Big Picture Podcast – Episode 11

Ionic Bonding (Chapter 6B)

With special co-host JW

For this "Do the Review" episode, we explore the nature of the ionic bond, which is what forms when an atom that easily loses electrons is placed beside an atom that likes to gain electrons. Topics include the shell model, electron-dot structures, and effective nuclear charge. We also spend a bit of time answering off-topic questions from guest co-host JW. With this foundation, the discussion is extended to include the nature of the metallic bond. Duration: 49:47.

John: Welcome to the Big Picture podcast. Today we're going to be focusing on the chapter on chemical bonding with us today, Tracy. Our co-host, Tracy.

Tracy: Hi there.

John: And also we have a special guest co-host with us today, JW

JW: Hello. Glad to be here.

John: JW, here, you're gonna be asking lots of great questions. Make sure we don't fly too fast rate.

JW: I'm going to ask a lot of questions and you can fly, walk or run. Either way, you're going to get questioned.

John: Ok. Chemical bonding. Where shall we begin

Tracy: At the beginning.

John: The universe is made of these very tiny fundamental particles called atoms, atoms.

John: We know by now are very, very small, but they are a fundamental unit.

John: And as we've learned, the atom itself is made of even smaller particles that we call subatomic particle, excellent subatomic particles named three subatomic particles.

John: Electron proton and it's great dust, make sure everybody's up to speed here.

John: How is it that those subatomic particles are, generally speaking, organized within the atom?

John: I'm going to jump right out and say that they are bond.

John: They're glued together. Yes, somehow by what force? The electrical force and and also the nuclear force right within the nucleus. But it's the electrical force that holds the starts with all the electrons, the electrons. Excellent. Orbiting that central nucleus. All right. So the model got here is that the electrons are whizzing around that atomic nucleus. And we talk about chemistry. We're talking primarily about those electrons and their behavior.

John: And so when we talk about how it is that atoms can connect with other atoms, it's basically done by way of the electrons. And so in this episode, you notice we'll be focusing a lot upon the electrons.

John: Good. I'm good. We're good. Sounds good. All right. Here we go.

John: The electrons behave as though they are arranged within a series of concentric shells, concentric means they are all centered around the atomic nucleus. And in that first shell, you have a capacity for two electrons in that second shell. You have a capacity for eight. And the third shell? Eight and so forth. This is actually from earlier material we talked about and we understand that how the notes are arranged on a musical score gives rise to the character of the song. Likewise, how the electrons are arranged around that atomic nucleus gives rise to the character of the atom. So let's start simple, showy, picking atom any atom, fluorine, good hydrogen.

John: So hydrogen has one proton in its nucleus and it's surrounded by move. How many electrons? One. One electron. Right. And it's going to be found in that that first shell that when electrons are going to be whizzing around in that first shell.

John: Got that? All right. So you have kind of like a planetary model inside your head. Yeah. Yeah. All right. Now, what about helium? Would that be two electrons?

John: Two electrons? Excellent. Because there are two protons in the nucleus. So envision a helium atom. Now in what you've got are two electrons whizzing around that nucleus. Now, where are those two electrons exactly?

John: The first shell is now. Well, we'll go into orbitals. The shell is actually a simplification of what you're talking about with orbitals. And what we're gonna do today is a simplification of the simplification. We're leading toward what's called the electron dot structure. And the electron dot structure is a summary of the shells, which is a summary of quantum mechanics and atomic orbitals. All that juicy stuff from the earlier chapters. Mm. Yeah. So we're just gonna cut to the Jays and get to the simple of simple models called the electron dot structure. But it does require you understand that electrons are orbiting around the nucleus. Right. So.

John: Let's go to the third, Adam, I'm going to ask a question.

John: Having a science background, you say?

John: Again, helium. And we have.

John: The ring of.

John: Just something amazing.

