it in millimolar. In your lab report, you can use whatever quantity you measured. So if you measured it out in grams or milliliters, then that's what you should write in your report here. So that's an example of thing-- and something to note.

This didn't copy over well when I copied and pasted it. But you should definitely always make sure to superscript and subscript things as appropriate. Take the time and do it.

Yeah, that should go without saying. And one of the handouts that I gave you is also another example of a procedural section that has been written for a lab that you guys are not going to do. But it's another example of how the language can go and what it looks like when it's all written.

The next section is the results. So the results that you collected are going to be summarized in your results section, obviously. This is best done using tables or graphs if you can.

And this is not the place to analyze your data. So you don't want to be making any comments about it, saying, oh, I got this terrible yield of 22% or whatever. You really want to write that anywhere. But here, you're just presenting your results.

And then you will talk about them and what they mean in your discussion section. So what sort of results are you going to have for your ferrocene lab? And if you're going to put them in a table, what would our table look like? What are some good headings for the data that we will have from ferrocene?

AUDIENCE: Yield?

SARAH HEWETT: Yield. What units?

AUDIENCE: Grams?

SARAH HEWETT: Grams, sure. You can do grams, you can do milligrams, depending on how successful your synthesis was.

AUDIENCE: The first column should be, like, name?

SARAH HEWETT: Yeah, compound name. What other data can we talk about? All the way on the left.

AUDIENCE: Melting point.

SARAH HEWETT: Melting point, yeah. We'll throw that over here because it's small.

AUDIENCE: Molecular weight?

SARAH HEWETT: Molecular weight is not necessarily a result. So that would be something that you could include in your calculations when you're doing your theoretical yield calculation, something like that.

AUDIENCE: RFs.

SARAH HEWETT: RF. So you could include that in the table, but it may be smart to do a separate table for your RF values. But that definitely should be in there. Yeah.

AUDIENCE: I mean, you could include qualitative-- like, appearance, color.

SARAH HEWETT: Yeah. Color or appearance. So you can say it was light orange, dark orange, red. It was a powder, it was clumpy.

You got big, giant crystals of it-- whatever you got. What other information are we going to get? Related to yield, but what's another way to report yield?

AUDIENCE: Percent.

SARAH HEWETT: Percent yield, yeah. Excellent. So this would be a really great table to include in your ferrocene report with all of this data in it. Then what compounds are we going to have all of this information for?

AUDIENCE: Ferrocene.

SARAH HEWETT: Ferrocene. What kind of ferrocene?

AUDIENCE: [INAUDIBLE] crude ferrocene.

SARAH HEWETT: Crude ferrocene. What?

AUDIENCE: Purified.

SARAH HEWETT: Purified ferrocene. And?

AUDIENCE: Acetylferrocene.

SARAH HEWETT: Acetylferrocene, both crude and pure of that as well, pre and post column? You may not have all of this data for all these compounds, but you should be pretty close. And if you made any diacetylferrocene, you can put that in here, too, if you have enough to collect off of your column. And you'll find out next week if you enough of that. So yeah, those are your results.

Anything else that we're missing in terms of results for this lab? No, it looks pretty good. So if you wanted to insert a graph, which in this case, we don't really have any graphs necessarily that would go into your report. Yes?

AUDIENCE: I was wondering, where does the calibration come from?

SARAH HEWETT: What a great question. So you guys are making the calibration curve for your melting points. Where would you put that? We have one vote for calculations, one vote for appendix. Any thoughts?

So the things that get inserted into your results section, or your calculation section, are things that are very directly related to the goals of the lab. So if you need something to get whatever data that you care about-- so like in the catylase that you guys are going to be doing, you'll need to make graphs in order to get some rate constant data. So those graphs are super-important to the goal of the lab. Is a melting point calibration curve very important to our stated goal of this lab?

Not necessarily, but we need it in order to get the data that we care about. So that's something that can go in an appendix. And that would be an excellent spot for your melting point calibration curve, because just like anything else, if you put something in an appendix, you need to reference it in your lab. Because why would you include it anywhere if it doesn't matter for your lab? Maida?

AUDIENCE: So would the procedure for that go under procedures, or would we not include that?

SARAH HEWETT: The procedure for making the melting point calibration curve? That's a good question. Any thoughts? Put it in the appendix? Yeah, so again, that's something that can probably go in the appendix, because it's not super-important to your actual lab, but--

AUDIENCE: What about in the procedure section a list of every instrumentation we use, it is typically written in the synthesis section and then a list of different techniques. Can we put melting point determination in there? The machine's calibrated x, y, z.

