Big Picture Podcast - Episode03

Team-Based Learning

Tracy: Welcome to Chem 101. The big picture podcast with your hosts John and Tracy Suchocki.

John: We're here as your expert tutors helping you to learn the concepts of chemistry and to recognize how these remarkable concepts apply to modern living

Tracy: And of course there's a deeper story which is that the very process of learning chemistry holds many benefits including improved thinking skills and because we learn best when we learn together improve social skills too.

John: All of this we call the big picture. You can think of this podcast as your personal coach. We're here for your support as you journey into the big picture.

Tracy: At your service

John: is the Chem 101 Big Picture podcast. So glad to have you on board. Welcome to this episode of The Big Picture podcast. We're here today with the notable Brian Prichard. gotta let me say this. He is an overall guru when it comes to team based activities study of human performance. Brian has worked in the profit and non-profit sectors state governments and importantly with multiple colleges and universities in their organizational development. If you want people in your organization to be working together not only effectively but in a way that's enjoyable and meaningful to each member then that's where Brian steps in. An ardent Taiko player, guitar player, as well as our dear friend, Brian thank you so much for joining us for this big picture podcast. It's quite the honor.

Brian: Thanks for having me.

Tracy: Brian. It is so nice to see you here. I'm wondering if you could tell us about some of your work with teams with sports teams.

Brian: So I play games with sports teams and take them on adventures. The primary purpose of playing games with them. As a group is to get them to work and function together better. And then the individual work is to help with their mindsets during crucial points of contests.

John: Could you describe some activities

Brian: So the group games with them are basically usually them against some sort of task getting over a wall getting across a wire getting across a space with obviously restrictions where if they work together and communicate and there's leadership they'll be successful. And if they don't do that they won't.

Tracy: But why would a student want to work as a team if they're competing with their classmates. Why would that be beneficial.

Brian: Well. If they're set up to compete with their classmates they might not. There might be something not in it for them in terms of things like scoring on scored tests and curves and like that but. The reason why they wouldn't want to is that if they can practice the skill of team teaching and team learning they're going to go a lot further in the in the future in the workplace and in other endeavors as they go forward.

John: Brian if you were in front of 100 chemistry students and say they had an exam coming up soon. What advice would you give to them.

Brian: That they've got it. That there's really nothing to lose in there in the exam because if the if the exam is coming from the right place it's going to be a learning experience no matter what. And so it's just another page in a chapter of learning for them. If they can relax get themselves in a good place and just do as well as as they can. At that point they'll be good.

John: Brian what about that time when you're a student and you ask your instructor question. They may give you the answer that you just don't get it and you're kind of embarrassed tech actually so you just politely say thank you. Pretending it's all all now perfectly clear but it's not.

Brian: So one of the greatest drivers of for all of us is the notion of shame. We don't want to say that we don't know things. And so. It's going to be difficult to ask for help because that's one of the things that our culture teaches this is a sign of weakness and especially for men. Weakness leads to shame. So if they can't get it from the teacher they should be looking for all of their other classmates who may be able to put it into different words and get the notion across in a much more palatable way than the professor could.

John: So the classmates really are not your competitors

Brian: They shouldn't be there sometimes set up to be or there's sometimes a presumption that they are but they should be one of your greatest allies.

John: I see in classes sometimes a large lecture classes and I'll sit in the back and and the instructors giving a gosh a beautiful lecture I would say. And all the students just looking from behind what I see are their heads bobbing up and down up and down as they're looking to the instructor and then taking notes looking to the instructor taking notes and they're just not interacting with each other they're interacting with their new notebooks. And I wonder why are they all here now. My personal opinion is that lectures they're important that they have their place but human interaction is also important especially when it comes to learning. Shouldn't there be a balance can't there be a balance.

Brian: It's pretty clear that lecture is maybe a way to get across to transfer information from one pallet to another which could be the end. The instructors notes to the notes that the student takes but that doesn't mean that

John: Any

Brian: Anybody's

John: But

Brian: Really learned anything.

John: So but but by learning you're pointing out we talked about in a previous episode. We are not computers. Just download the information to us. Maybe it's a first step right but. Only a first step to true deeper learning

Brian: That's going to come much more from interacting with other people. It's built by relationships and by working with concepts and information with other people not just an attempted. If we can use the now pretty basic modern metaphor of a download of information

John: Provision.

Brian: That's not the way people work.

Tracy: So you come to school you come to campus not just for learning the content but really for human interaction as well. Right.

Brian: Yes and that I mean that that's going to increase learning. The more that students avail themselves of primary kinds of of experience the better. So

John: You mean by primary.

Brian: So most of the information that student is going to get in a lecture. For example about the experience of Anne Frank would be the professors interpretation of Anne Frank

John: World War

Brian: In World War 2 or for any famous person. But what students hunger for is not just the professor's interpretation of Anne Frank but let them read her diary. That's the primary information

John:

Brian: Is Anne Frank. What they want is the primary experience as much as possible and then interacting with the professor about how they interpret that together with questions not the professors interpretation now given to the student where the student is told. This is what they should conclude.

