Representing Sodium Sulfate in Water

Dr. Kalyn Shea Owens North Seattle College

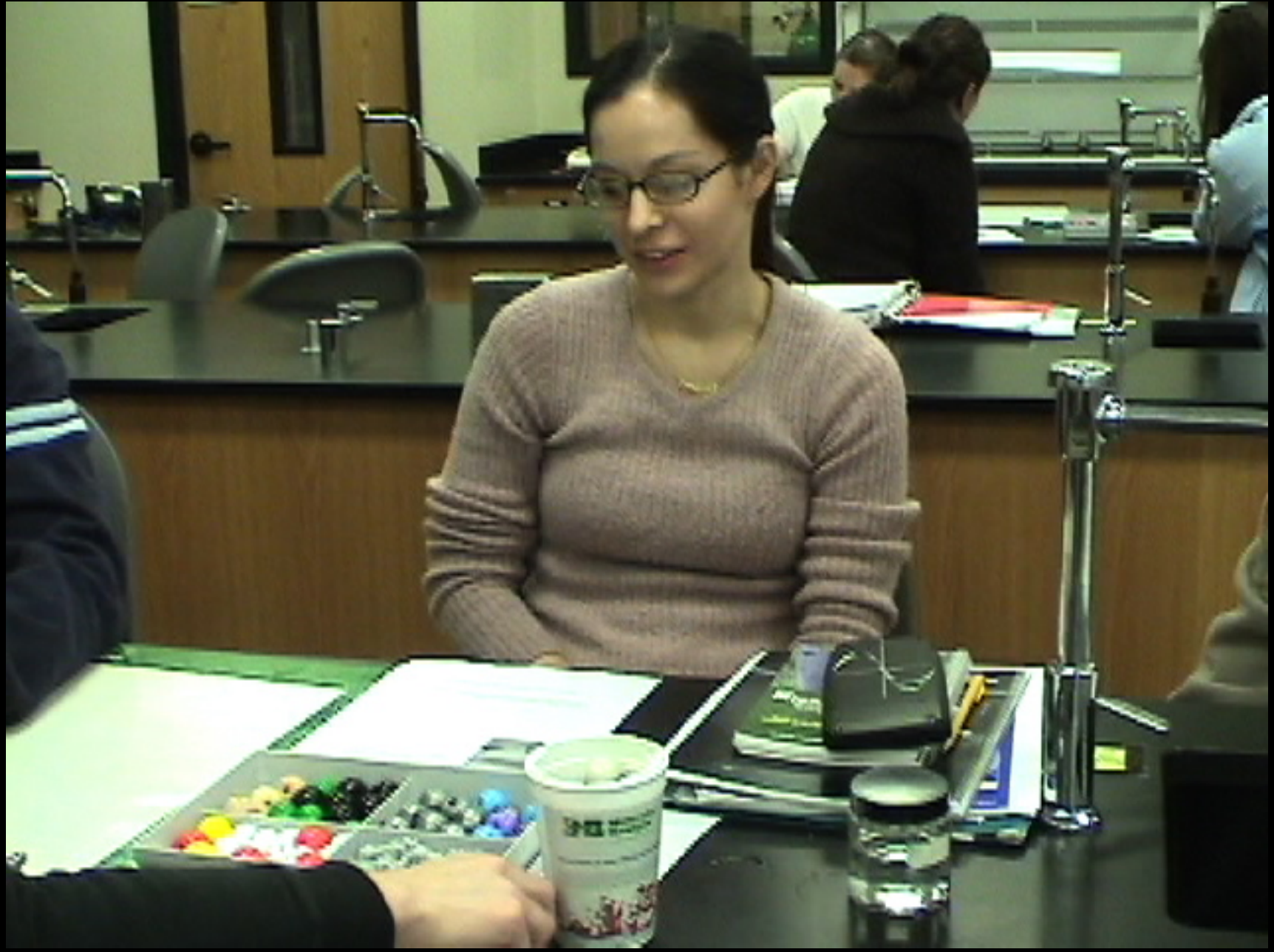
Liz: It's breaking apart.

William: It's like that salt experiment. It's salt water.

Anna: All right. So. Draw an atomic level picture.

William: Perhaps we need to know what sodium sulfate looks like.

Nathan: Anyone feel particularly confident in their drawing?

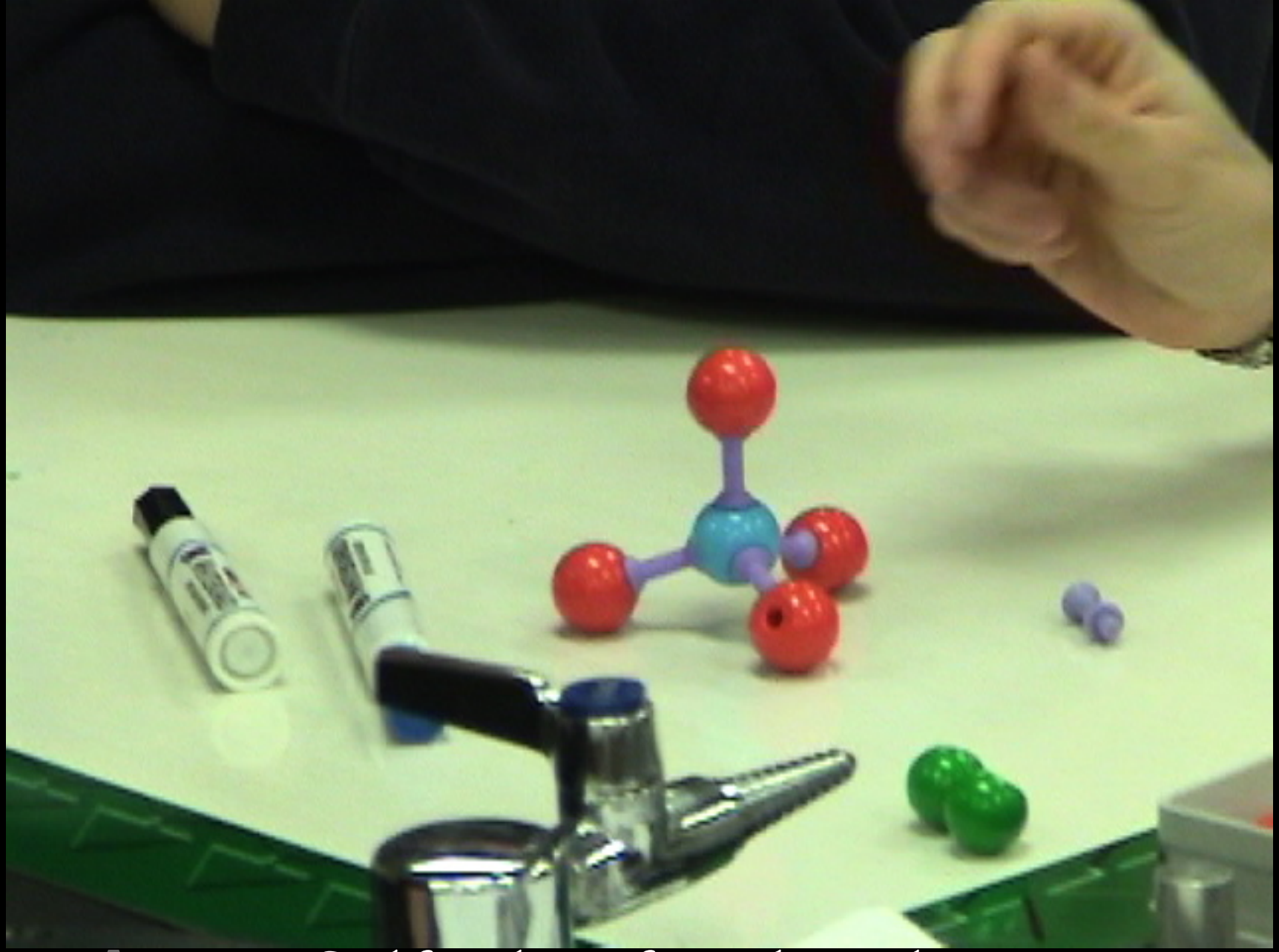


Anna: Not particularly.

Nathan: Oh, darn.

Liz: Four oxygens. It's red.

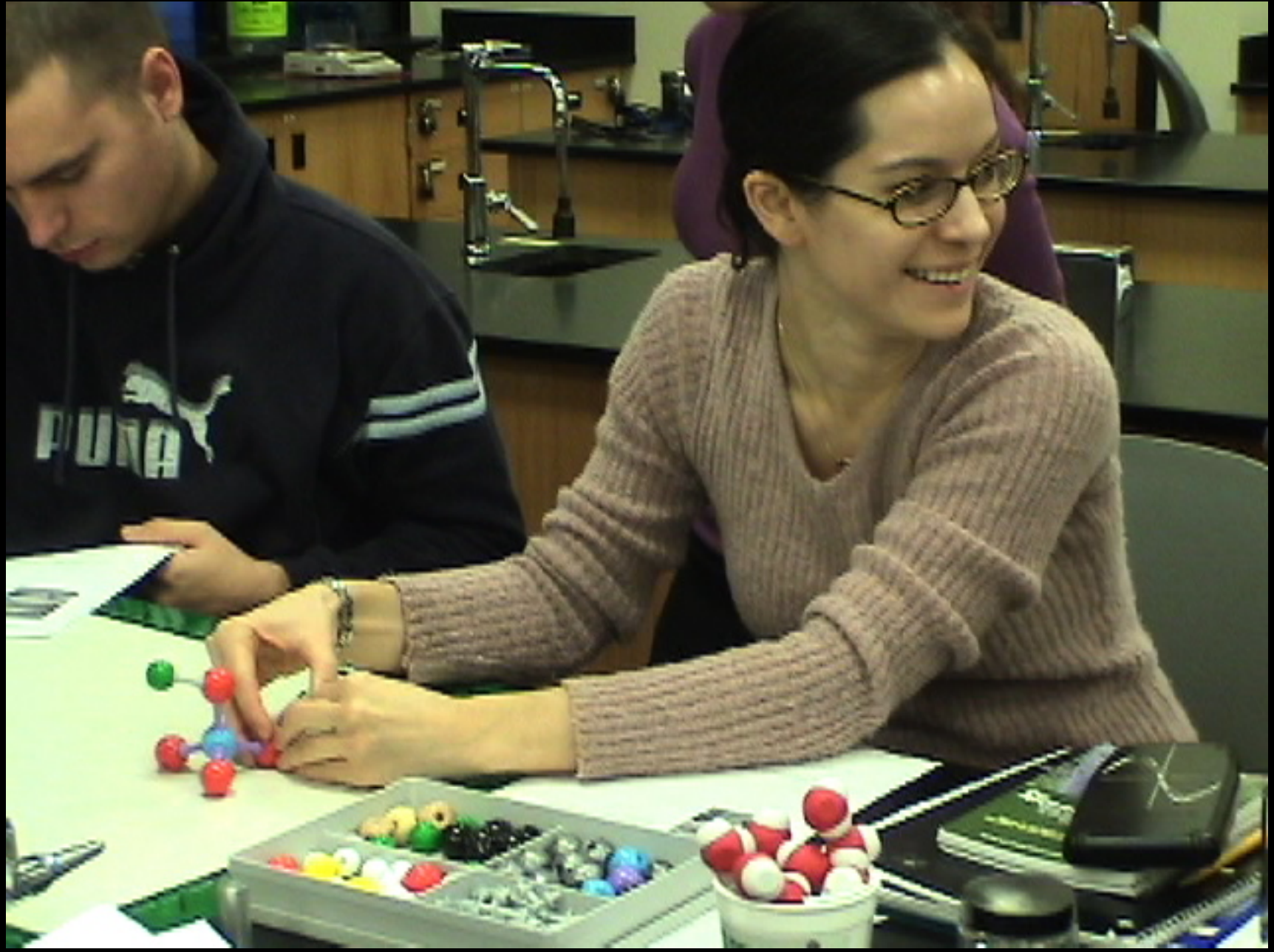
Liz: Two sodiums.



Anna: Sulfur has four bonds.

Liz: All right. Sulfate-sulfite? Sulfite.

William: Where would the two sodiums come off? It would have to go off one of the oxygens.