John: Yeah, the picture that I keep in mind is one of a bunch of bees hovering around of sweet flower. They can go in random randomly in 360 degrees around it. The variable you've got there is the radius that they would have from that sweet flower. So would the first show the fairly close angstroms close to that sweet flower.

John: So for the third electron now for a lithium atom which has three electrons, that 30 electrons gonna come along and it it's negatively charged in the nucleus is positively charged. And it would love to get to that nucleus. But what's the problem?

John: There's two other electrons.

John: So that first shell is filled. It has the capacity for only two electrons so that third electrons can't go into the first shell.

John: Guess where it goes to the next.

John: So the next shell out being the second shell, which happens to have a capacity for eight electrons. So that third electron jumps into the second shell. It's got a lot of room. There's room for seven more electrons in there, but it's just one electron by itself in that second shell. So what we have here is called wait for it. The electron configuration for a lithium atom. Okay, j.w. You're ready. I'm ready. Test time. Talk to our audience about the electron configuration of a lithium atom.

John: The electron configuration.

John: So shall we need a cowbell? Me, me, me, me, me, me, kids concur with that.

John: Yeah. Okay. Now, how about a beryllium madam, which is an atom with four protons and four electrons? Tracy, can you take this one? Described the electron configuration for a beryllium atom.

John: To you in the second show, room for six more.

John: Six more, right? OK, so that's the basic idea in terms of how I mean, really basic in terms of how the electrons are organized around the atomic nucleus. And we're going to talk about chemical bonding here. We're going to focus our attention on just really the first few elements of the periodic table. May I ask a question? Absolutely. Anytime.

John: Tell me, why can't we take that new shell? Mm hmm. Nothing. The lithium in the electronics and the third drill. Mm hmm.

John: Why can't.

John: Herschelle That's a great question. Yeah. If you want to take that 30 electron and squeeze it into the first shell, the universe would complain. It's one of those laws of physics that they cannot occupy the same space at the same time. It is a law that is a law. There are, of course, some exceptions, for example, within a neutron star. You can actually have enough of a gravitational force that could actually force that to happen, which is some fascinating stuff. We can get into talking about astronomy.

John: That's in later chapter upperclass. Yeah, yeah, yeah.

John: But we're going to talk about the bonding of some of the lowest mass atoms, specifically the ones in the first row of the periodic table, the other atoms of the periodic table follow suit. But there's some caveats that become involved. So you'll find chemists, you'll find chemistry instructors. They tend to focus on myself. No exception. On the first in the second row of the periodic table. Just for simplicity's sake, you get the idea. Now, the idea of the shell thing you get understand the first two electrons are buried away within that first shell. All the action, if you will, occurs within the outermost shell. Because let's face it, you have two atoms are going to bump into each other. They bump into each other from the outside. And so the real question is what's on the outside of that atom? And so when we look at, say, the lithium atom and we want to think about its electron configuration. What's important is that there's just one electron. Wait, wait. You told me there are three electrons for lithium, right? Explain. Why do I focus on there being just one electron for lithium? The buried away. Yeah, that's what the electron dot structure provides. Let's turn to this second page here. What you'll see is the the elemental symbol and a bunch of dots around that elemental symbol. Those dots are the electrons that are found in the outermost shell. And for the second period of the periodic table, that that would be the second shell for the third period of the periodic table. That would be the third shell and so forth. Then you'll find that elements above and below each other in an atomic group all share a similar electron configuration for the outermost shell. So for oxygen, it's the second shell first. Sulfur s, that's the third shell and so forth. So you'll see the the similarities. From one road to the next. So by just focusing on that second row of the periodic table, you're gonna get everything else. So let's do that. Let's just focus here on that second row of the periodic table.

John: Ok, so let's describe the electron dot structure for lithium. John, want to describe that?

John: I'm going to pull the book a little bit closer to me. The electrons. Do on the initial one on the outer shell, are the two in the inner shell shown?

John: No. So it's just a fly with a dot. OK. And Tracy, how about the beryllium atom? You see there. Which raises a question, why don't they have the two dots on the same side? Why are the two dots on opposite sides of that B.E?