Tracy: So it's creating some space for people to find their voice and express what they're learning and experiencing.

John: So so the student takes your time out their voice so they're not passive members they're they're actively involved. So you're

Tracy: Being.

John: Saying.

Tracy: Actively involved and even those that have a stronger voice or stronger knowledge letting them sit back a little bit and inviting more people to participate and express maybe a different angle on the subject.

John: What if you're an introvert As you deal with that. You just want to stay home. You don't want to come to class and do all that interaction. You know I'll see you the first day of class. Use these to be really noisy students talking to each other. Now the first day of class all those students are looking down at their smartphones

Brian: Yes extroverts get. Their energy from interacting with a lot of people and large lecture halls and those situations are you know it gives a a nod to those extroverts What the. But the introvert doesn't want to be a hermit in a cave. What the introvert wants is a conversation maybe a cup of coffee with a couple of other students where it's just three people talking about the subject area rather than one hundred.

Tracy: Yeah I would say introverts have a voice too. It's not that they don't want to participate they just might need a little more space or a different environment.

John: Conducive for their different learning style. Yes.

Brian: So a lot of introverts are actually gregarious. They like to talk. They like to listen. It's just they don't want to do it with 50 people 30 seconds at a time. They what they want is a conversation with a couple of people or one person for a much longer period of time because they treasure depth. So that's that's where they're going to. That's what they're going to seek. And when they walk into a lecture hall under a time period and then walk out and don't have that structure then that's a problem for them that they need to solve so that they can learn better.

John: So it's almost counter-intuitive. With team based learning if you're introvert or your introvert side of yourself is coming out you might think oh you're not going to want to work with a team you're saying no no no no. Working with a team of say three other classmates is actually ideal for the introvert as a platform for for some serious learning

Tracy: I think it's ideal for everybody.

Brian: Yeah I do. And there's also it's pretty clear that you are starting to grasp information when you can form questions about it when you are simply reciting it. Somebody gives you a list of information that you're supposed to regurgitate on a test. All you've done is maybe fire a few short term memory neurons that are going to lose it in a couple of days just for the purpose of a test. If the only purpose of the test is that regurgitation of of a list but if you can ask a question about it something that means that you're starting to understand what it's all about. You've gotten enough base information to say this is what I think or this is what I don't understand. In order to make it information that they can actually maintain hold on to and use.

Tracy: So then how does playing games help somebody learn about themselves or learn about the material.

Brian: So I want to distinguish between my work with teams and some of what we've been talking about in terms of processing information a lot of what I'm working with with teams is about communication and trust and leadership which is not information. It's how do we relate. How do we behave in order to either make the the team perform better or the community be in relationship with each other better. That's I think a different focus. Then how does somebody process information how does somebody become a better learner. On an individual basis.

John: So you have teamwork on one hand. And the idea of processing information on the other. Well the two may be different but they go so very well together.

Tracy: Right.

John: Okay now I've said that's the big picture huh.

Tracy: Right. So in terms of the big picture we go to school so that we can learn the material. We want to learn the curriculum but also we're learning about ourselves and we're learning how to work as a team.

Brian: In an earlier portion of my life when I because I'm fairly chronologically gifted I'm

John: Getting information

Brian: Involved going to a library and understanding a card catalog so that you could find the book and find the information and that required a considerable amount of work before you found a list of stuff especially today where you can google search any information. The notion that you should be wasting your time your memory and your energy on just trying to store information that you don't need every moment at an instance let your let your brain be working on how it understands information and concepts and work with other people instead of trying to make it a memory computer that just doesn't work as well as technology does. Now.

John: I got a question about something I had said earlier a relative to the attributes the five attributes of a successful company.

Brian: So Peter sang a couple decades ago started studying organizations that he deemed to be that were very successful. And he tried to figure out OK what are they doing that sets them apart. And he came up with an assertion that there were basically five things that those groups shared. He called them learning organizations even though some of them were Fortune 500 businesses he was saying that they had to be a learning organization in order to make them successful. Those things are having a. A mission that's clear to everyone a mission or a vision a shared mental model of who they were and how or how they were conducting what they were trying to move forward. They needed people in the organization needed to do systems thinking. So even if they're just making a widget they needed to understand what their widget making how it fit in with a much bigger process. If I'm late with my widget what does that do to the production line. So having a concept of how your own work fits into a bigger system and how the bigger system affects your work that's systems thinking. And then two things that were very strong around how people learn and become masters. One is. Individual mastery that people were trying to get to be the best they could be at what they did. And at the same time that there was a focus on. Team teaching which of course these last two would be a great thing for our educational system to adapt is a combination of people realizing that they had a responsibility to teach and learn from each other and that each one of them. Was trying to become a master at what they needed to know themselves.