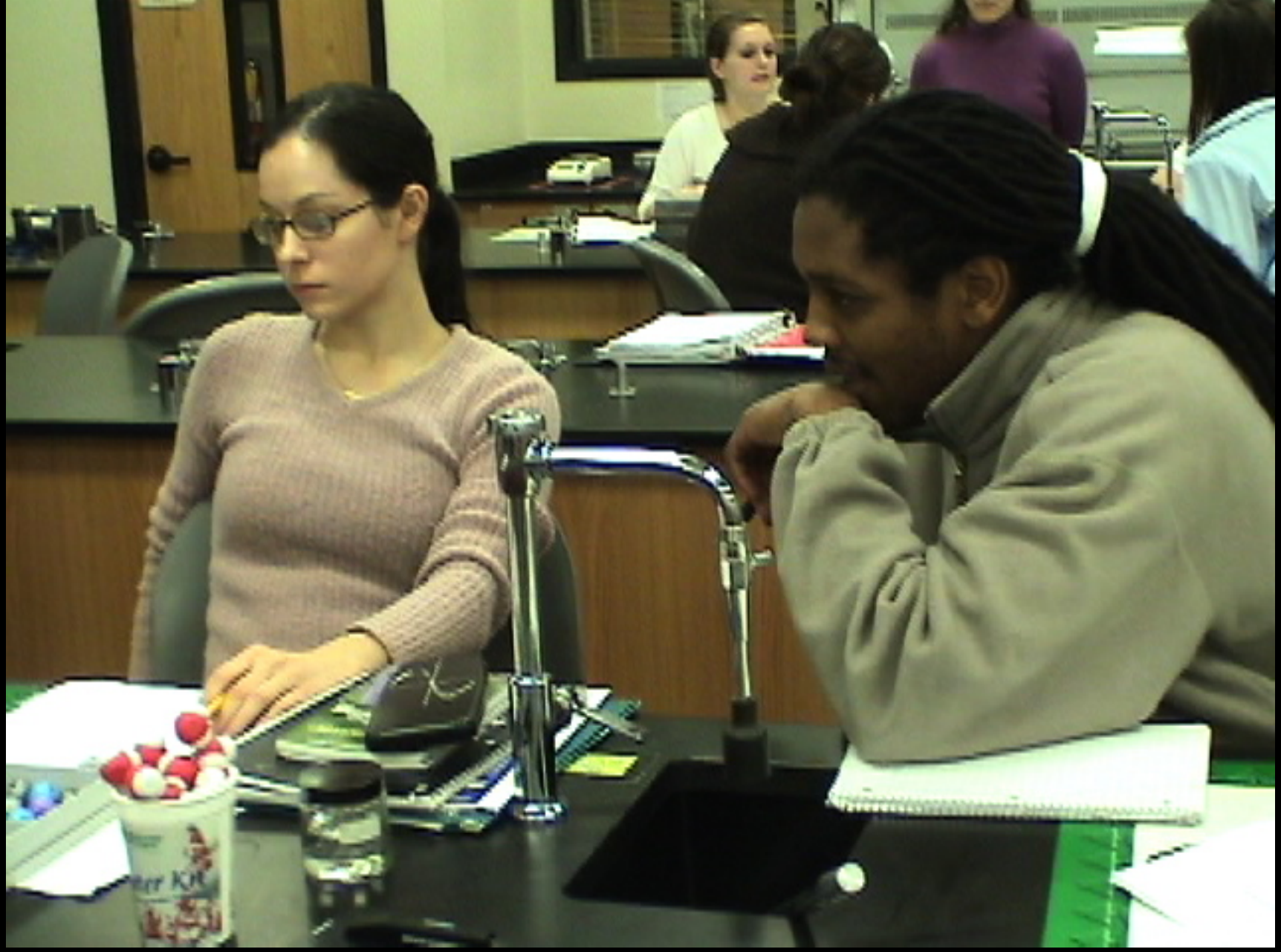
Anna: Is that really what would happen, or is that just the number of holes that we have?

William: No, that's the way it goes. The four oxygens take up all the valence electrons on the sulfur.

Liz: Because the sodiums each have one.

Nathan: Would there be a bond between the two oxygens?

Anna: Like a double bond?



William: I think these two are actually free.

Liz: What is a sulfate? Is it a plus...?

William: A plus 2. No, a minus 2.

Anna: Yeah, a minus 2, because Na is one.

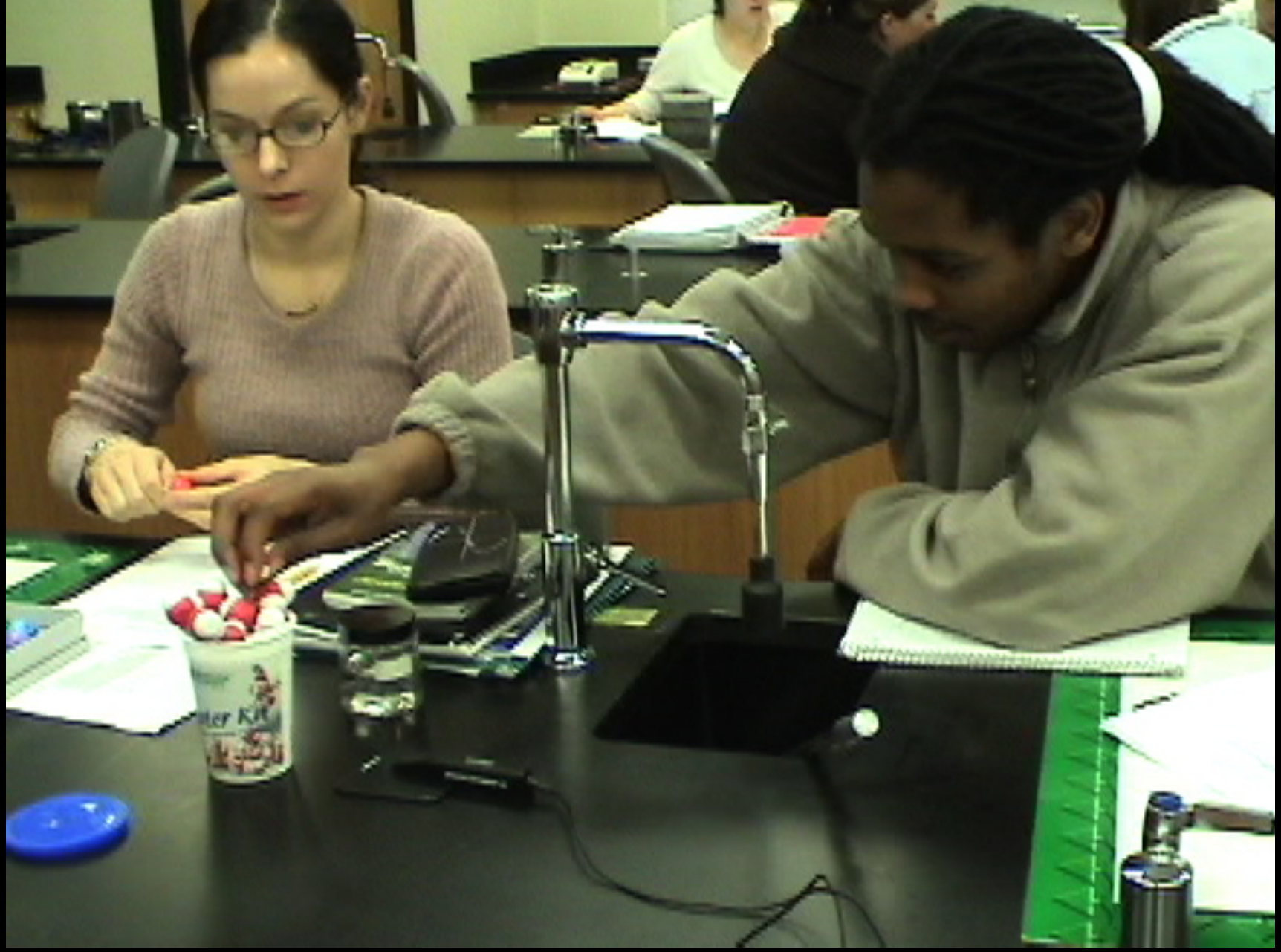
William: Because sodium is a plus one.

Liz: Is it? Is sulfate a minus 2 or a minus 3?

William: Minus 2, because we only need two sodiums.

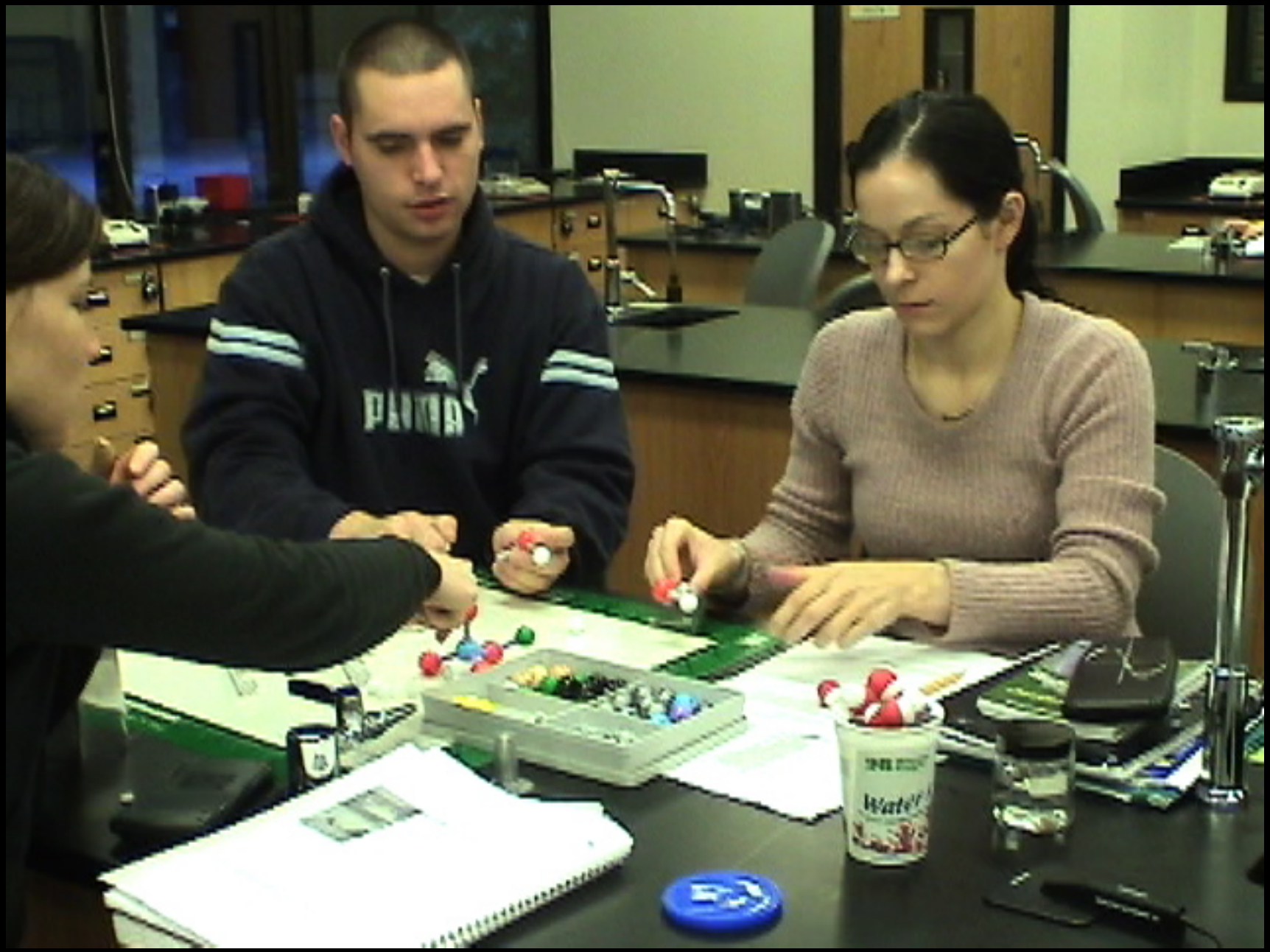
Anna: You want to make some water molecules?

Nathan: OK. **Anna:** We're running out of red.



William: Is this a water molecule here?