John: Excellent. Okay. And then I'll do the next one. It's Boron, letter B for Boron, and there are three dots around it and that means there are three electrons in the outermost shell of the boron atom in note. They're not paired together. There's through there want to be as far apart from one another as they can. John, do carbon. Carbon.

John: Each other. East and west.

John: Yes. Yeah. And of course, in three dimensions, it would be a tetrahedron. Well, I'm sorry, jumping in. We'll talk about that later. Now we get to the nitrogen and with the nitrogen, the electron dot structure, you got five electrons. Now, what was the capacity for that? Should the second shell capacity is eight?

John: All right. And so here's the deal. What we find is that those shells have remfrey electrons, but those rooms are akin to seats on a school bus. You know, those double seats on a school bus. And the kids are piling into the school bus and say there are one, two, three, four, four double seats. Initially, the kids, they want their own seat.

John: But then enters the 5th student.

John: They see all the seats. Have somebody else in it. Decision. Take the airplane, right, just to look at the person when they're walking down the aisle. And somebody has got a pair up, right. So if you envision the shell as a bunch of double seats, you'll understand what's going on with a nitrogen atom that fit the electron coming in has to pair up with another electron. And how that happens. It's fascinating because you expect that the the two electrons are going to be repelled by each other that both negatively charged and indeed that happens.

John: But the electrons have another property called spin. They're like little tops. And they can spin and they can spin clockwise or they can spin counterclockwise. And from physics, we know that whenever you take a charge and move it, you generate.

John: Magnetic field. I did not know that.

John: Excellent. You generate a magnetic field and so if your electron is spinning clockwise, you'll have north and south one way. But if it's spinning counterclockwise, it'll be flipped. You'll have south and north the opposite orientation. So how is it that electrons can sit together in the same seat? The answer is they spin in opposite directions.

John: So sometimes you'll find the electrons are represented not by dots. You'll find the represented by arrows. And if you have two electrons next to each other, you'll have one pointing up and the other pointing down. It's simply referring to the spin of those electrons. So the electron configuration for nitrogen, it gets bizarre.

John: You've got to think of it as four double seats. And in three of those seats you have just a lone electron in one of those seats. You have a pair of electrons spinning in opposite directions.

John: Right. So if you can get nitrogen, you can get oxygen GW on to describe the electron configuration for an oxygen atom, that's going to be six electrons. Yeah. But wait, oxygen has eight electrons, does it not? But remember the first two. Okay. Okay.

John: It's six electrons on the outer shell. We have two next to each other and we have two singles.

John: Okay. So we have two pairs in two singlets. All right. Listen to that terminology. It's gonna come in later. So you can have electrons that are paired together or you can have electrons that are singlet. And for the fluorine, you've got total seventy electrons, invision, seventy electrons jumping into that school bus. You're gonna have six of them that are paired up and one is got the seat all by themselves. So for fluorine atom you'll have one singlet in three pairs.

John: And then you have the neon, which has a total of 10 electrons, two electrons will be in the first shell. Those eight electrons in the second shell, they fill up every seat available. So no singlets, no singlets, no singlets in the neon, they're all paired. So that's the electron dot structure. It's a shorthand notation on how it is that the electrons are organized within their shells.

John: Question You mentioned that maybe I misunderstood. Arrows where there was an indication of arrows.

John: Yes, sometimes they will use arrows to represent an electron is post to a dot.

John: Oh, and one more thing, when electrons are paired, there's a stability, when there's an unpaired electron.

John: Watch out. You have.

John: Instability. You have reactivity. We'll get to that in a moment. Any other questions?

John: Surveillance indicates the outermost shell, so those electrons within the outermost shell are sometimes referred to as the valence electrons, so the valence electrons for like oxygen, those are in the second shell. The valence electrons for like sulfur, those are those electrons in the third shell and so forth. Surveillance is a shorthand way of saying, oh, those electrons in the outermost shell.