John: So no one Got this right. A shared mission for everybody within the organization. To a mental model of of how things are working within that company or organization. Let's say three systems thinking you aren't alone you are your cog within this machine and it's important to identify your role. Within that city so you can have a broad overview of where things are within the organization. In the last to my notes that see you said individual mastery that the

Brian: Yes.

John: Be the best you can be but understand you're not alone. Number five team mastery you're working together with others. So you're talking about the best practices for doing excellent work and like beyond college company if they're going to make it in that list you just gave you didn't say chemistry mathematics understand biology I didn't see any of that but what I'm seeing is is all human performance human interaction human communications.

Brian: Yes. And even in an academic 7 setting. In for example systems thinking about you understanding any any how any one thing affects somebody else. Well how does math affect chemistry. Can you just study

John: The.

Brian: Math without

John: Chemistry.

Brian: Well maybe. But can you study chemistry without math. Having some mathematics maybe in some parts of it but how the two interact together is what makes things move in any of these in in any of these five things. With a little bit of an exception being the individual mastery it's understanding along with another with a whole bunch of other people that's going to make it make it all work. And if the individual mastery.

John: Say, chemistry.

Brian: Is in fact helped by team teaching then it's obviously related as well.

John: So this is work from Peter Senge. You're saying

Brian: Yes I

John: Believe that it was

Brian: Written around 1990 from research that was done obviously just up to that and it continues to be a work that people lean on as they look at power organizations do well.

John: We will definitely put that in the show notes. Anything else Tracy.

Tracy: Thank you

John: Brian thank you so much for joining us. We look forward to you coming back to another episode of The Big Picture podcast.

Brian: Thank you and you're welcome.

John: Tracy. I think it's time to do the review

Tracy: All right let's jump in. OK. Let's dig in to do the review and look at the elements of Chapter 3.

John: Chapter Three is the elements of chemistry. It is where we really begin to dig into the heart of chemistry a jumping right in. We begin with Section three point one matter has physical and chemical properties. Tracy do you want to take a stab at what we mean by a physical property.

Tracy: Of physical property is by how something looks its physical attributes.

John: Some examples.

Tracy: Density.

John: Yeah. What it looks like. Basically those are physical attributes and as you describe those physical attributes. Technically we can say we're describing its physical properties. This is in contrast to a little bit more complicated idea of what we mean by chemical properties.

Tracy: This gets tricky.

John: Now the chemical property is its tendency to change into something else. Gold has a chemical property of not changing it to something else. It's inert. We would identify that as a chemical property of gold. It's a chemical property of gasoline. When you add oxygen and the spark to it to change into carbon dioxide and water plus the release of a lot of energy that's a chemical property of the gasoline to combust. It's a chemical property of iron to rust. When Iron is rusting what's happening there is the iron is reacting with oxygen in water moisture in the atmosphere to form a new compound iron oxide a new material is formed during a chemical change. So we just switched over from chemical property to chemical change. Tracy.

Tracy: Chemical property has to do with how it might react with another material.

John: You know. Let's go to the example of oxygen to ozone. Oxygen is gaseous material that we need to breathe to live. You'll know it as O What happens there is you have oxygen atoms that pair off with one another there couplets you've got two atoms per molecule two oxygen atoms per oxygen molecule and we do note that by the symbol O as the subscript that's an oxygen molecule you see someone breathing oxygen from a tank on the side of the tank it'll say they're breathing let's say molecular oxygen it has the physical property of being a gas at room temperature it also has a chemical property of helping with combustion and helping with respiration inside our bodies. Now oxygen it can react with oxygen to form a completely new material known as ozone.

Tracy: Oxygen can react with oxygen to form something else.

John: Yet it's really bizarre. So check this out. Say you have three oxygen molecules. That's three couplets right.

Tracy: So that six atoms six oxygen atoms.

John: Yes six oxygen atoms. That's three couplets are let's say three doublet

Tracy: Or three

John: Three O2's. Excellent. What can happen upon zapping it with a little bit of a little bit of energy. Is those doublet its will freak out they'll split up and they'll recombine into triplets. So if you've got six oxygen atoms you can have three doublet or you can have two triplets a triplet oxygen oxygen oxygen put together into one molecule. That's the ozone molecule

Tracy: So that ozone molecule has different chemical properties than an oxygen molecule.

John: It even has different physical properties so it'll have a different boiling point.

Tracy: A different density.

John: A different density. It'll also have different chemical properties. Turns out ozone is even more reactive than molecular oxygen Now here's the deal. When you take three oxygen molecules O2 changed them into two ozone molecules of three. You have moved to something that's completely different. O2 something you breathe to live. is a poison you start breathing. you won't live for very long. Wait stop the music. Here's the key idea how the atoms are connected makes all the difference in the world when they're connected as doublet. You have this when they're connected as triplets the very same atoms connected as triplets. You have that two completely different substances from the very same atoms

Tracy: Ozone has that funny smell after a rainstorm doesn't it.