SARAH HEWETT: Yes, that's also a good way to do it. So there's a couple of ways. So one would be to put the procedure in the appendix with the melting point calibration curve, and have a note in your procedure saying, see appendix for calibration curve and the procedure for generating it. Or when you are making your procedure section, you can have different sections for all of the different things that we did. So you would have sections of the procedure for the synthesis pieces, and then sections of the procedure for the techniques that you use.

And if you wanted to put a technique section for the melting point, then you could say melting point was determined this way, and then talk about how you made the calibration curve there. So there's a couple of ways to do it. As long as the information is there and referenced well, then that is acceptable

So if you are planning to insert a graph into your lab report, if you want to put the calibration curve or any other graph that you make throughout the semester into your lab report, you will insert it as a figure. And the way that you reference your figures is that you insert the figure or the graph or whatever it may be. And then you need to put a caption, which goes underneath the figure or the graph. And even though this is a graphic, it's labeled as figure 1. And then you number your figures 1, 2, 3, 4, or 5, as many as you have throughout your lab report.

And then you need some sort of description of what the figure is or what the graph is showing. And if it's a graph, then you need to make sure that the graph itself has a title and axes that are labeled with units. That goes without saying, and a legend if you need one. And then all of that information also gets reiterated in the caption.

The caption goes below the graph, which is important, because if you're going to insert a table, then the tables also get inserted. However, they are called tables, and the caption goes above the table. So you want to make sure when you have your table that you have all of your columns with headings and with appropriate units, and if you choose a unit that gives you a reasonable number of digits in your data.

And if something is getting out of hand, or if you have one measurement that's on a different scale than the others, use scientific notation. Or you can change the units for one column, but try to avoid that. So yeah, that's how you insert a table into your lab report.

Calculations-- so any time that you present data that was not directly measured, you need to show how it was calculated with appropriate units. So when the data is presented you should show an equation-- so the general form of the equation that you're using, a sample calculation with one set of your data, and then the final answer.

So if you're going to be doing a calculation repeatedly, like percent yield you're going to calculate percent yields for a whole bunch of different compounds. You just need to show the calculation once, and then just show the yield for the other three compounds that you're calculating it for. If there are lengthy calculations that you can do in an Excel spreadsheet, then you can include the Excel spreadsheet in an appendix, as long as in your report you have shown a sample calculation, and the equations that you're using to get all of the data in that Excel spreadsheet.

If you have a lot of calculations, you can include them in an appendix, as long as the data is well-labeled, and the sample calculations and equations have been shown. And again, all of this should be in your report somewhere. And then if you need to add more in an appendix, you can if your report's getting really long.

So the discussion-- this is where you finally get to talk about your data and what it means. So you will summarize your key results. Explain any difficulties or errors that led to erroneous results. So if you accidentally spilled some of your ferrocene solution, then you might talk about how that impacted your yield.

Offer suggestions to improve the experiment. So one of them could be maybe change the glassware that you're using if you're spilling a lot of chemicals. Or if you have an idea for different chemicals that we could use that would be better for the similar procedure, that would be a good time to talk about it, or adjustments to the length of time that you do something. Anything that you can think of that may improve the lab, this would be a nice spot to put it.

And then answer any questions that are posed in the lab manual. There are no questions in the lab manual for the ferrocene experiment. But you'll notice, if you look at the other labs throughout later in the semester, at the end of the lab, there are a set of discussion questions that relate to the procedures in the data that you will collect in the lab.

Do not just answer those questions in a list. A lot of them are numbered. Don't go through and make your discussion a bulleted or numbered list of answers to these questions, and don't just write one sentence after the other. That's very obviously just answers to the questions.

Your discussion section should flow nicely. This will be the longest section of your lab report, and it should be the one with the most thought put into it. So make it flow like a nice piece of writing.

Your TAs have to read these. They will appreciate them much more if you write with good grammar, and in a way that is intelligent and easy to follow. The answer should tell a coherent story throughout all of your discussion.

You can talk about sources of error that either came from you or random errors. And we'll talk about different types of error again next week. And then analyze your data in your errors.

So your calculations should have already been done. So do not include more calculations in your discussion. If you need to calculate something, go back and do it in the results section. But now you want to analyze the data and talk about what it means.