John: Now, what's fascinating is that with this understanding, everything else falls into place. That little bit about the electron dot structure from that you can derive much about how it is that atoms get together in bond. There are three basic types of bonding that we're gonna be talking about. The ionic, the metallic and the covalent bonds. The ionic bonds are fairly straightforward to describe as are the metallic bonds. There are lots of nuances, though, when we get to the covalent bonds. So let's zip through what we mean by ionic and metallic bonds and then we'll probably spend a little more time talking about the covalent bonds. Ready? I'm ready. OK. So the ionic bond. Here we go. Pick an atom. Any atom.

John: Hydrogen. OK. Let's do sodium.

John: The electron configuration for sodium atom. It's got eleven protons and eleven electrons. But what about valence electrons? How many valence electrons for sodium atom? One. Yeah. Just one. And that's an electron in the third shell for the sodium. It's got ten electrons buried deep within the first and second shell. But in that third shell, which is the outermost shell, there's only one electron. Right now look down to the nucleus. What's the charge on that nucleus? Coming protons are in there. Eleven eleven protons. All right. Guess which exerts a greater charge? One proton or eleven protons? That would be eleven. The more protons, the more charge. Right. What kind of charge? Positive or negative? Positive. But so protons are positively charged rate. So that nucleus of the sodium is emitting a plus eleven positive charge. You're an electron. How do you feel about that? Recharged. Yeah. You're negatively charged and you're looking there at a +11 and that's a sweet flower and so you're attraction to that, +11 is pretty darn good. That makes sense. It does. It's by what we call cullum's law, which says the greater the charge, the greater the force of attraction or repulsion. But there's a caveat here. You're that electron in that outermost shell. That third shell for sodium atom. Do you have a straight line of sight to that nucleus?

John: Or are there things in your way?

John: There's two other layers, two other shells, and John G.W, this gets back to your earlier question. How exactly are they organized, right? Is it like Saturn? If you think of it like a globe or a bunch of think three dimensional instead of the three dimensional, you've got electrons hovering around that sweet nucleus, much like a bunch of bees hovering around a sweet flower. And you have the first wave of bees, electrons that are in the first shell, and then you have a second wave of electrons that are in that second shell. A total of 10 electron's. So you're that 11th electron. Way out there in the boonies and you try to see that nucleus, that juicy +11 nucleus. It's hidden. You have 10 other negative people. And how do you feel about negative people in front of you? That would be a if you're negative in their negative, everything's just negative and they're gonna repel. And so understand, there's a tug of war here. You have a +11 pulling it in that you got minus 10 pushing you away. Who wins? Much bigger.

John: Well, +11 is still get the sweet aroma. You just may get distracted easily.

John: Yeah. So from your point of view, way out there, you're not really seeing a +11. Do you really see?

John: Negative 10.

John: And +11 put him all up. Adam all up. What do you got plus one.

John: So the net the net of what you're seeing, you have ten electrons pushing you outward. Now you have eleven protons pulling you inward. Right. I'm with you. Here's the deal. You got to think of it from the point of view of the electron. How's it feel to be that electron from that electrons point of view when it looks down to the nucleus?

John: These electrons in the first and second show are negating the nucleus.

John: Yes, but not completely because the nucleus is still +11. Consider if that nucleus were plus 10, there'd be no reason for that third shell electron to be there. Right. You've just described a neon atom. Right. But first, sodium atom. You've got eleven protons. Loosely held, loosely held, not strongly held. Yeah. Is to say, what if you wanted to knock that electron away?

John: It could be easily distracted and off to somewhere else. There's a better thing coming.

John: If there's a better thing coming by that 11th electron way out there in the third shell is easily lost. I know there's plus eleven in the nucleus, but from its point of view it doesn't witness the +11. It really witnesses a plus one. And so that's why that outer shell electron for the sodium is easily lost. And when it is lost, you now have eleven protons.