John: If there's lightning a thunderstorm you're going to smell a tinge of ozone. If you're playing with an electrical train set you're going to smell a tinge of ozone it's a very pungent molecule it arises from electrical sparks it's the spark of the electricity that zaps O2 molecules into molecules. That's what we call a chemical change going from one material to another material. And so now we can backtrack to talk about what we mean by a chemical property. It is a chemical property of oxygen O2 to transform into 0 3 upon an electrical spark

Tracy: What are

John: Some other chemical properties. Let's see it's a chemical property of iron to rust. And what happens there is the iron is reacting with oxygen and moisture in the atmosphere to form this new material known as Iron oxide tr Rust is not iron. Iron is not rust. And so we talk about the chemical property as something we're talking about its propensity to transform into something else and backtrack to the gold. Gold being fairly inert. So you see it's chemical property is a tendency to not change to be inert

Tracy: What happens with copper. You have a really cool picture of a gargoyle.

John: Copper will react with the carbon dioxide in the atmosphere to form what's called Bettina.

Tracy: And is that the green

John: Substance

Tracy: That

John: Covers

Tracy: The

John: Any

Tracy: Copper form.

John: If you see like a copper roof when it's first put on it's just brilliant copper color then after a year or so it will turn to that greenish blue color. Tina. Yeah. So that's a chemical property of copper to react with carbon dioxide.

Tracy: So just to clarify copper is a different combination of the molecules than patina. Is that correct.

John: Copper is made of copper atoms. It's what we call an element patina is a compound of different elements and that makes a nice lead into Section three point two where we talk about what we mean by an element and that in turn sets the stage for talking about compounds. Okay here we go And an element is a material made out of only one type of atom. When we talk about an element we're typically talking about a macroscopic amount of it. What I mean by that macroscopic about it means it's enough you can hold in your hand maybe see through a microscope when you're dealing with an atom you're talking about something that's really really really really really really small you're not going to build to see one single atom Now the definition of an element is a microscopic material made out of only one type of atom. For example copper if you're given copper you're given a whole bunch of copper atoms. And we define copper as being an element because it is made of only one type of atom. You see

Tracy: Okay so copper element is a bunch of copper atoms.

John: Yeah if it's gold. Someone gives you gold 24 karat gold ring then that it consists of nothing but gold atoms. You talk about purity. What we mean by purity and a little bit the elements are listed in. Name it.

Tracy: The periodic table. Yeah.

John: Elements are indicated by the atomic symbol which is typically the first letter of the name of the Element hydrogen for example starts with the letter H. So the atomic symbol for hydrogen is H. Of course there are some exceptions. For example gold has the atomic symbol a U. That's actually from the Latin word for gold which is awesome. So there's actually a bit of history within the periodic table the elements that have been known for quite some time. Gold silver even copper you'll find that their atomic symbols don't quite match up with the modern name of that element

Tracy: It looks very complicated.

John: Well nature is very complicated. The periodic table we find is a remarkable organization of the elements found in nature And importantly the periodic table is not something you should memorize. I'll have students who come into class and they are fearful that a chemistry course means memorize the periodic table. And so you can imagine the anxiety that builds up coming into a chemistry course.

Tracy: Why would you want to bother to memorize that.

John: Yeah there's no need. I mean should you memorize a dictionary the periodic table is something you learn to use just like a dictionary. It's a reference. So here Look I have in my wallet right here. Here you go. What's this?

Tracy: The Periodic Table.

John: table. You never know when somebody is going to ask you what the symbol is for like something. The periodic table is something you need not memorize unless you're into memorizing. It's something that you learn to work with. Now do you memorize the dictionary. No. You have the dictionary available there for you to use on an ad needed basis. Don't be surprised if your instructor actually passes out a copy of the periodic table for you. You need to learn how to read the periodic table much like you need to learn how to read the dictionary. It's a reference both of them are a reference So let's take a quick look at the periodic table. Notice that there are 18 vertical columns each vertical column as is called a group or family of elements. And what we find is that elements above and below one another within the periodic table. They share similar chemical properties for example lithium sodium potassium and redeem all within the first group. First vertical column they are are metals soft metals they all blow up when you throw them in water. They all tend to lose one electron they all tend to this they all tend to do that there. They have similar properties both physical properties and chemical properties. So that's why we call them a family of elements.

Tracy: I think that's amazing that they all have similar properties.

John: Check this one out. Group Eleven

Tracy: Oh.

John: Copper silver and gold. Those are

Tracy:

John: All the coinage metals.

Tracy: Those metals are a in the same family.