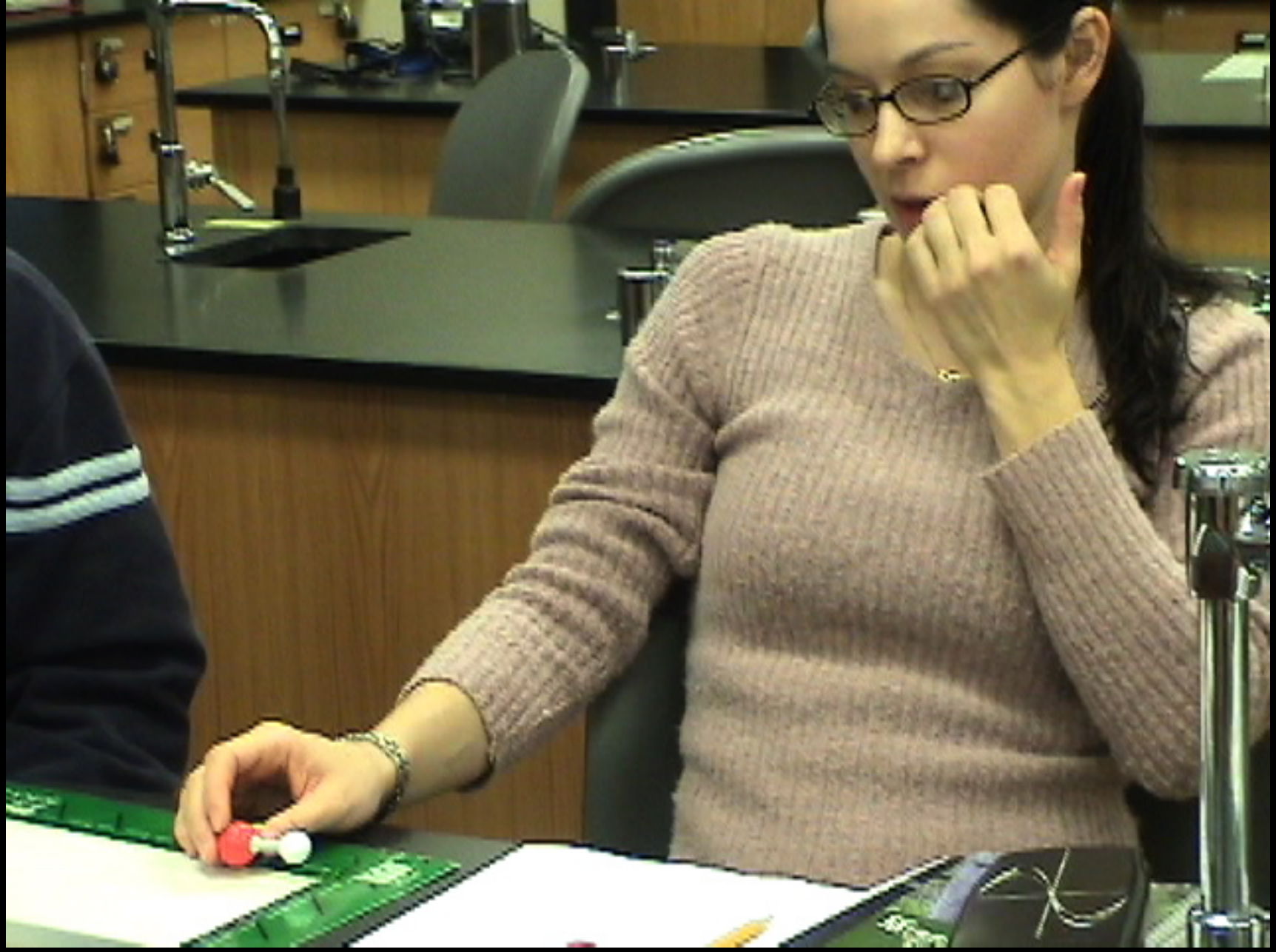
Anna: Yeah.



Liz: But you can't use them with this set.

Anna: So.

Liz: Draw a picture.



Anna: Hydrogen bonding would...

Anna: Wouldn't that pull...? How does that work? I forget. We haven't covered that yet.

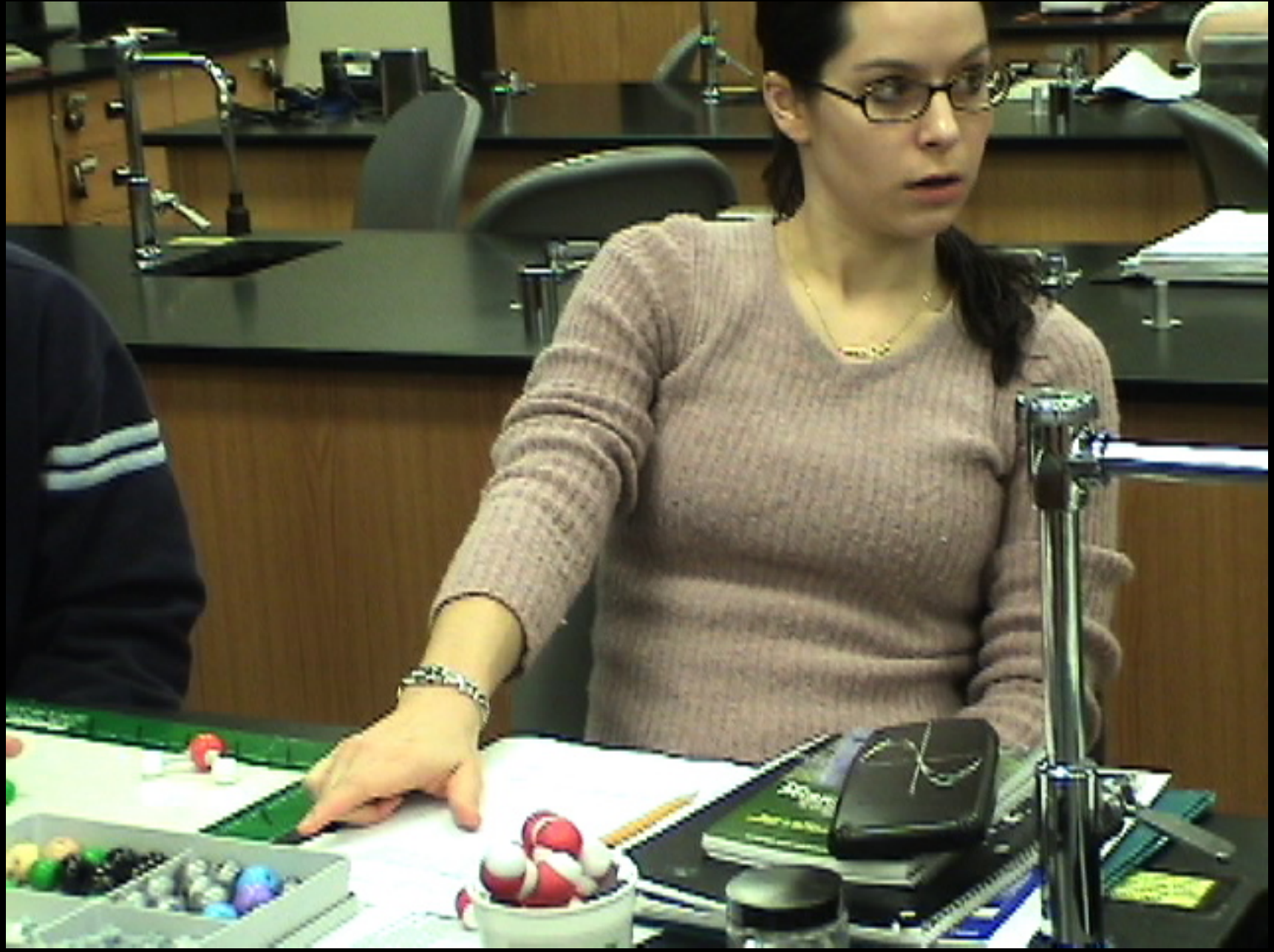
Nathan: The Na is giving an electron to the oxygen, right? **Anna:** Right.

William: It's taking an electron.

Nathan: It's taking an electron? OK.

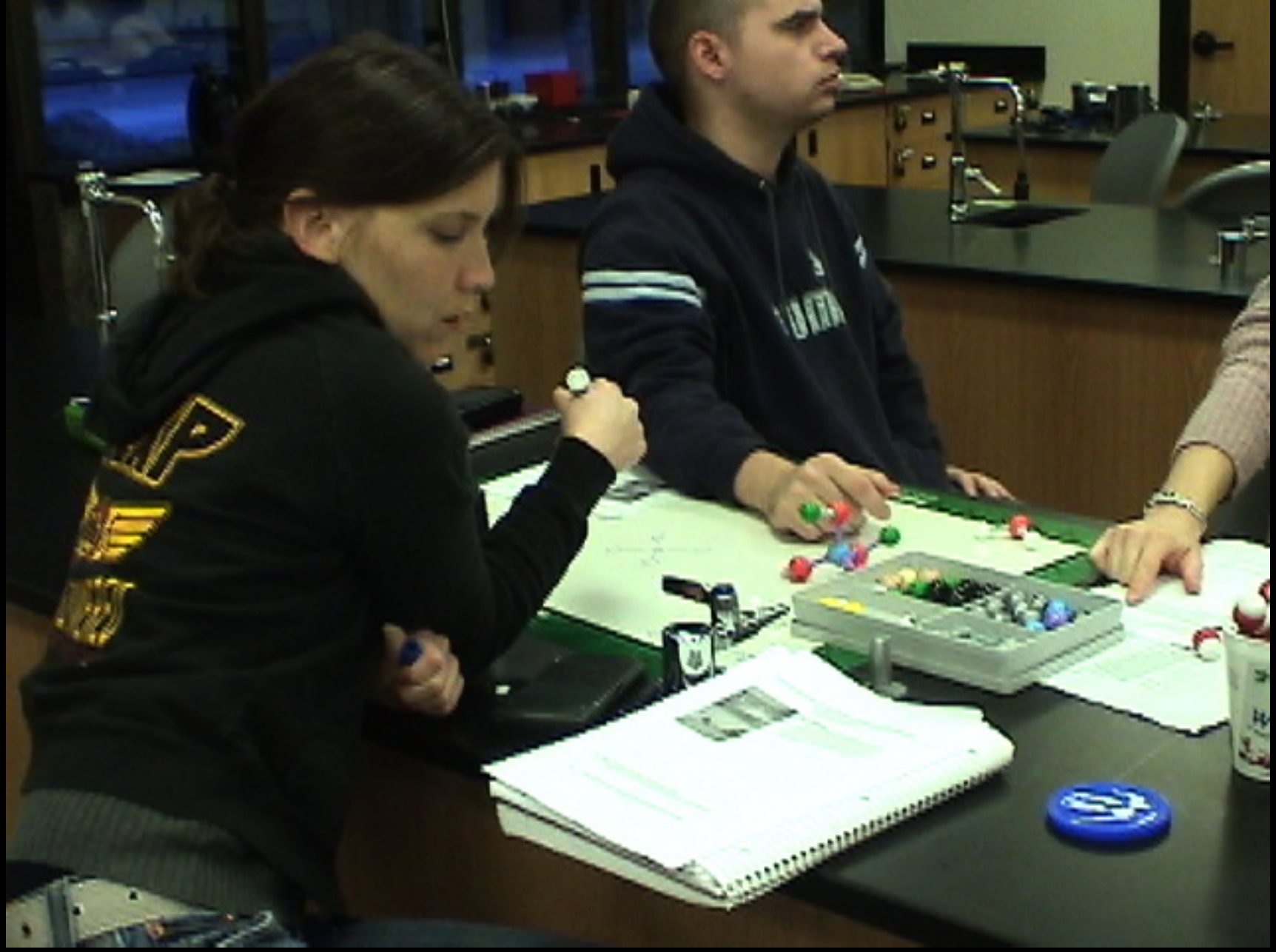
Anna: No. No.

William: Sodium is lacking electrons.
It's a positive charge.



Anna: Positive because it is less one electron, so it would be giving one away.