John: And not eleven electrons, but ten electrons that atom. Now has more protons than electrons, and we call that in.

John: Out-of-balance it is out of balance. Yeah, it's out of balance. Ireland, it's called and everyone an eye on. Excellent. And where they get the term from. But it's an island is a charged. Adam? It's an Adam that has a different number of electrons versus protons.

John: Right.

John: And it can be positive or negative.

John: Well, let's consider. Where did that electron go? The sodium lost its outermost electron. Where might it have gone? You mentioned earlier, Tracy, that maybe just saw something better.

John: We're going to turn the page and look at the flooring, Adam. Mhm. Okay. J.W. Europe describe the electron configuration for a flooring atom.

John: All right. And it has seven electrons and the second shell, yeah. Six of those are paired. One of those is singular.

John: Singlet. Singlet. Yeah. All by its lonesome. Yeah. Wrestlers, wait right here. OK, now let's go.

John: Because it's true. All right.

John: Now let's consider life from the point of view of that singlet electron. What does it see in the nucleus?

John: It sees there's a.

John: I'll tell you right out. There's a plus nine. In the nucleus, because there are nine protons. But how many electrons are in between that electron and that nucleus? Remember, that electron is in the second shell. Just two. So there are two electrons in the inner inner shell. In those two electrons are, we say, shielding that nucleus. They're hiding the nucleus. Those electrons are negatively charged. And so they have the effect of pushing everybody else away from the nucleus. I like obscuring. That's pretty good. Yeah, it's obscuring it pretty darn well. There's some caveats in there, but let's just do the math. If you're that electron in the second shell and you're looking down to the nucleus, there are plus nine protons there, but there are two electrons in the innermost shell. What do you actually experience if that second shell weren't there? To understand, you witnessed the whole +9. Yes, but that second show of two electrons is there. So what's the net result that you witness? Seven.

John: So there you are, an electron in a flurrying atom in the second shell looking down toward a +9 nucleus. You don't see a +9 what you actually see as a plus plus seven. Yeah. All right. What was it that that electron witnessed when in the sodium atom? When it looked down to the nucleus member 1, it was a plus one. All right. So here's this sodium atom walking along one day mining its own business in a flooring atom. Come Scruton by. And that outer shell electron of the sodium looked up and it saw a free vacant position there that had. What we call an effective nuclear charge of plus seven. Now you're an electron and you have your choice. You can stay with a plus one. I could go to the +7. What are you going to do?

John: 7 7:11 7 is the winner, 7.

John: So we asked earlier, well, where did that electron go, that sodium atom at last? The electron, the electrons not just gonna go off on its own. There's gonna be a reason it goes in. We're now talking about the reason it left because it saw something more attractive within the fluorine atom. So recognize for the fluorine atom, it's now gaining in electron and Tracy after it gains that electron. What kind of accounting do we have?

John: Shell the second shell valence electrons. It's full, it's full. There are now they're all paired up.

John: They're all paired up. And that adds up to what he calls some stability. And is it an atom or an island? It's got to be. Ha ha. So we're so close. We're just so close so that electron jumps from the sodium to the fluorine and the fluorine turns into an iron. Now, as the flooring turns into an iron, it's gaining electrons. So it's now what we call a negatively charged iron. The sodium which lost in electron is what we call a positively charged iron. Now, how do you suppose the negatively charged fluoride ion and a positively charged sodium ion might feel about each other once positive?

John: All right. And they get together and they ba ba ba ba ba bon bond. We have just described the ionic bond. The ionic bond is a force of attraction between oppositely charged ions. In our story here, we've talked. We actually went into the detail of how those ions formed. But once they form, understand, there's going to be an attraction between them. And we call that the.

John: We did it. Any questions?

John: So what you end up is what you call a compound in the compound here would be sodium fluoride found in toothpaste.

John: That's a great expression, John. And if it were a chlorine atom sodium giving its electron away to a chlorine atom, you'd have the sodium ion in a chloride ion in you get sodium chloride.