So you've reported your melting point. You've reported all of your yields. You've reported your RF values. What does it mean? What does it say about the success of the experiment?

Go back to your intro and say, hey, this is what I said I was going to do. Did I do it? And here is my data to explain why. So what can we talk about in the ferrocene discussion?

AUDIENCE: You get a sense how our percent yield isn't 100% because of errors, potentially because you didn't scrape all the ferrocene off of the culture dish, something like that?

SARAH HEWETT: Yeah. Yeah, so you can talk about your percent yield. It's not going to be 100%. And why might that be?

So different parts of the procedure, where did you lose product? Scraping it out of the round bottom, that was really hard. A lot of people were struggling to get all their acetylferrocene out of the round bottom yesterday, or scraping stuff off of the ferrocene when you sublimed, different pieces.

So you can go back again-- and this is a good spot when your notebook is going to help you a lot. If you take good notes in the lab, then you'll know, oh, yeah. That's where my product went. What else can we talk about?

AUDIENCE: After we do chromatography experiments we'll have a percentage of [INAUDIBLE] compounds and products.

SARAH HEWETT: Yeah, so after you do your TLC, you'll have one way to tell how pure your final mixture was. Did you still have ferrocene left when you thought you only had made acetylferrocene? So amounts of compounds left over. So you'll have that information from TLC.

And from your column, when you run your column, and you separate out your ferrocene and your acetylferrocene, you'll see how pure your product was. And you can talk about that and why you may not have had a completely pure product. What else? So what else is in our results chart that we have not discussed over here?

AUDIENCE: Melting ranges.

SARAH HEWETT: Melting point. And what does that tell us?

AUDIENCE: Same thing-- purity.

SARAH HEWETT: Same thing. You can get purity. So was your melting point too low or a wide range? What else can your melting point help you tell, to some extent?

In our case, we're using it to determine the identity of our products, because we don't have a lot of really spectroscopic ways of characterizing this product. So we are going to use it to identify your products. So you can tell us how pure your product was, and then compare it to the literature to see what the identity is.

And hopefully, your melting points of ferrocene and acetylferrocene are not the same. So you did, in fact have some evidence that you made a different compound. Anything else?

AUDIENCE: Maybe explain the color and appearance [INAUDIBLE]

SARAH HEWETT: Yeah. So you can, again, bring in some more of your results. Talk about the color and the appearance of things. So your ferrocene and your acetylferrocene are different colors. You can talk about why that might be, and how you can use that to identify your different compounds, especially on your TLC plate. So when you run your TLC, in your column, you'll be able to tell your compounds apart by color-- hopefully.

So yeah, and then again, if you had any suggestions for how to improve the procedure, those can also go in your discussion. If you were doing something and said, oh, this would be much better if we did it this way, or the sublimation, I found this cool trick for it, please tell us. And perhaps your genius idea will help us improve the lab for future semesters of students.

Then at the end, there's a conclusion. So you briefly summarize your results. This again is pretty similar to the abstract. It'll just be about a paragraph, maybe a little bit longer. A statement about whether you achieve the goals for the lab, then wrap up your discussion section and tie everything together.

Based on the abstract and the conclusion, if people read those two parts, they should have a generally pretty good idea about what happened in the lab. And if they want details, then they can read the rest of it. So conclusion-- again, wrap it all up. And then once you're done with all of this, go back and write your abstract, because now we have all of the information that needs to be neatly summarized in our abstract.

The very last thing that we need to talk about is references. So at the end of your report, you need to list all the sources that you use, but you also need to cite them in the text. And this should not be anything new. Do not use Wikipedia as a reference. You can cite the lab manual and the lectures that's a good idea.

And then there's also a handout that I gave you as to the format of how to cite different commonly-referenced sources, like books, articles, things like that. The *ACS Style Guide* also has information about how to cite any type of reference that you could ever need to cite. The in-text citations, there are three ways that you can do them. So if you're planning to cite this article in your lab report for some reason, then you would have a sentence.

And then the first way to do it is to include the author's name and then the year. You can also have a numbered list, and you superscript at the end of the sentence. Or the last way is to put the number of the reference in parentheses in italics at the end of the sentence. So up to you. All three ways are ACS-approved, whichever one you find the easiest or most familiar.

Appendices, we talked about this a little bit. It's a really good way to include relevant information that doesn't fit well into the body of the lab report, or maybe isn't the most important thing to the goal that you're trying to achieve. They don't count towards your page limit.

