Acids And Bases

Transcript

Instructor: Tallis

00:00:00:00 - 00:00:38:29
Instructor: Hello, everyone. My name is Talis and I'm going to be talking about acid base chemistry, specifically acid strength. We're going to go over a couple examples using PKA, KA, electronegativity, size, resonance, and then inductive effects like electron withdrawing groups and electron donating groups. For our first example, we're going to look at which is a stronger acid. We're going to be given these two dissociation reactions where both acids released a hydrogen or an H plus or proton in solution, and we're going to determine using PKA and KA, which one is the stronger acid.

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Instructor: So we're given HBR reat to give H plus and BR minus, with a PKA of negative nine and then HCl to H plus and Cl minus, with a PKA of negative eight. If you remember, Ka is equal to the concentration of our products over the concentration of our reagents. So if the products is bigger, then the reagents, which would be small, then we are going to equal a bigger Ka and vice versa. For a reminder, pKa equals the negative log of Ka. If we have a small PKA, this will equal a large KA and a large KA, as we just said, refers to bigger products.

00:01:46:81 - 00:02:31:91
Instructor: That means that our equilibrium is going to want to go this way and shift towards the products more. If we look at our examples, this one is a smaller PKA and this one is a larger PKA. Oops. So based on this, we can determine that HBR is shifting towards the products and HCL is shifting more towards the reagents. If we were to redraw these arrows, like this.

00:02:31:91 - 00:03:01:55
Instructor: We could say the equilibrium is favoring products in this reaction and favoring reagents in this reaction. What does this mean for acidity? So if the HBR really wants to lose its proton, then it's going to be shifting more towards the products. If it doesn't really want to lose it that more, then it's not going to be shifting towards the products as much. From this, we can see that HBR is more willing to lose that proton than HCL.

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Instructor: Therefore, HBR is the stronger acid. Now we're moving on to example two, where we're going to do similar thing, which is the stronger acid. But this time, instead of looking at Ka and PKA, we're going to look at size and electronegativity. This is just our rough poor man's periodic table over here with our periodic trends. So we have electronegativity increasing as we go up into the side and size increasing as we go to the other side and down.

00:03:40:40 - 00:04:16:62
Instructor: And we're going to be comparing HCL and HBR again. So if these are acids, these are going to lose their protons right here, and we want to know which one is able to support that negative charge better. Let's write some facts about these. For HBR, looking at our periodic table, BR is bigger. If we look at HCL, CL is smaller and more electro negative.

00:04:16:62 - 00:04:44:17
Instructor: How do we know which is going to be more important? In this case, we have HBR directly below, HBR directly or BR directly below HCL or CL. In this case, HBR. Oops, not erase that properly. There we go. HB is

00:04:44:25 - 00:05:39:73
Instructor: a whole electron shell bigger. This means that it is going to have a longer bond between the H and the BR, and it is going to have decreased electron density. In this case, because we're moving and there's such a drastic difference in size, HBR is going to be able to hold that negative charge better. It's also going to be easier for this proton to leave because it has a longer bond. For this example, this is the stronger acid.

00:05:45:91 - 00:06:25:23
Instructor: So just a reminder. So if you're comparing up and down, size is more important because like we said, we're going down in eletron shells, so we're getting really big. But if you're comparing side to side, say, you're looking at oxygen and nitrogen, then electronegativity is going to be more important because the size is not really increasing. Okay, so now we're going to do our last example, example three, everyone's favorite rank the acids from strongest to weakest. So when I do these questions, I usually try and put all the information directly below.

00:06:25:23 - 00:06:52:78
Instructor: And I go from the first one and I work my way all the way across. In our first example, we have an oxygen. All of our molecules have oxygens as this top molecule, sorry, we're losing this hydrogen, for all of these molecules, we can underline these. These will become an O negative. When the acid loses its proton.

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Instructor: This is what we're concerned with when we're ranking the acidity. When we look at this first one, every single molecule has oxygen, so we're not going to worry about that too much. When we look at the ring and what's affecting the oxygen, we see we have a

ring, we don't have any resonance. For this one, we're going to write no resonance. Now when we move to the next one, this one does have resonance.

00:07:16:19 - 00:07:53:37
Instructor: If we draw some electrons here, we can go down here and we can go down here and draw resonance arrows and we're pulling electron density away from the oxygen. But we also have this methyl group here, which is putting electron density into the oxygen. So we can go res for resonance and we have an electron donating group. And this one is in the octo sorry, Ortho. I keep getting mixed up. Ortho, which

00:07:53:37 - 00:08:26:13
Instructor: is a CH three there. Okay. Then for our next one, we have resonance again, we have this fluorine down here, which is pulling electron density away, which means it and we have pulling electron density away with our resonance. I don't want to draw that like this. So this one is an electron withdrawing group in the Para position.

00:08:27:53 - 00:09:07:80
Instructor: Then number four, we have resonance again. But there's nothing really else that we have to worry about. Then in number five, we also have resonance and we have a flourine. So we have another electron withdrawing group in the ortho position. Okay, so now that we have kind of a little summary of what's happening for each molecule, we can begin to put that together and rank them.

00:09:07:80 - 00:09:37:27
Instructor: So if we were to start with our we want to start with our strongest, so we could go strongest over here. So which molecule is going to be our strongest? We know that to support the negative charge better, we want to have things that are pulling the electron density away from the oxygen. So we're going to look at things like electron withdrawing groups and resonance that's pulling it away. So we have these two, three, and five that both have electron withdrawing groups and both have resonance.

00:09:37:27 - 00:10:10:18
Instructor: When we compare the two, though, we have our flooring in the orthoposition and the flooring in the paraposition. So inductive effects decrease as they go farther away in bonds. So this one actually has a stronger effect than this one because it's closer. So our strongest is going to be number five. Then we're going to look at our second strongest, and we're going to see that that's number three for the same reasons.

00:10:10:18 - 00:10:34:55
Instructor: It has electron withdrawing groups, it has resonance, and nothing else has two things that are helping it be more acidic. Number three is going to be second. So now for our kind of mid range one, we're going to knock, number one, no resonance, so that one's probably going to be pretty weak. Okay? So we look at two and four.

00:10:34:55 - 00:10:58:85

Instructor: Both of them have resonance, but two has an electron donating group, which is going to be adding electron density onto the oxidant. So that one is not going to be super acidic either. So for our third one, we're going to go number four. And then comparing one and two, we have no resonance for this one. We have resonance and electron donating groups on this one.

00:10:58:85 - 00:11:21:73
Instructor: Resonance is more important, so we are going to rank number two and then number one, which has no resonance. And then number one is going to be the weakest. And number five is going to be the strongest.