John: It is bonding is the creation of molecules are molecule by definition.

John: Sorry about this. Has to have covalent bonds involved. Yeah. What we're talking about here, crystals. OK. Yeah. So when you have a bunch of ions stuck together in a compound, it's typically a crystal in structure.

John: Different atoms tend to lose or gain a different number of electrons. The beryllium atom recall has two electrons in its second shell and it it gets what tends to form the plus two iron. So it has two electrons to lose fluorine as we talked about, can gain one electron because it has this empty space in it. So the fluorine tends to form the minus one iron. If you look at oxygen just to the left of fluorine, it has two vacant spaces and that's why it tends to form the minus two iron. If you look at the periodic table, you'll find that elements toward the right side of the periodic table. Those are the elements that tend to gain electrons in those elements to the left side of the periodic table. Those are the elements that tend to lose any electrons. So whenever an ionic bond forms, it's typically between an element on the left side of the periodic table with an element on the right side of the periodic table.

John: So what we've got here on the left side of the periodic table are typically metals. On the right side of the periodic table we have non metals. So it's often said that an ionic bond occurs between the ions of a metal in a non-metal. That what's more important is you understand is that they're on opposite sides of the periodic table.

John: Black hole. Mm hmm. Then then that should rules change. It's a whole new ball. New ballgame. New ballgame. But I tell you, you cannot have a sodium atom cruising next to a flurrying atom without this thing happening. Yeah. And that's called chemistry. It's a chemical reaction when that happens.

John: I have a question then. So you're saying on the left hand side of the table they tend to lose on the right hand side? They tend to gain. Yeah, electrons.

John: Final rule, the group 18. What do you think? Let's ask our listeners. What do you think? Elements toward the complete far right side of the periodic table, those within Group 18. Do they form ionic bonds? Is to say, can they lose electrons? Can they gain electrons? You could answer that question by just looking at the electron configuration. Remember how the notes are arranged on a musical score gives you the the quality, the character of the song. Likewise, how the electrons are arranged in the atom gives you the quality, the character of the atom. So look at something like neon, and you'll find neon has no singlets. All those electrons are paired together. And if you ask yourself how attracted are those electrons to that nucleus, you'll find the answer is very. So the neon aname can lose any electrons. Can it gain electrons? There's no room for any extra electrons. That's how it is. These elements are called the noble gases.

John: They don't react argon, krypton, xenon and radon.

John: Yeah, there are, of course, exceptions within the heavier noble gases. They do undergo some chemical reactions, but certainly not elements like helium or neon.

John: And then I have another question on that side. Would you say that? Are those the number? Is that the first shell? Second shell and the real correspond to the shell?

John: Yes. So for the the periodic table, each horizontal row corresponds to a shell. The first row corresponds to the first shell. Second row to the second shell. And remember, the first shell has a capacity for two electrons. Look carefully at that periodic table. You'll see there are two elements in that first row. What was it for the second shell? Eight, eight. Okay, eight. Take a wild guess how many elements there are in the second period. Eight there, eight. So there's a periodic table. So if the row is called the period. Yeah. A rose called a period for reasons we talked about earlier.

John: So any questions? I'm going to do something, John, that you've taught me, I'm going to try to explain. Oh, you're talking a beautiful Hassed. Oh, half hour or so. And I might oversimplify sometimes, but this is you're going to make the whole podcast straight. This is what this is what resonates in my head.

John: I want to be clear on a few things. And the first thing I want talk about irons and my understanding is an eye.

John: An eye on is a for lack of a better word, a thing where the number of protons in the nucleus are different than the number of electrons. Yes. Or they're not out of balance isn't the right word, but the number is no out of balance is a good word.

John: But keep in mind, it's the electrons that are coming and going. The protons stay put.

John: So what what I was thinking then is what the common going of the electrons is because of the the attractiveness of the of the nucleus.