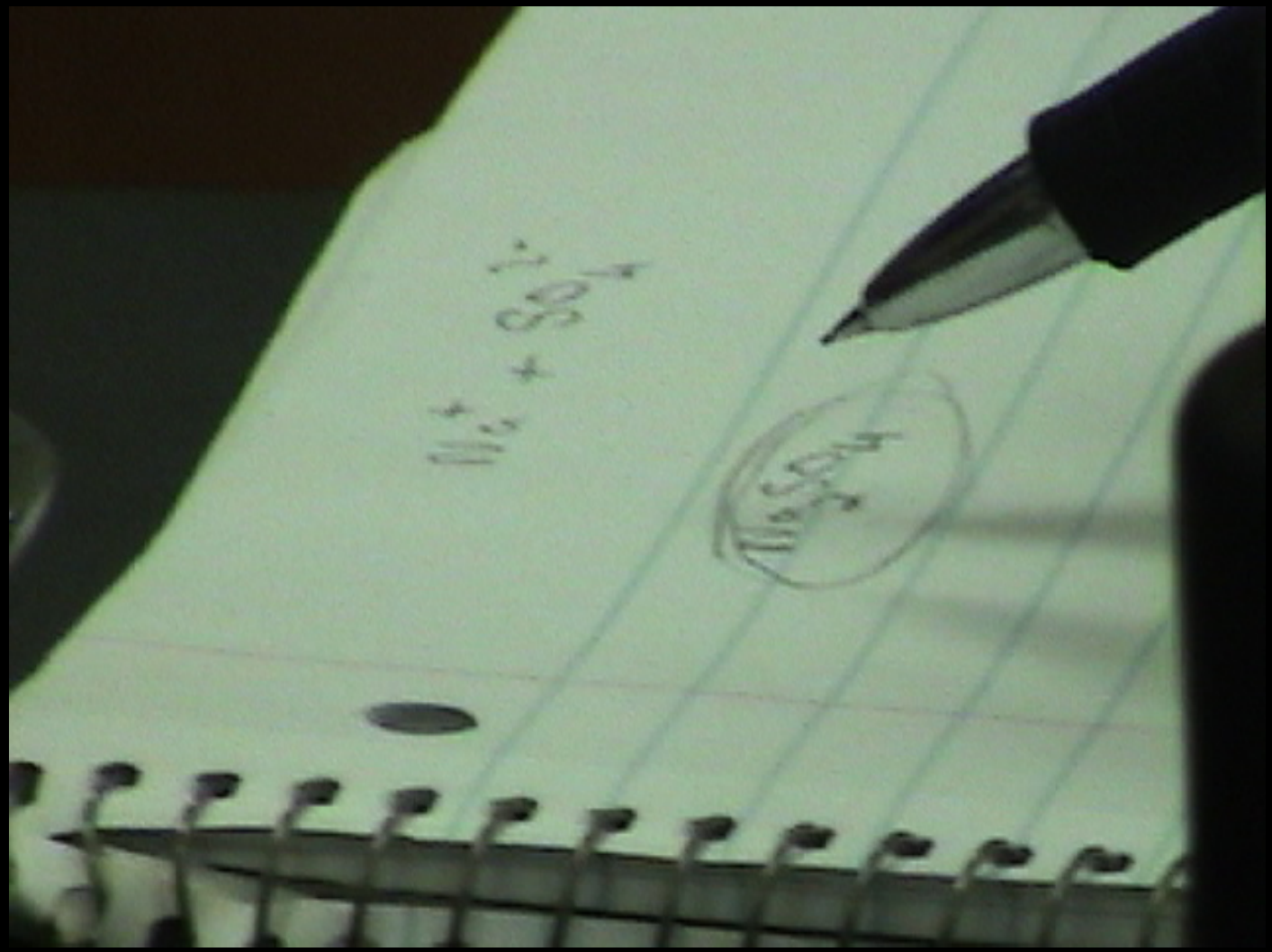
Nathan: No, it'd be taking... (pause)
Liz: Which one? Anna: Sodium. (long pause)



Liz: It's dissolved in the water, so the water is pulling it apart.

William: Before we had an Na plus...

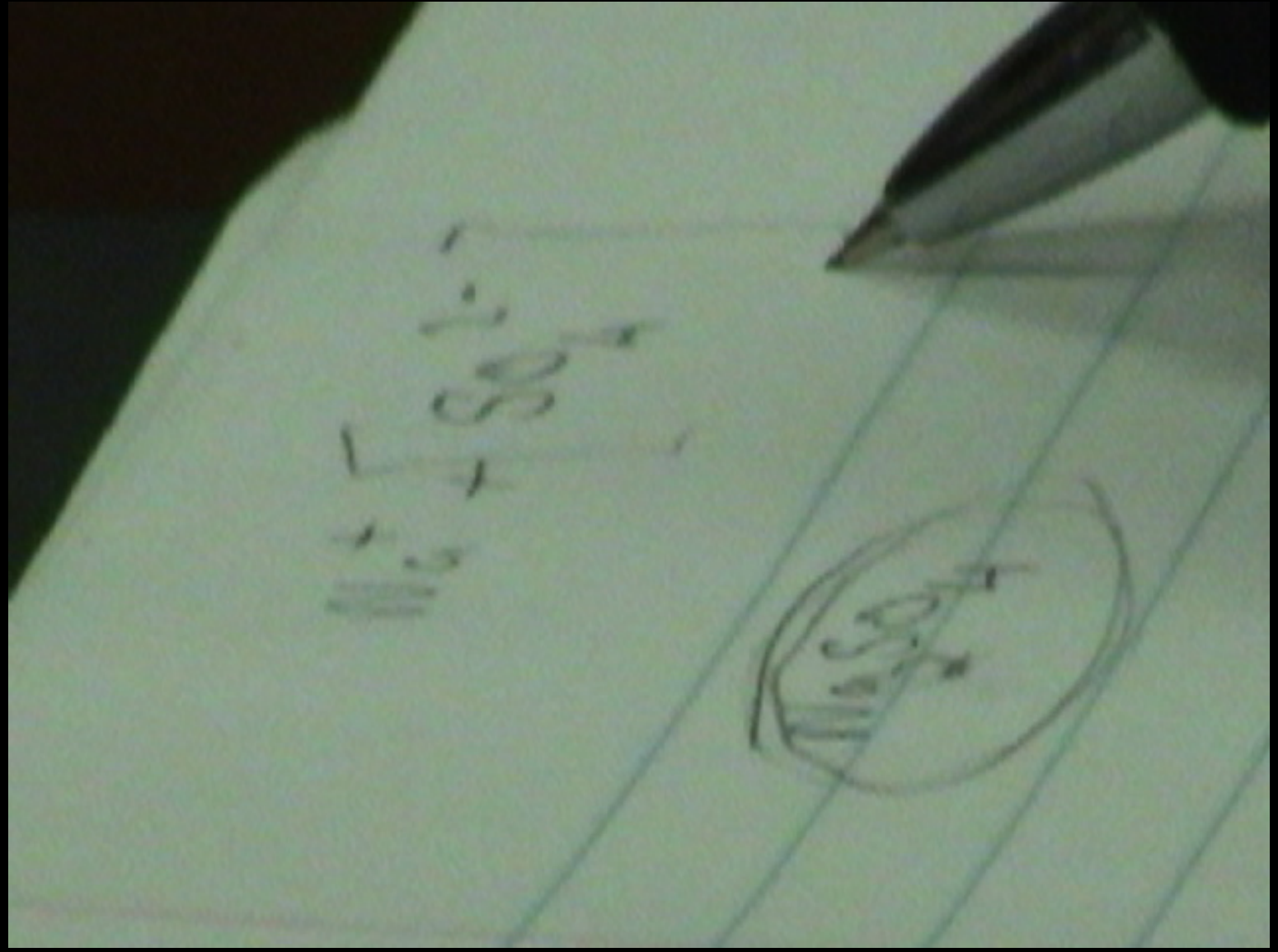
Nathan: An Na plus because it gave an electron away.



William: Before we add them up. **Anna:** Oh, OK.

William: Right now we have a salt that is already balanced out.

Nathan: And how it got balanced out was because the sodium...



William: The sulfate had two extra electrons to give away.

Nathan: Right.

William: And the sodium is lacking, because the electron is always a minus.

Nathan: No, but the sodium is not lacking until it gets into the compound.

William: It is lacking, for if it was stable it wouldn't react with anything.

Nathan: It's not stable because its electron shells are full, or not at the right number.

Liz: (to Anna) So what do you think? Anna: The sodium is going...

Nathan: For it to be an ionic bond, it has to make an exchange of an electron that charges each particle, and then they are connected because they are charged oppositely. William: That's true.

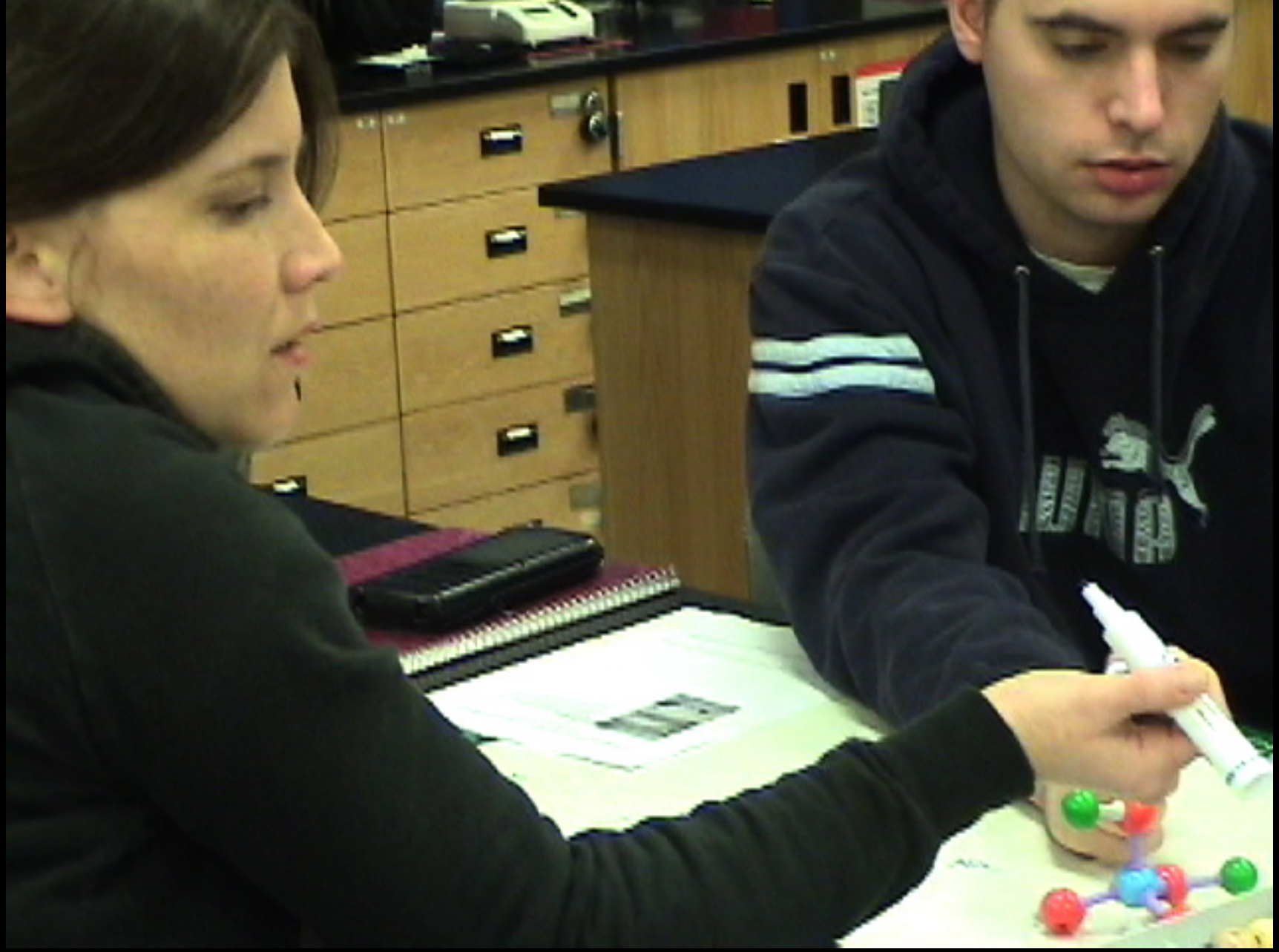
Liz: So it's going to pull the oxygen out of this? The reason I am asking it that these should be bonded to more than one thing. These two are sitting out here without...

Anna: I'm wondering what the hydrogen bonds do.

Nathan: They come in like this.