John: Yeah same vertical column looking across the horizontal rows you have what's called an atomic period. What we see across a row a horizontal row is that the properties of the elements slowly change in a good example to talk about is the size of the atoms of the elements. Notice I said that the size of the atoms of the element the element might be a bar of gold. You want to know about the size of the atoms within that bar of gold or the size of the atoms within that bar of copper. So if you look across an atomic period you're going to find a gradual change in the properties of the atoms that a good one is the size starting say with the fourth period. The fourth horizontal row you have k which is for potassium and that's a fairly large atom as you move to the right to calcium the atom gets a little bit smaller scale idiom it gets even smaller and the atoms just get smaller and smaller as you move from left to right all the way over to Krypton and krypton would be the smallest of all the atoms within that horizontal row. Then suddenly after Krypton number 36 you move to Rubidium number 37 you might think that Rubidium be even smaller than Krypton. It's not suddenly Rub is a huge atom. It's like you've reset the typewriter cartridge and the old typewriters you do do do do do do do do do do do do do do do do do ding! playing well Perry Mason movies yeah. So everything starts over again and that's that's why Rubidum back to the beginning. Back to the first group. And sure enough you go to strontium left to right across the fifth period the atoms once again get smaller and smaller so that's what we call a periodic trend as there's a gradual change as you move from one side of the periodic table to the other.

Tracy: Okay. What about that. The two rows that pop out from the periodic table I always see that. Down below. Yeah.

John: Those are subsets within the periodic table. They ideally should be squeezed right in between numbers 57 and 72. Those are the lanthanides and between 89 and 1 0 4. Those are the acti If you move forward to another figure you'll see a stretched out periodic table and they're called the inner transition metals. The thing is that makes for a very wide periodic table and it just doesn't fit well on an eight and by 11 sheet of paper. Those are both subsets or perhaps we should say extensions of the sixth and seventh periods.

Tracy: Many of those elements don't even look familiar to me. Are these or are they more rare.

John: They're called the rare earth elements which is a bit of a misnomer because turns out they're fairly abundant within Earth's crust. The land the nights are particularly important. Somarium number sixty two Europ 63 those find great purpose in the fabrication of LCD. Most of those rare earth elements now are actually produced in China. They cornered the market on these rare earth elements. And an important one is neodymium which is used for powerful magnets and magnets are really important especially with something like a windmill. The stronger the magnets within that windmill the more power that's going to be produced. You know the applications of magnets. Now those powerful magnets in modern society today it's only going to get more so. So mines within the United States now are beginning to open up after suddenly we've realized wait a second. Other countries are cornering the market on these rare earth elements. We better start opening up our minds as well.

Tracy: The lanthanides Does that have anything to do with lithium batteries?

John: No. Lithium is

Tracy:

John:

Tracy:

John: Number Three reason lithium batteries are so awesome is because they're light. Remember we've talked about inertia.

Tracy: A.

John: If you want a bicycle that's not made out of lead you want it out of aluminum. Well if you have an electric car that electric cars are going to have batteries in it right. You want really heavy batteries or do you want really light batteries. So naturally you want a battery that doesn't waste too much doesn't have that much mass or inertia. So batteries based upon lithium the element lithium tend to be lighter simply because look at Lithium. Number three in the periodic table. One of the least massive elements we know of great applications for lithium. Each element itself has its own fascinating story. If you had a research paper to do you could just randomly point to an element within the periodic table and go go look up some of some of its history and where it comes from and what its uses are. Fascinating stuff

Tracy: You can learn how to find the information that you need. By the way the table is organized but you have to learn how to read it.

John: Yes. Look let's let's do an example. We understand that as you move from left to right the atoms get smaller. There's also the trend that as you move from the top to bottom the atoms get bigger. Put those two trends together and what you'll find is that the smallest atoms of the mall are toward the upper right side of the periodic table. The largest atoms of the mall are to the lower left of the periodic table. I could ask you this which might be larger a zinc atom number 30 or a platinum atom number 78.

Tracy: Ok. Based on what you just said the trend is that on the upper right of the periodic table the atoms are smaller and they get larger as they move toward the lower left. So zinc is to the upper right of platinum so platinum would be bigger.

John: So you're just looking at where the elements fall within the periodic table. And from that figuring out which atom is larger than the other

Tracy: Yeah. If that's so the periodic table is arranged then I can just look at it to see the size the

John: Sizes. So

Tracy: The

John: Relative

Tracy: Sizes.

John: So that platinum is going to be larger than zinc.

Tracy: Yes

John: You didn't memorize

Tracy: A

John: Whole list of atomic sizes and I could computer figure out You didn't memorize anything did you.

Tracy: No I just because I was able to look at it I could find the information I needed.

John: Bam there you are reading the periodic table. So how the elements are actually placed relative to one another is huge. It tells you so much about the property of the different elements. And let me emphasize the periodic table is nothing we invented. It's something we discovered. There's this natural rhyme and reason within nature as reflected within the periodic table. It's a wonder. So

Tracy: We

John: Have a question.