John: And the kids staying at the atom is because of the attractiveness of that particular nucleus.

John: The departure then of the neutral r of the electron is when, for lack of a better word, something better comes along. And Adam and Adam.

John: That has a better situation. So.

John: Better situation, meaning that all of the atoms existed before there was ever an iron. I'm trying to understand the ions came first, atoms came first, or they all happened at the same time because the ion bonding that we were talking about is it seems like a natural process. Yeah.

John: Again, it's chemistry that causes the electron to move from one to the electron, moving from one situation to a better one. Is the chemistry now relative to it happening in the universe? Understand that when the temperatures are really, really, really, really hot, the electrons are completely scattered away from the nucleus. And that's a fourth state of matter we call plasma in the sun. You'll find the temperatures are just too hot in order for you to have neutral atoms within the sun with this hot, hot temperatures. Electrons flying all over the place. You've got ions all over the place.

John: In fact, it's the fourth state of matter we call a plasma, a plasma state, which is like a gas, but it's an ionized gas. So at the big bang, like the beginning of the universe to me had all comes out.

John: But the atoms, if you will, precipitated from that hot mess. It's only when things cooled down sufficiently that the electrons became firmly held by each of those nuclei.

John: Well, hydrogen and some helium from the big bang itself, then helium and all heavier elements of the periodic table were created in stars through a process called Nucleus Synthesis. As we discussed within the nuclear chapter.

John: Term ionosphere. Huh? In the end, I think that's the northern lights. What's what's the significance of the word ion that we just talked about the ionosphere.

John: If you go up, up, up, up, up, up in the upper atmosphere, you've got solar radiation just zapping things like crazy. And so any atoms up there, they get zapped by the solar radiation and they become wait for it ionized. Yeah. And so way up high, you'll have not just molecules and atoms, you'll have ions. And that's why it's called the ionosphere. Got it. Cool. All right. So one other thing we want to talk about before we wrap up this first half of the bonding chapter is the metallic bond recall. When we look at chemical bonds, there are three major categories. The anik in the metallic, in the covalent, the metallic you'll find is much easier described even than than the ionic. So let's spend just a little bit more time to wrap up this episode talking about the metallic bond.

John: The metallic bond would then be those people in the audience in Los Angeles is going to see Motorhead, dude.

John: Yeah, they're all stuck together. They they're they're held together by a common cause of the love of the music. Music. It's music or a podcast. So remember those elements to the left side of the periodic table. They are the ones that tend to lose electrons. Right? Right. What might happen if you took a bunch of those atoms and you stuck them together? Think of it like this. You have somebody who has a propensity for losing their keys. Think of someone you don't name. No names, no names. Sit and think. I can think of someone. OK. Think of another person who has a tendency to loose their keys. I can think of two such people. Okay. Let's think of 100 people who have the tendency to lose their keys. Right? Those names put them all in a room and it's time to go and they all have to find their keys. What happens? There's no transportation. Because can you. Can you see them all looking around? Words or McHugh's argues irrigator's movement. There is confusion. Yes. Yes. Yes. Yes. There's still. Yes. You have just described the metallic bond, which you've got are a bunch of atoms together that tend to lose their electrons.

John: And so those electrons all get lost and they're just running around. The electrons are like the keys, if you will. But it's the electrons that are running around. And what is it that holds those people in that room? They have the same intention of trying to find their keys. What is it that holds those metal atoms together? They have the same intention of trying to find those electrons. Now, those electrons are running loosely within this network of metal atoms. And you know what? I'm not going to say metal atom anymore.
John: I'm going to say metal ions, because as soon as the metal loses its electron, it becomes in an iron.

John: Okay. Well, I was thinking back on the word loosely. When you say leaves that outer shell, maybe third, fourth, fifth shell.

John: Yes.

John: Far away from that nucleus, shielded by all those inner shell electrons is interested, but it just doesn't have the longing for the nucleus.