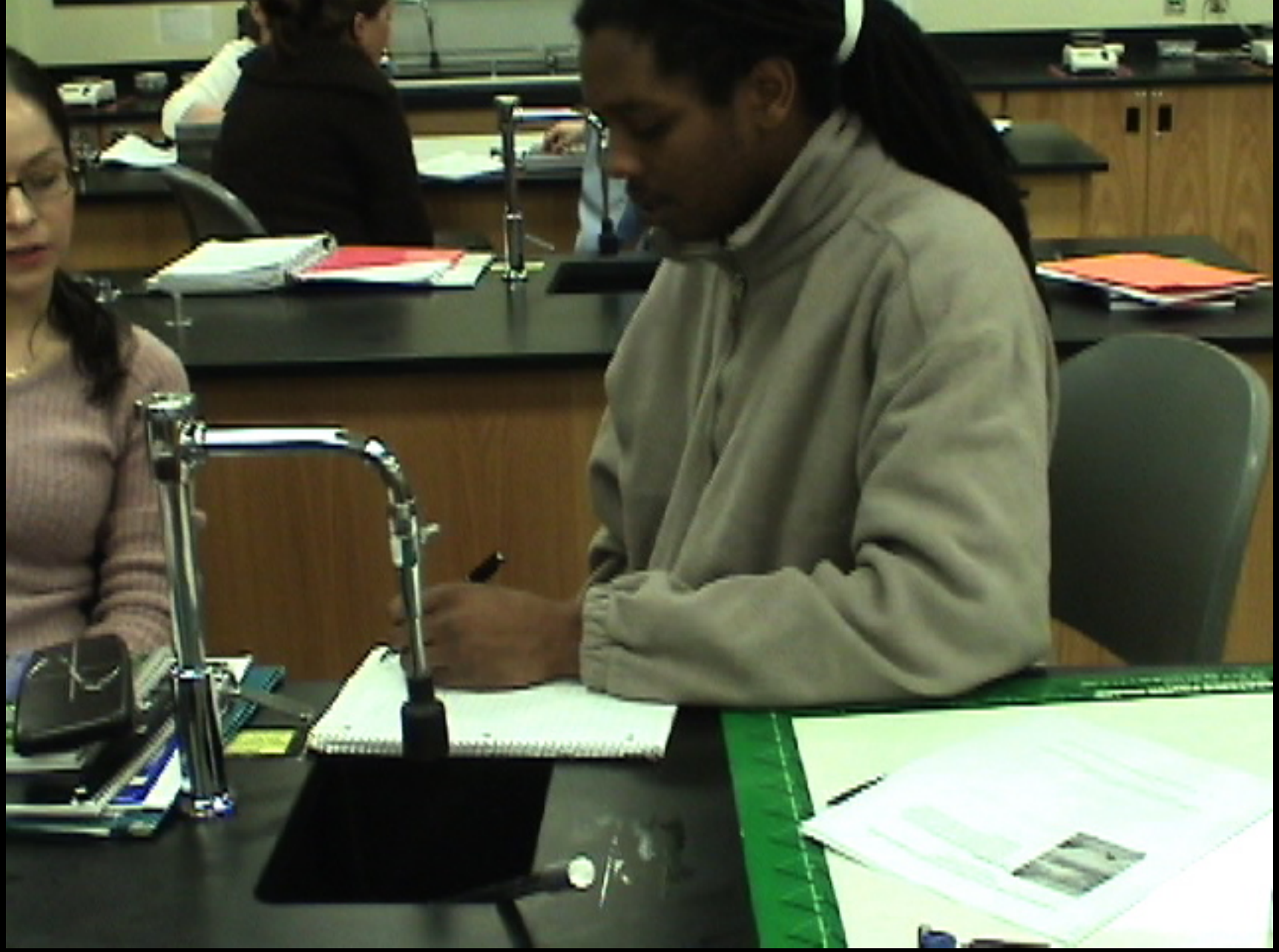
Anna: Doesn't it form a hydrogen bond?

William: No.

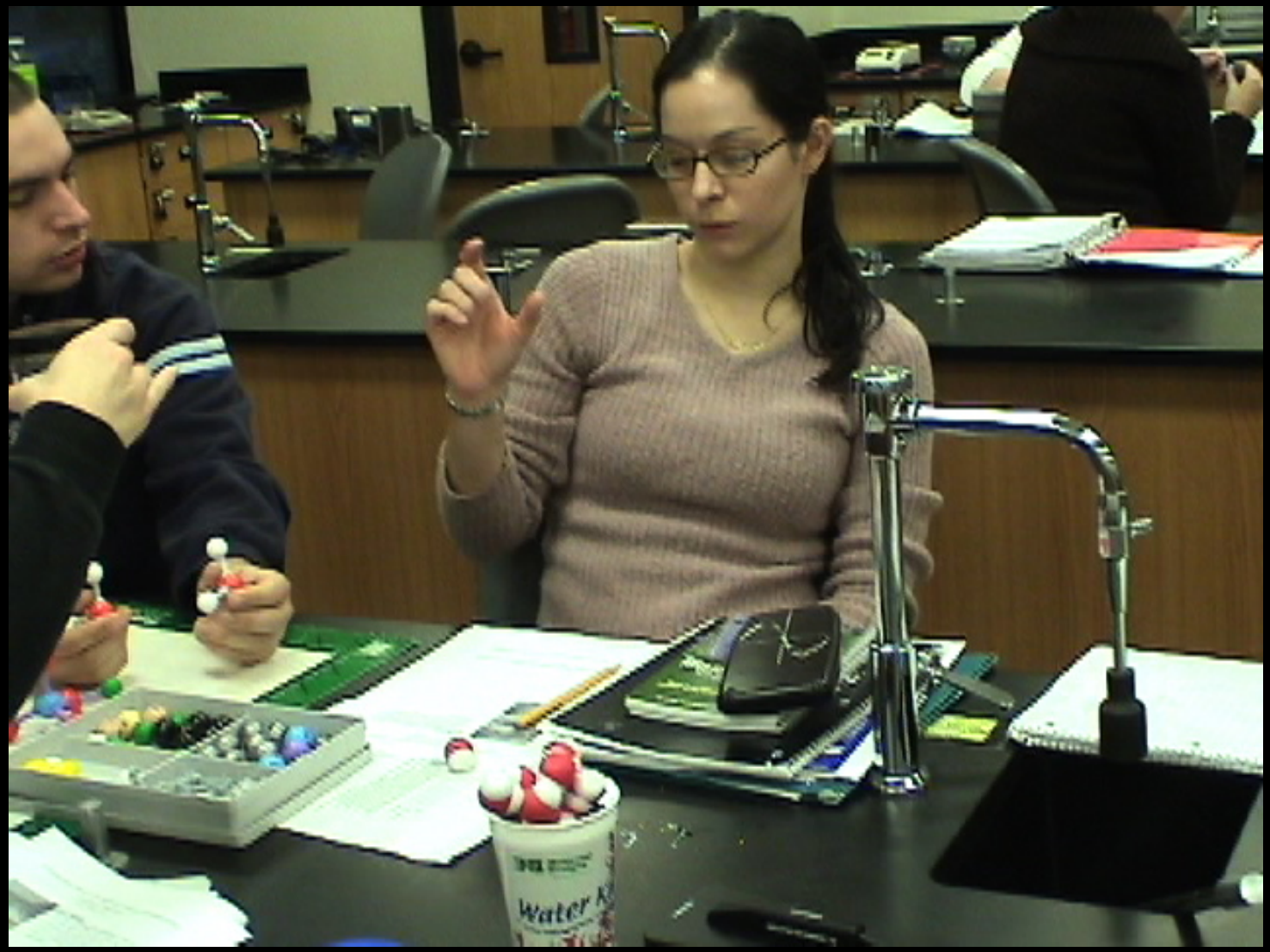


Liz: No. Because the water is acting as the...

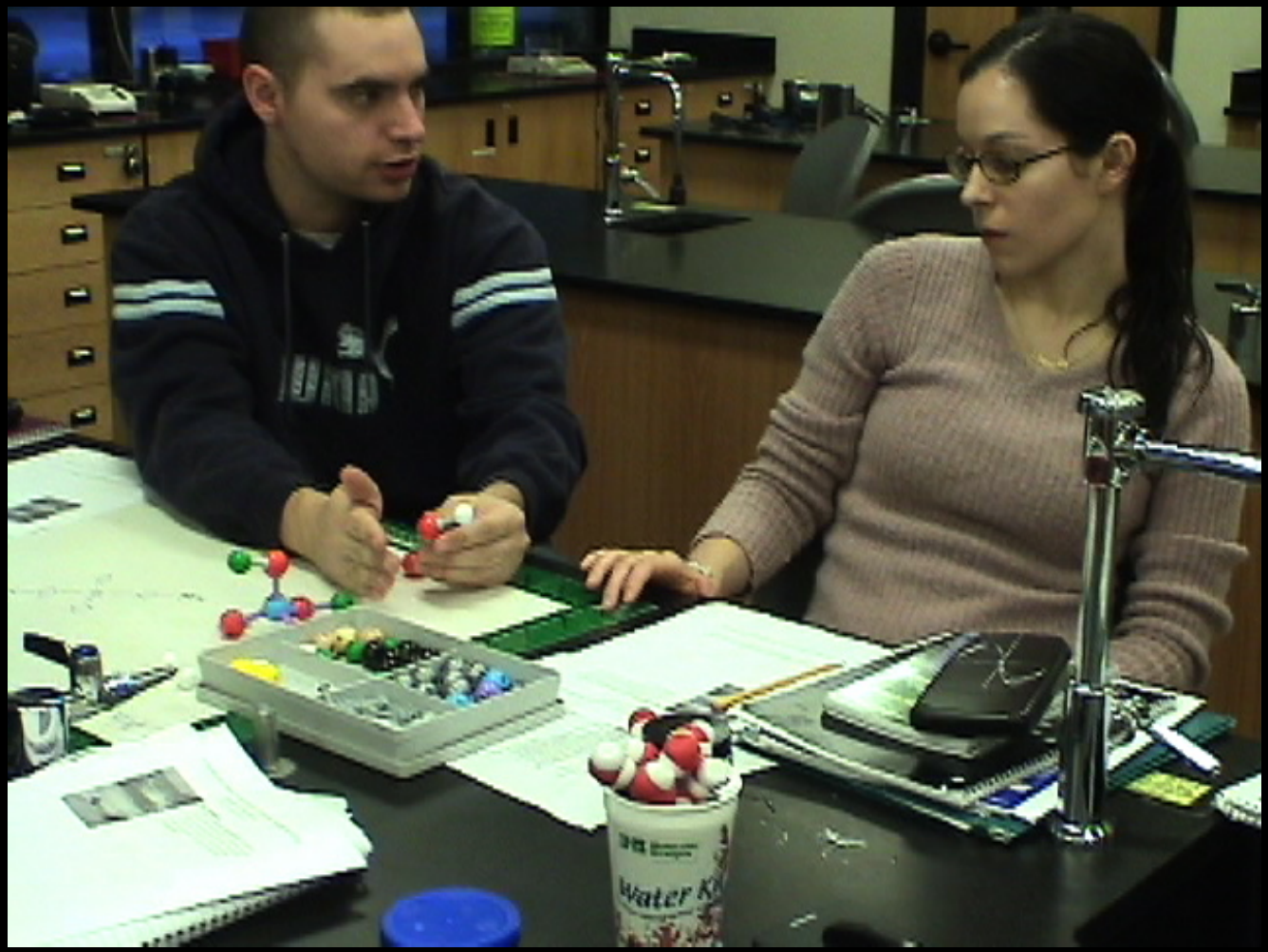
Nathan: It kind of forms a hydrogen bond.