Tracy: Have a question.

John: Oh another question.

Tracy: Are there other elements that we know of that are not on the periodic table.

John: Hoo hoo. You look down to the bottom of the periodic table I think go goes up to 118 now. Those those really heavy elements are all very radioactive. They only exist for like fractions of a second and they do not occur in nature. They are produced within the laboratory.

Tracy: Cool and we're going to talk about radioactivity later on in the.

John: Yes. We'll be digging it into the atomic nucleus and talking about things such as radioactivity look to the act tonight elements you have famous ones like uranium and plutonium right. And so those are used for nuclear fission for power plants and also used with nuclear bombs. We'll get to talk about that when we talk about the atomic nucleus.

Tracy: Okay.

John: I'm ready to move on. All right.

Tracy: You ready.

John: Okay so

Tracy: Says.

John: That's a quick overview of the periodic table of beautiful thing. Section three point four elements can combine to form compounds. We've already got into this a little bit but the section provides a great example with sodium chloride sodium chloride is salt. Table salt you put it on your popcorn. It's sodium and chlorine. Turns out sodium is a metal. The periodic table most obvious is how it's organized by metals non metals and metal Most of the elements are actually metals. Those are the ones to the left side of the periodic table and only to the upper right. You have what are called the non metals look to the far far left and you have sodium number eleven and a that sodium is not the sodium that you put on your popcorn. The sodium and a number 11 is a metal it's a reactive metal that blows up when you throw it into water and it would certainly not be good if you were to put that on your tongue. The one of the products is actually sodium hydroxide which you just eat right through your tongue not good. You do not put sodium metal on your popcorn. There's the chlorine element number 17 chlorine atoms combine to form these doublet much like oxygen. Oxygen is seen as 0 2. Chlorine is seen as C L two chlorine is a very toxic gas. You inhale the chlorine. You're not going to live for very long. So sodium metal is very toxic chlorine gas is very toxic. You would not want either of them into your body. Take the sodium in the chlorine put them together. Chemical reaction atoms change partners you get a new arrangement of atoms to an ACL and you have a completely different material

Tracy: Table salt.

John: Sodium Chloride is not sodium sodium chloride it is not chlorine it's uniquely sodium chloride. That's the magic if you will of chemistry. And what I'm about to say here is real important. All right so stop the music stop stop stop stop. OK. Thank you. What I'm about to say here is really important how the atoms are combined makes all the difference in the world.

Tracy: Literally

John: Yeah. It's like letters of the alphabet you have just say 26 letters in the alphabet. How many ways can you combine them to make different words. Are there what only 26 pages in a dictionary. No. It's the different ways that those 26 letters can be combined. That gives rise to zillions of different words the periodic table is made out of nearly about a hundred different elements. Those are the fundamental ingredients of everything around us. So that means they're only about 100 different things around us. No it's the various combinations of those atoms those elements that gives rise to the great variety of materials around us. Now here's the thing when you take something like sodium put it together with chlorine you think you might come up with something that's kind of like sodium and kind of like chlorine. The answer is a resounding no.

Tracy: Now

John: You

Tracy: Come

John: Up with something that is uniquely different. That's the magic. That's the way it can teach you how to boil fume. That's the Harry Potter wizardry if you will that you come up with something that's completely different is so bizarre to the point of being who magical it's chemistry.

Tracy: Cool so that's a chemical change.

John: So go from sodium to chlorine is a chemical change because.

Tracy: You have a different chemical. What do you call it.

John: A compound

Tracy: It's not an element anymore.

John: Different arrangement of atoms means you have something that's completely different. You don't have what you had before. When you go from oxygen O2 to ozone It's the same oxygen atoms in the air. But how those oxygen atoms are combined makes all the difference in the world. You can take sodium chloride and eat it put it on your popcorn. Yum yum yum. Because it's something completely different different from the elements from which it is made. Section three point five. There is a system for naming compounds. Okay. Notice we just talked about sodium chloride. It comes from sodium in chlorine. Why did I not call it sodium chlorine. Why did I call it sodium chloride. I lied when I'm using theirs called nomenclature. It's how to name substances. It used to be in the olden days these compounds were given these wild names Blah blah, and blut blut you just had to memorize what those names were. They didn't describe what the material was made from here. In modern day chemistry what we have with this nomenclature a way of describing a material based upon the elements that make that material so salt is the common name for salt. Chemically we want to describe what elements make up that salt. And so we use the name sodium chloride.