John: Well, the charge emanating from the nucleus ain't much because of all that shielding. You're an electron in that outermost shell and you look down to the nucleus where the positive charge is supposed to be. Well, yeah. Tell me it's a plus fifty six. I don't see a plus fifty six. Why not. Because you have all those inner shell electrons in the way so they're negative and those inner shell electrons are negative pushing you away from that sweet nucleus. You don't have much interest in staying with that atom and that's how it is for these metals. You find those outer shell electrons are easily lost, just like keys can be easily lost. And so when you have a bunch of those metal atoms and you put them together and think they're all losing at least one electron, what you end up with is a bunch of metallic, positively charged ions within, they say, a sea of electrons, an ocean of electrons, a fluid of electrons. And that actually helps to describe many of the properties of a metal. Metals are opaque. Light can't pass through a metal, even a thin sheet of aluminum foil. It's opaque. What's happening there with all those loose electrons? The light is absorbed or reflected by those loose electrons quite efficiently. Explains why metals are opaque. Metals can also bend.

John: Sometimes you have to warm up a little bit, but you can bend the medal into various shapes, which is quite useful, frankly. Building structures out of like iron for example, in so it's understand if those metal atoms are held together by the sea of electrons, they can take on any orientation configuration that that you might might want them to. Another sign of metals is you can create what are called alloys for something like water will see. You have to have two hydrogens for every one oxygen. That's very specific ratio of two to one. But for a metal you can actually have any ratio that you'd want. You can take gold and add some platinum to it and maybe 40 percent platinum. And and that's what's called an alloy. So an alloy is a mixture, a physical mixture of different metal atoms blended together. Now, you might have to make it molten at first, but it will cool down and you can have it have those different metals in any proportion you want. So those are various properties of of metals that we're all familiar with. And they can be attributed to how it is the electrons are running around within a lattice of metal ions. And that describes no pun intended in a nutshell, the metallic bond.

John: Let me ask this question. So first, we talked about the ionic bond.

John: And now the metallic bond and the only distinction I see between the two is the climate or the environment of the metals. It is different, isn't the chemistry the same? In other words, an electron hopping from one atom to another.

John: But that other atom, it's hopping, too, doesn't want electrons either. When we talked about it with the ionic bond, that electron was jumping from an atom that from which it's easily lost to an atom that actually actively wants to gain that electron. That's it's absolutely not true with metallic bonds within a metallic bond. You have only atoms that tend to lose electrons stuck together, only atoms that tend to lose electrons. So if one atom loses the electron, where's it going to go? The answer is nowhere and it ends up loose within this what we call an ocean of electrons, a fluid, if you will. And that explains how metals conduct electricity so well because of that ocean of electrons.

John: I just had a moment. Electricity going on, a copper wire, just the electron kicked down the road. Yeah, a little bit easier with gold, a little bit less easy was silver a little bit less easy with copper and less easy with aluminum. So different metals, different different properties.

John: Sure, they're similar, but you'd expect differences between the two and even down to their color. Gold is able to absorb certain frequencies. And that's why the gold comes out. It's particular color. So, yes, there are certainly differences, but the similarities are significant in that how it is those metal atoms are held together. That wraps up this episode of the Big Picture podcast on chemical bonding. We've covered ionic and metallic bonds in the next episode. Be very appropriate that we go in to big one because the covalent bond will leave a whole episode to that. G.W, we want to thank you for joining us. Here's co-host.

John: Thanks for having me. Thank you, Tracy.

John: Good chemistry to you.

John: Our theme music by Zach Jefferey Musical Flourishes by CPro Music. Production Assistance from Greg Simmons and John Wright. A note of appreciation to all instructors using conceptual academy. Thank you for your support into the hardworking student. Thanks to you as well for your learning efforts, which we see as the path to making this world a better place into you. The casual listener were so excited to have you with us. Welcome to our Conceptual Academy Learning Community. For show notes and more. Please visit conceptualscience,com. Good chemistry to you.