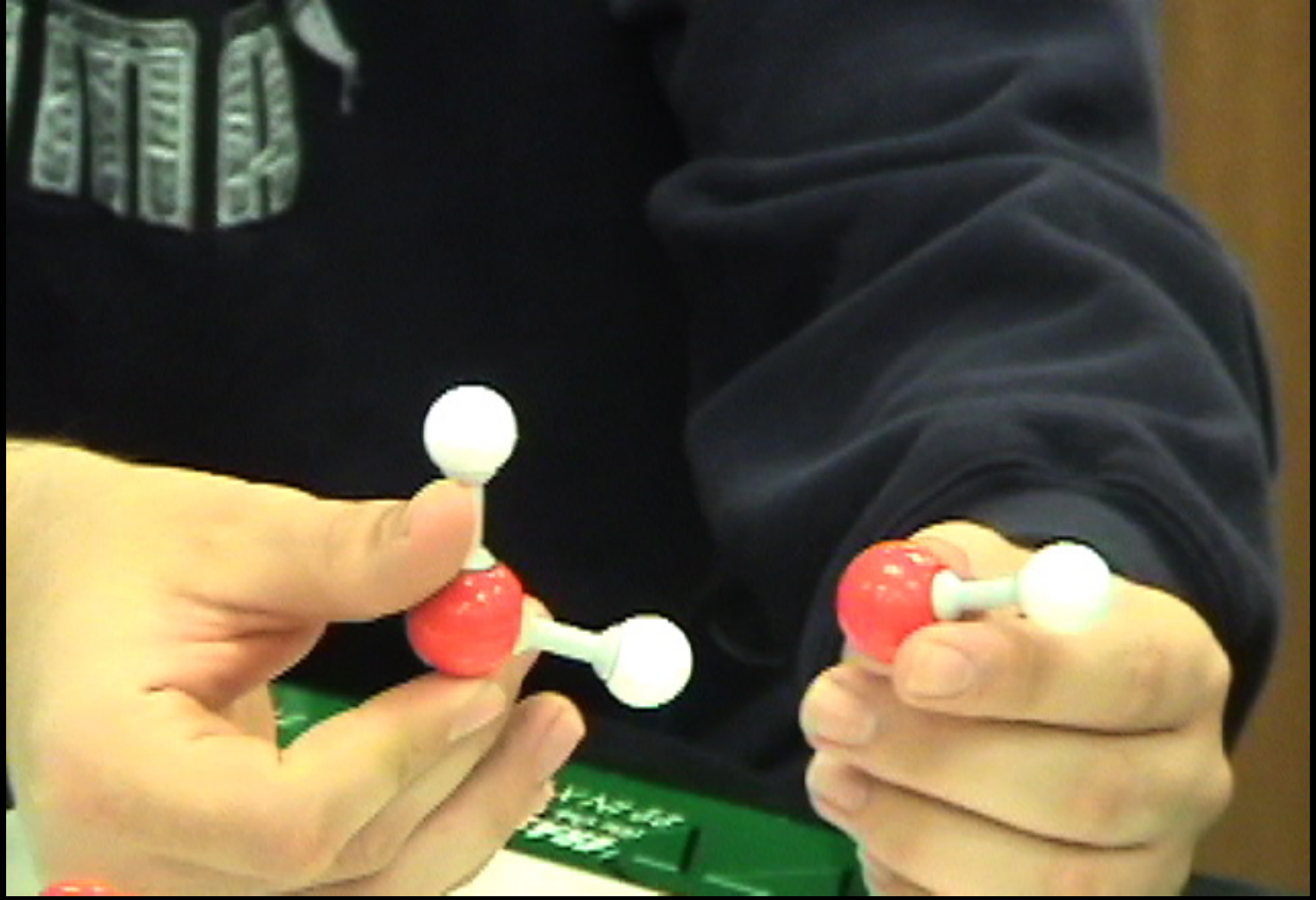
William: It takes it from the crystal lattice which is squarish...



Anna: Maybe I am describing a hydrogen bond from my anatomy classes. A chem chapter went into a hydrogen bond, something I don't think we've done yet.



Nathan: Hydrogen bonding in water is where these two hydrogens both gave up an electron to the oxygen, so it is negatively charged over here and positively charged over here.



Nathan: So if another molecule comes close, then it arranges itself so the negative charge is close to the positive charge.

Anna: OK. So our positive hydrogen is going to go... (pause)

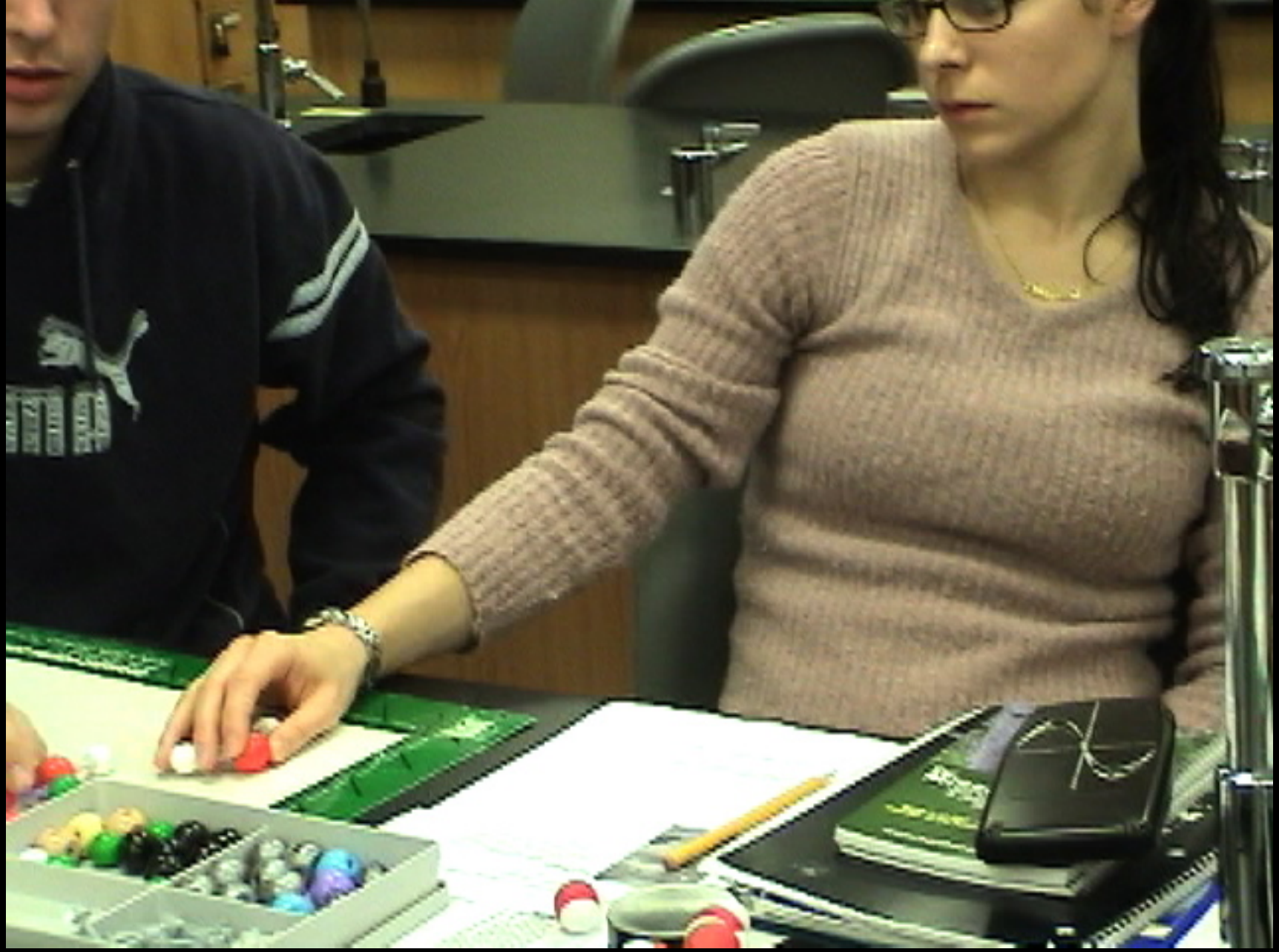
Liz: So what is the polarity on this thing?

Anna: Yeah.

Liz: So the oxygens on these are going to be negatively charged.

Nathan: No.

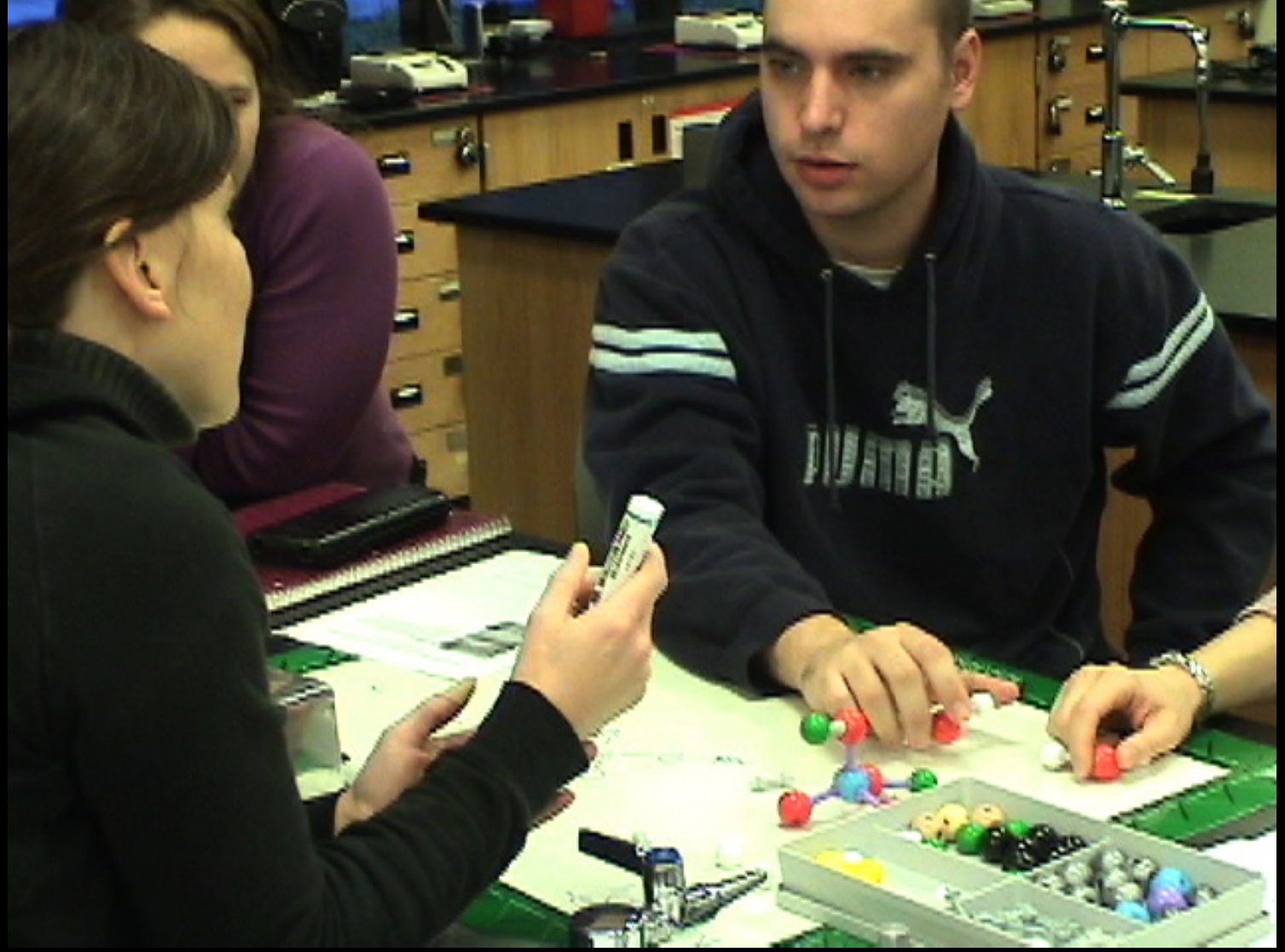
William: They have more electrons. The more electrons you have the more...



Anna: They have extra... They are not bonded as fully as they should be.

Nathan: Right. They get more electrons from the sodium and the sulfur, so they should.

Liz: But these two are...