John: Now in most cultures we read from left to right. So look to the periodic table and you'll see that sodium is to the left in chlorine is to the right. That's what we don't say. Chlorine sodium we specifically put the sodium first in the chloride second. Why. Because we read from left to right across the periodic table. So it's sodium chloride. The IDC is added because it sounds cool. That's guideline number one. The element farther to the right put the suffix IDC and you're going to sound really cool. Then there's other guidelines you'll see that are spelled out. Sometimes you'll have a situation where you need to distinguish one compound from another because the ratios of atoms within that compound are different. Carbon monoxide is c o carbon dioxide is CO2 carbon monoxide you know is a poisonous gas you know what to breathe carbon dioxide you know you're exhaling from your breath all the time carbon monoxide is one substance. Carbon dioxide is another substance the mono indicates there's one oxygen the dye indicates there's two oxygen so that's a bit of the nomenclature use mono tri tetra to indicate how many atoms are within that compound. So here's the test sulfur dioxide. Tracy how many oxygen atoms and sulfur dioxide.

Tracy: Di means two so to in dioxide.

John: How about tetra

Tracy: Die two so two nitrogen is.

John: To truck side what's that mean.

Tracy: Four so for oxygen

John: Yeah. So N2 is the chemical formula for di tetroxid Table three point one common poly atomic ions. We should say just a word or two about that. Table three

Tracy: 2.

John: Point one common poly atomic ions. These are ions that you'll be encountering a fair amount within this course. And so here they're spelled out for you. Wait but we haven't talked about an iron yet. We'll talk more about ions in I think it's comes to chapter 6 but these poly atomic ions means poly means you get many atomic atoms many atoms in their ions means they have a charge either positive charge and negative charge. These are fairly common within chemistry and so you might take an interest into using your flashcards to memorize these things if your instructor feels that's appropriate or just referring back to this table as needed.

Tracy: All right. So back to step 1 step to learning do you think it's better to try to memorize these all at once or do you think there's a better way.

John: Oh just sort of memorize them

Tracy: Right. And then as you become more familiar and you can keep going back and checking yourself that that should work well try it.

John: Section three point six talks about most materials are are mixtures so first you gotta have the idea of what we mean by an element and what we mean by a compound a compound is a group of different elements put together. Great example is sodium chloride so we identify sodium chloride as a compound made from the two elements sodium and chlorine right. Okay so here you have this compound sodium chloride. Now the sodium chloride is the fundamental unit of that material. We know as table salt. Just as water H2O is the fundamental unit of that material. We know as water if you dig dig dig down down down down to the water molecule you're looking at the fundamental unit of that macroscopic material we know as water split that water molecule and in half you no longer have water. I mean you can take the H2O and break it apart. You can do that but when you do that you no longer have water. So that's the idea of a compound. It's made out of a group of different types of atoms. Now if you have nothing but sodium chloride we say you have pure sodium chloride. If you have nothing but water you have pure water H2O. You know you can mix the two together so that you have a mixture of sodium chloride and water and we call that had a mixture. So you can take compounds and mix them together and in fact that's how we find compounds all mixed together in a good part of chemistry is actually separating compounds away from a mixture to purify them a fair amount of energy is actually spent doing just that.

John: So in nature we start with the mixtures of all these different compounds salt water is a great example it's a mixture of sodium chloride and water Section three point seven talks about how matter can be classified as pure or impure if it's pure. That means you've only got one thing if you have pure gold that means you only have gold atoms but because atoms are so incredibly small that notion of purity of 100 percent purity is really just not possible. So for example within one gold bar you have the Gold atoms. If just one of those gold atoms was an Aussie an atom or something then you've lost your 100 percent purity. You can actually take a gold bar and place it next to a silver bar because the atoms although it's solid the atoms are in fact moving. The silver will migrate into the gold. The gold will migrate into the silver. They're just moving all the time so to have something 100 percent pure is just not practical. But what we can talk about is the level of purity we can make something more pure than it was before. You can take water that's like maybe salt water it's not very pure water and you can distill it and you would say you are purifying the water orange juices and pure orange juices.

Tracy: Natural.

John: So we distinguish between natural and pure and then there's the schematic of if you have if it's impure it's gonna be a mixture. It can be a homogeneous mixture a heterogeneous mixture. If it's a homogeneous mixture it can be a solution which means everything's mixed finally down to the molecular level. Salt water is an example. White gold is a good example. White gold being a mixture a homogeneous mixture of gold and palladium sometimes gold and nickel suspension is a homogeneous mixture where you have solid and liquid different phases that are finally dispersed within each other. Milk is an example of a suspension as his blood or or a cloud the fog then within mixtures you can also have heterogeneous mixtures. A pizza is heterogeneous mixture of different materials right sand and water oil and water sand and salts within a heterogeneous mixture. You can easily identify the individual components and sometimes with a microscope or magnifying glass or just with your eyes

Tracy: Okay. But these mixtures the components of these mixtures are not actually chemically bonded. Is that the difference.

John: You Excellent. The components of the mixture they're not chemically bonded but they are actually interacting with each other through these weaker forces that we'll talk about in Chapter 7. I believe we call those internal molecular forces their forces within the molecule like within water H2O and then their forces between molecules get this to water molecules they interact with each other. Those are what we call into molecular forces.