So if your lab report is getting long, and you can find things that would go in the appendix, that's not a bad thing. Don't put stuff that should be in the lab report in the appendix just for the sake of giving yourself extra space in the lab report. We will take points off for that.

Appendices have a number and a title. So appendix 1, and then you would say what's in appendix 1. Refer to that in the text of the report like anything else.

The format-- this is probably the most important thing that you guys care about. There's a 10 page limit, plus or minus 2 pages. So if yours is significantly shorter than 10 pages or significantly longer, then you will start to lose points. 10 pages should be the right amount of space to talk about all of the results in all of these labs. 1 and 1/2 line spacing in Word, one inch margins, 12 point Times New Roman font-- pretty standard stuff.

And then print it out. If we want an electronic version, we will request it. But most of the grading is done by hand. So we print it out, and we will give you back the hard copy the following week.

Ethics-- we've talked about this before already, but do your own work. Don't use a lab reports from prior students. Do not copy and paste anything that you did not write yourself.

Cite your sources, and do not go looking for similar reports on the internet. Some of the labs that we do here are similar to labs they do other places. Some of them are wildly different, so you won't find anything, anyway.

The TAs and instructors are here to help you succeed. So we're the ones who are grading your lab reports. So instead of going, looking up some random report from some other person at a different institution on the internet, come talk to us. We are the ones who know how we will be grading it, what we are looking for, and what you did specifically, so we can help you write your lab report the best way possible.

Here is the point breakdown for how most of the lab reports are graded. You can see that the discussion and the results portion are weighted more heavily than the rest of it. In the ester lab, you will be identifying an unknown. And so that's only for one lab, which is why the range is on here. It varies from lab to lab based on how much time and effort you're going to be putting into each of the sections.

Submission and grading-- so labs are due at the start of on the dates listed in the lab manual. There is a locked box outside of the stockroom in the lab, and that's where you will turn your lab in. Do not turn your lab into your mailbox or to my mailbox or to John's mailbox.

It goes into the lock box, then the TAs will collect them. They will grade them, and they will be returned one week from when you turned it in. So if have a Monday, Wednesday lab, if you turn your lab in on Monday, you will be graded the following Monday.

When you get it back on that following Monday, you have one week to dispute any points with your TA. So they'll give you back the lab report with their comments on it. And if you disagree with something, talk to you TA. Try to figure out why they graded it the way they did.

If you guys can resolve whatever point conflict you think that you're having, if the TA made a mistake, if you made a mistake and didn't realize it, figure it out. If you can't figure it out, then you can submit your report to me, and I will regrade the entire thing for either more or less points, depending on how well you wrote your lab report. So the last resort is giving it to me. And then grades will be posted on Stellar one week after the reports are returned, once any point disputes have been resolved, so that you'll be able to keep track of your scores.

Looking ahead, the final report is an oral report. It'll be a chalk talk, so no PowerPoints. You'll get a chalkboard and any handouts that you want to bring. It'll be you and your TAs, and you have to convince them that you understand the experiment and your data analysis.

So this will be for the final report of the semester. So it's a long ways off, but I wanted to give you a heads up. Just something to be thinking about.

It's the same information that's in a written report. It's just a different way of presenting it, and it should not be scary. You guys know what you're doing. And by that point, you'll definitely know what you're doing.

And the TAs are, obviously, here to help you guys with anything that you need. And there will be a couple of class lectures later in the semester, where the TAs will give you beautiful examples of good oral reports and bad oral reports. So if you want to come see your TA's acting skills, put that on your calendar. Does anyone have any questions about anything that we have talked about today? Yeah.

AUDIENCE: For the equations and figures that we draw [INAUDIBLE] lab report, or should we draw or scan them, and then hand in the scanned drawing?

SARAH HEWETT: You should scan them in and put them in your lab report, and print it out all together. Try not to write extra notes on the end afterwards, yeah. We want to have everything printed so that it doesn't get confused with the TAs notes and people adding things after they've been graded. Yeah.

AUDIENCE: So you talked about having office hours before having the labs turned in?

SARAH HEWETT: Yes.

AUDIENCE: Are those on Stellar?

SARAH HEWETT: They will be. So yeah, there will be office hours before every lab report is turned in. And the TAs are going to-- they'll be posted on Stellar next week once we schedule it with all the TAs. Great.