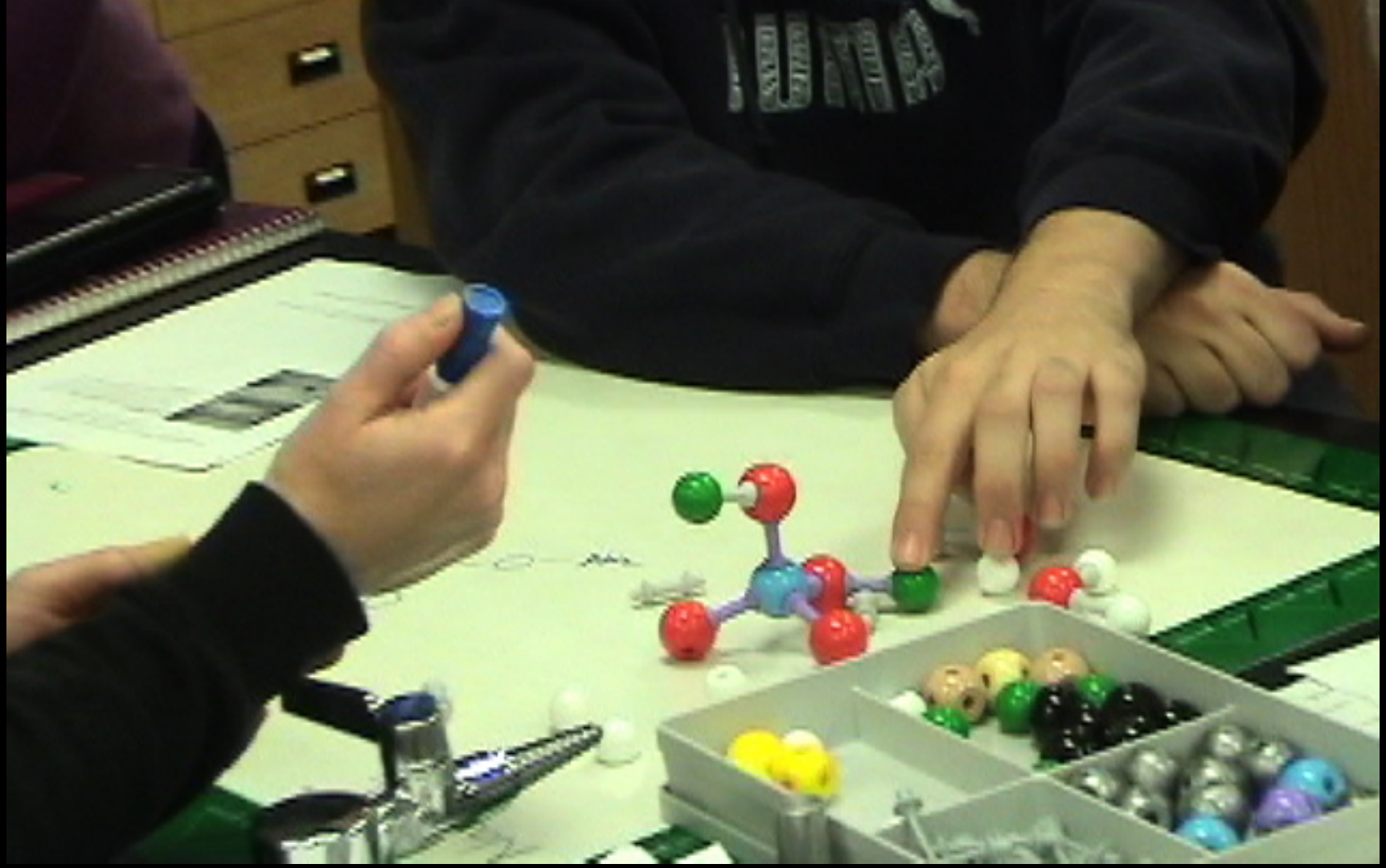
Nathan: They still have an extra electron.

Liz: So would that be what the water's coming to first?

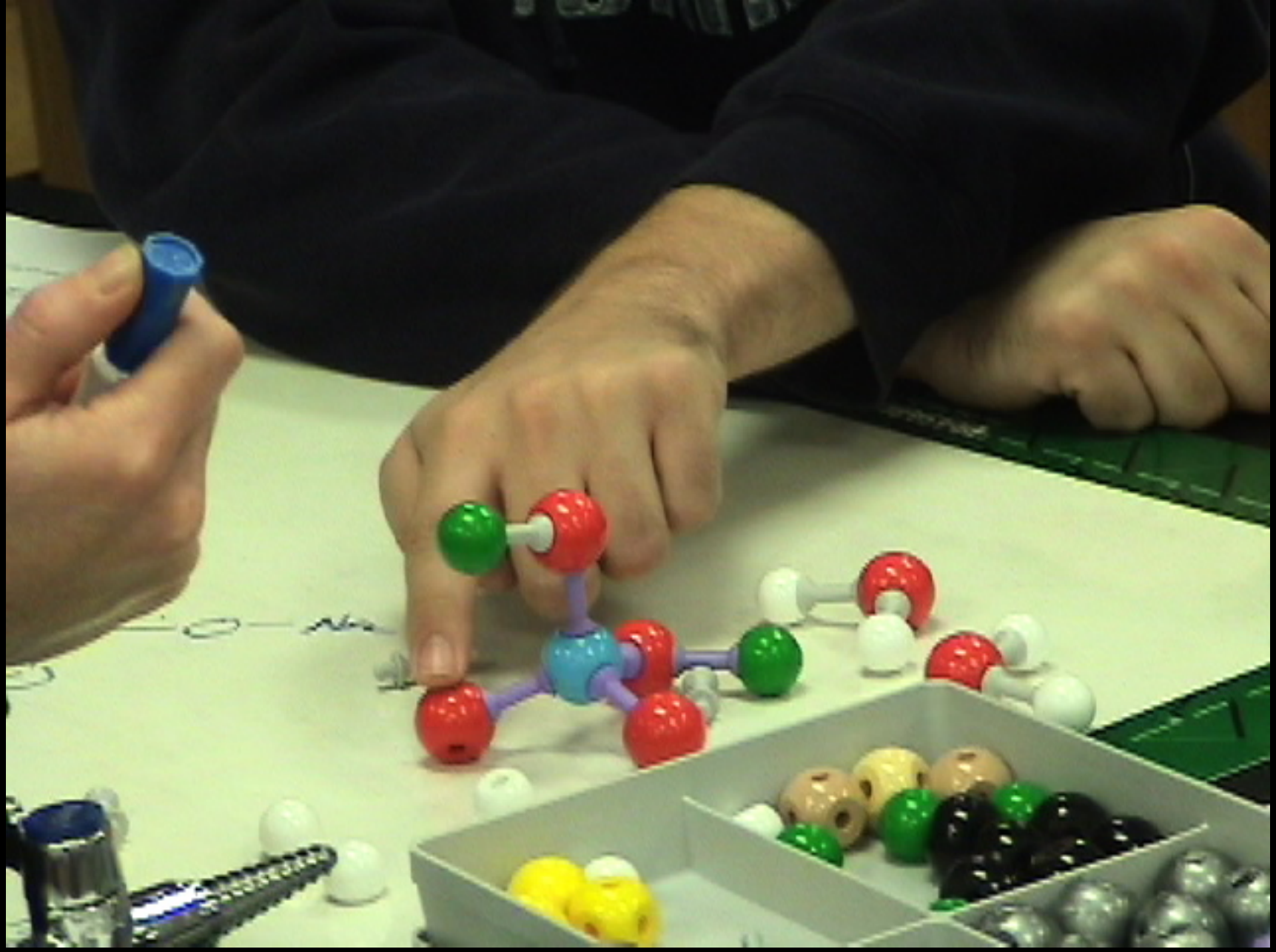
Nathan: Sure, it is quite possible that it happens... well, this is the most charged.

Liz: Is that one more stable?

Nathan: It's in two bonds. It might be harder to get out of the lattice.



Nathan: So, I don't know. I don't really see... This is one positive and this is one negative. I don't really see the difference between this one going first...



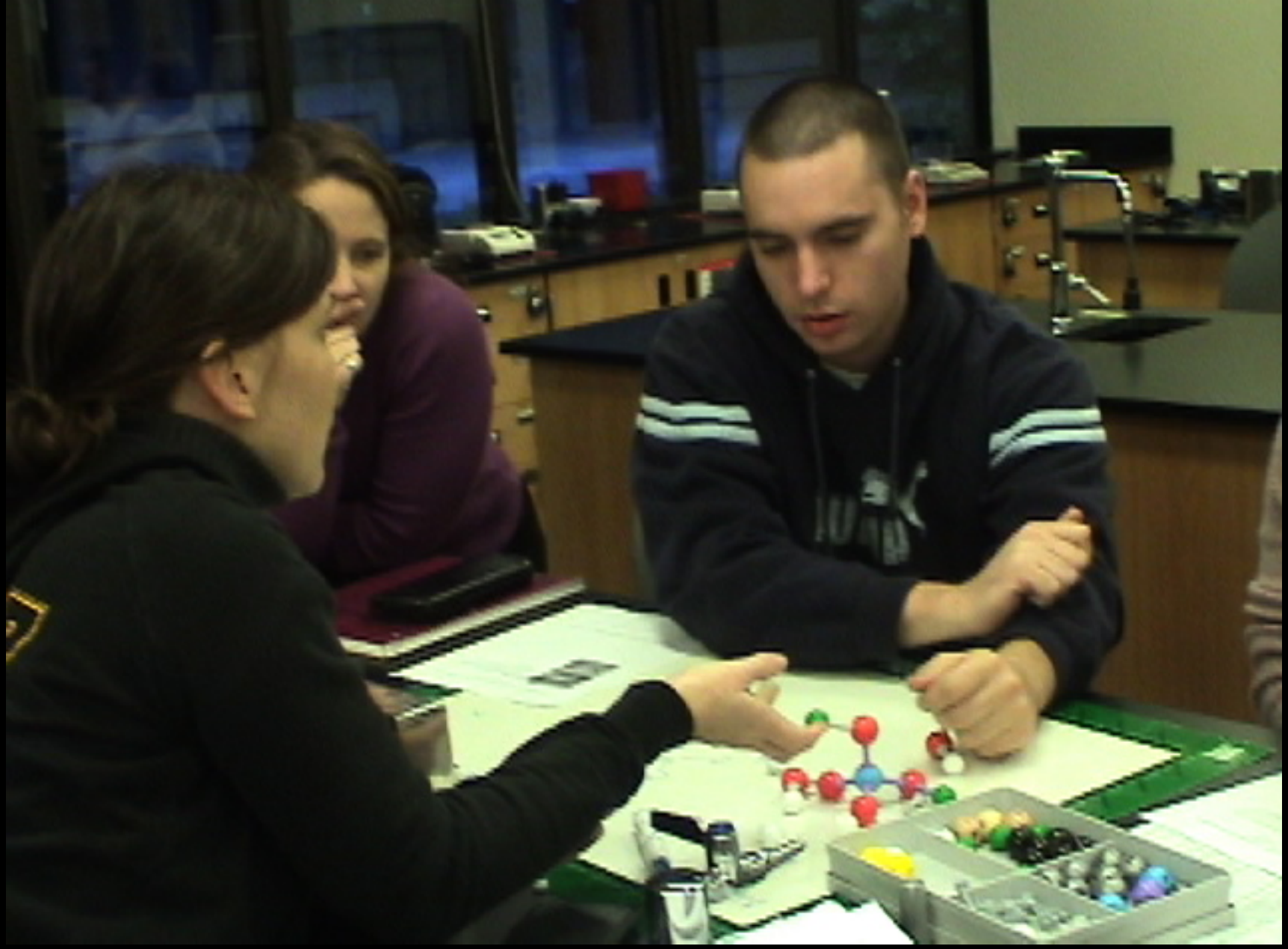
Nathan: ...and this one going first.

(long pause)

Liz: I suppose that is true.

Liz: This one can only form one bond and it has formed it. And these ones can form two bonds and they have only formed one?

Nathan: When the water molecules come in and take the oxygen...



Liz: That's what it would start to take off.

Kalyn: So the oxygen comes off in individual pieces when it goes into that solution?

Nathan: I am not entirely sure.

Kalyn: But that's your theory right now? Nathan: It's aqueous.