Tracy: Okay but to keep it simple solution of salt water. Each of those components still have their own properties. They didn't create something new like sodium chloride.

John: So in sodium and chlorine combined together chemically to produce sodium chloride you had something that was completely different something completely new. That's what we call a chemical change. When you take the sodium chloride that you've produced and you take the water that you've got and put them together you don't come up with something completely new. So within a mixture you're still going to have the properties of each. They don't lose their individual properties. They do combine average out if you will the more sodium chloride you dissolve in your water the saltier it is now put two materials together with a chemically react to form a new compound which is a chemical change or will they just mix together which is a physical change. That poll question Will the materials reactor simply mix is not an easy question. It requires understanding chemistry understanding how atoms and molecules behave and we're not there yet at this point. All you need to know is that if they do in fact react then a new material is formed and if they don't react then you simply have a mixture. Just by understanding this well you're off to really good start. The last section here three point eight on nanotechnology. It's similar to the field of micro technology which led to the computer the integrated circuit in computers and you know how that had an impact on society.

John: Nanotechnology is having a similar impact its impact in many regards is behind the scenes and not something that's brought out in the Daily News. Nanotechnology basically means the ability to manipulate objects on the scale of atoms and molecules. It's a blend between physics and chemistry. Chemistry is when you're doing a chemical reaction you're doing the reaction in bulk you'll take 100 milliliters of this and 50 grams of that and 80 grams of this and you'll put them all together and you'll figure out how they react with one another. Nanotechnology is getting those some microscopic tweezers and playing around with individual particles that provides us a lot of power in terms of what we produce. Fascinating thing I found with nanotechnology is that the properties of atoms and molecules they actually change when they're by themselves versus when they're in bulk. Gold is a good example in bulk. Gold has a gold color right. But when you get down to just a few gold atoms. They're red. Their properties. Physical and Chemical are different at that level. So you see it's opening up a whole new field of study a whole new field of what's possible. So things like your foldable phone the computers with much much higher processing power are just around the corner. Within this area known as nanotechnology. Stay tuned

Tracy: That wraps it up.

John: And that's that's our quick review of chapter 3. It's a chapter that digs into the heart of chemistry that's for sure. We go over atoms and molecules we talk about compounds talk about physical and chemical changes a physical change happens when a single material changes its properties. A great example is when water freezes. It goes from being a liquid to a solid but you know you still have water you still have H2O a chemical change by contrast means that you're coming up with a new material taking molecular oxygen and transforming it into ozone. and are completely different substances. So this is all step one isn't it.

Tracy: Well I've

John: Been sitting here

Tracy: In

John: Enthralled

Tracy: Thrall engaged

John: Enthralled.

Tracy: In listening. I've been sitting here engaged in listening to you in and taking it in and now you know.

John: The next step for the student or the lifelong learner would be to try to spit it back out.

Tracy: Oh yeah. Tr some of the questions "What did I just learn" and looking I think the questions in the back are really helpful. Because you know where to go to look for the answer. But can you try to dig it up in your mind.

John: You know how when you wake up in the morning you're an inch taller than you were the night before. Is that a physical or chemical change

Tracy: It's a physical change. Because you go back to being an inch shorter the end of the day

John: Physical

Tracy:

John: Physcial Changes tend to be fairly reversible. A case of your fingernail grows a millimeter. Is that a physical change or a chemical change?

Tracy: Oh, physical change.

John: Well you know after a chemical change the new materials look completely different. They have a whole new set of physical attributes right Of rusted car. Physically looks quite different from a non rusted car. Correct. But are those new physical properties the result of a physical change or the result of a chemical change with rusted car. It's from a chemical change.

Tracy: Right. Because you said rust is not iron and iron is not rust.

John: There

Tracy: So

John: You go.

Tracy: You have

John: So

Tracy: Two different

John: Where

Tracy: Sources

John: Did that extra fingernail come from.

Tracy: The chemical changes in my body.

John: It came from the Almond sandwich you ate That's what you had, right?

Tracy: How did you know?.

John: How is it possible for an almond butter sandwich to transform into a fingernail?

Tracy: Through a bunch of chemical changes.

John: Chemistry. So that growth of your fingernail is a

Tracy: Chemical change it's a result of a bunch of chemical changes.

John: Now. The task for all you real students out there. Is to explain this to others. How is it that the growth of a fingernail is a chemical change? And what do you mean by that? That's good chemistry. Our theme music by Zac Jeffrey our thanks again to Brian Prichard. Musical flourishes by Garth or John Andrew and the Silent Boys assistance from Greg Simmons from C music show notes and more please visit conceptual A note of appreciation to all instructors using a Conceptual Academy. Thank you for your support hardworking studen thanks to you as well for your learning efforts, which we see as the path to making this world a better place. There's a bigger picture a good chemistry. Good chemistry to you

Tracy: Good chemistry to you.