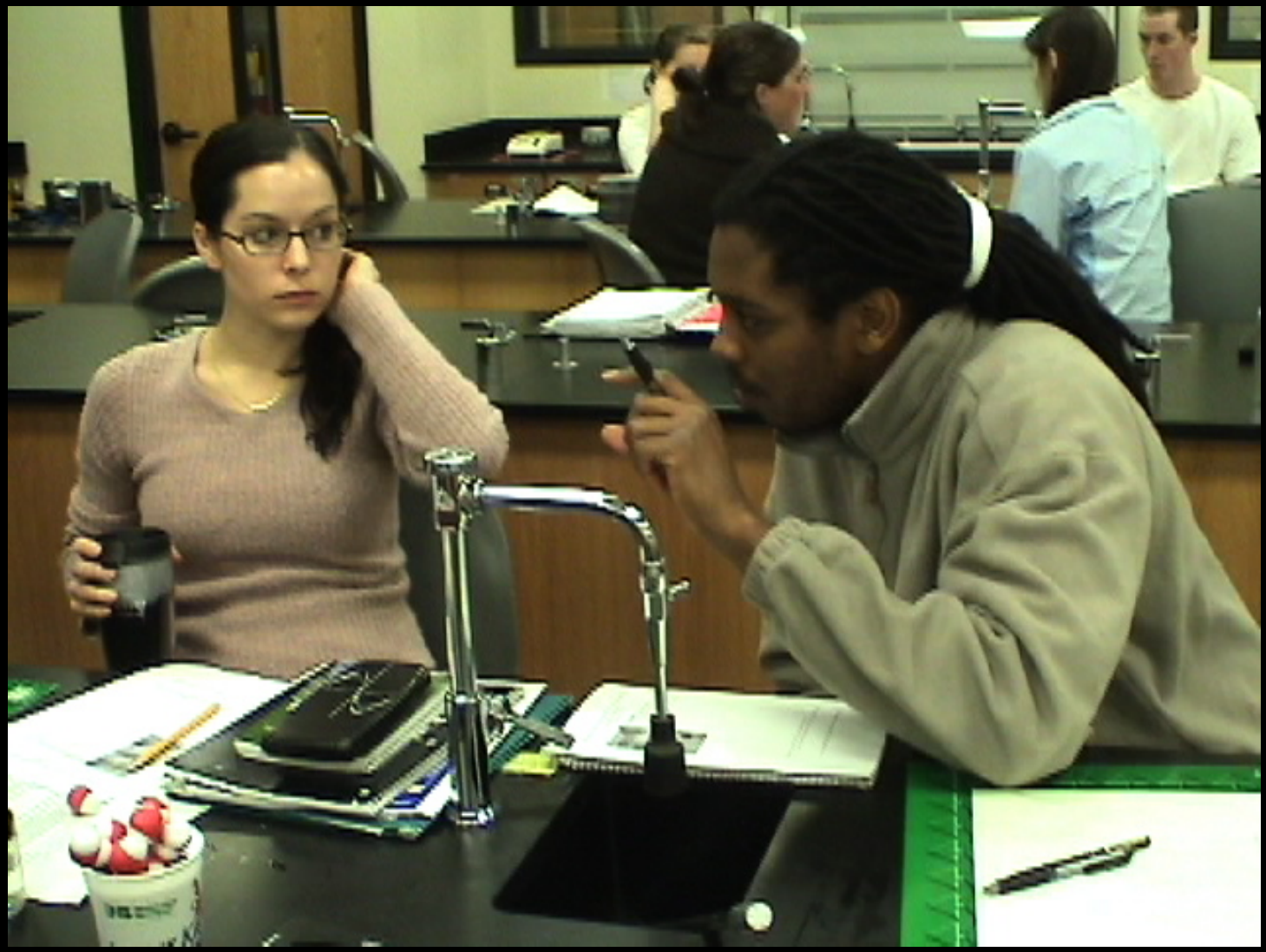
Kalyn: So what parts are in there? If an oxygen comes off by itself, what does it look like?

Nathan: It would be surrounded by water molecules.

Kalyn: So it would be O^{2-} in solution?

Nathan: Yeah. That's what I think.

Kalyn: Do you all agree that the oxygens come off?



William: No. I disagree. It is not a chemical reaction. The crystal lattice is being broken down into actual single sodium sulfate, salt, surrounded by the water.

Kalyn: So which part of the sodium sulfate comes apart? Or is the whole thing surrounded?

William: The sodium sulfate stays together. I know that sodium reacts violently with H_2O. So, there was no explosion there.

Nathan: When sodium chloride came apart there was no violent reaction.

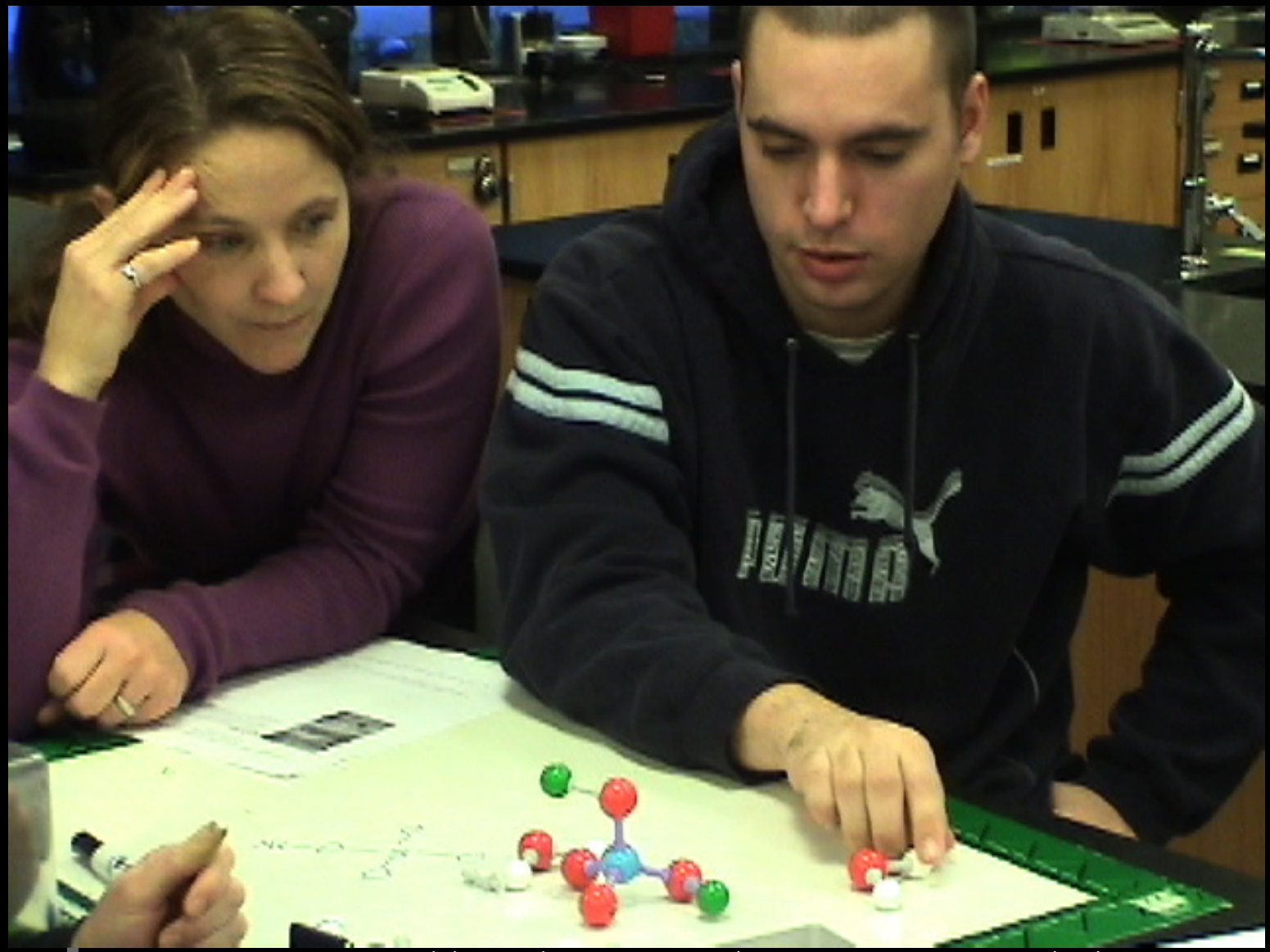
William: Sodium chloride. It wasn't actually chlorine and sodium in water.

Liz: But it broke apart into sodium and chlorine.

Kalyn: And how did it break apart? Into what parts?

Nathan: Ions.

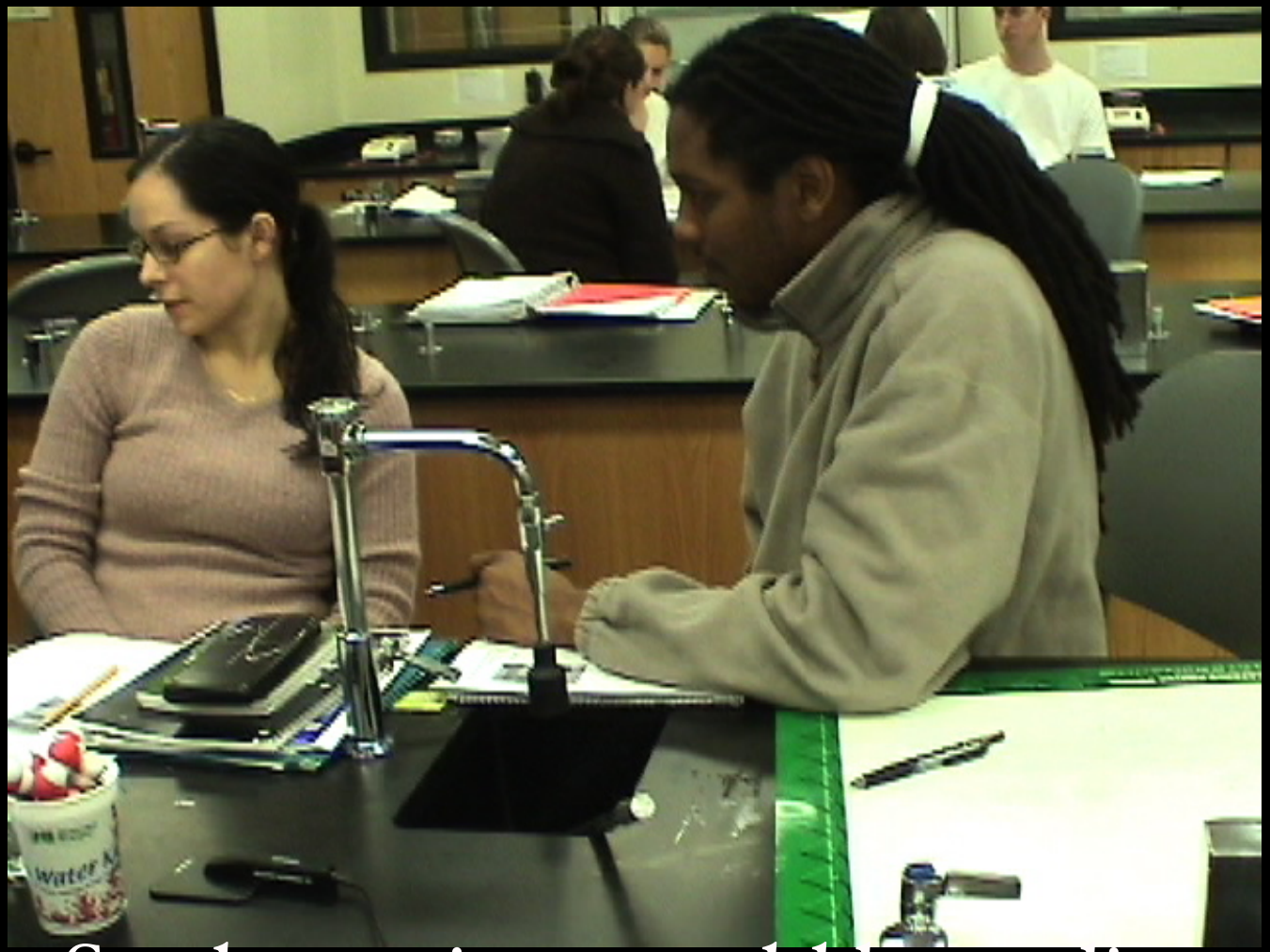
Kalyn: Could that be happening here? It is possible the oxygen atoms could come off, but then you'd be talking about a chemical reaction.



Nathan: Well, the sodiums could come off.

Kalyn: What would that leave?

Nathan: Sulfate.



William: So the easiest would be sodium to come off? Because there is a single bond as compared to the oxygen's double bond?

Kalyn: It is an ionic bond, held together by charges, the positive sodiums and the sulfate.

Kalyn: Why do we need two sodiums?

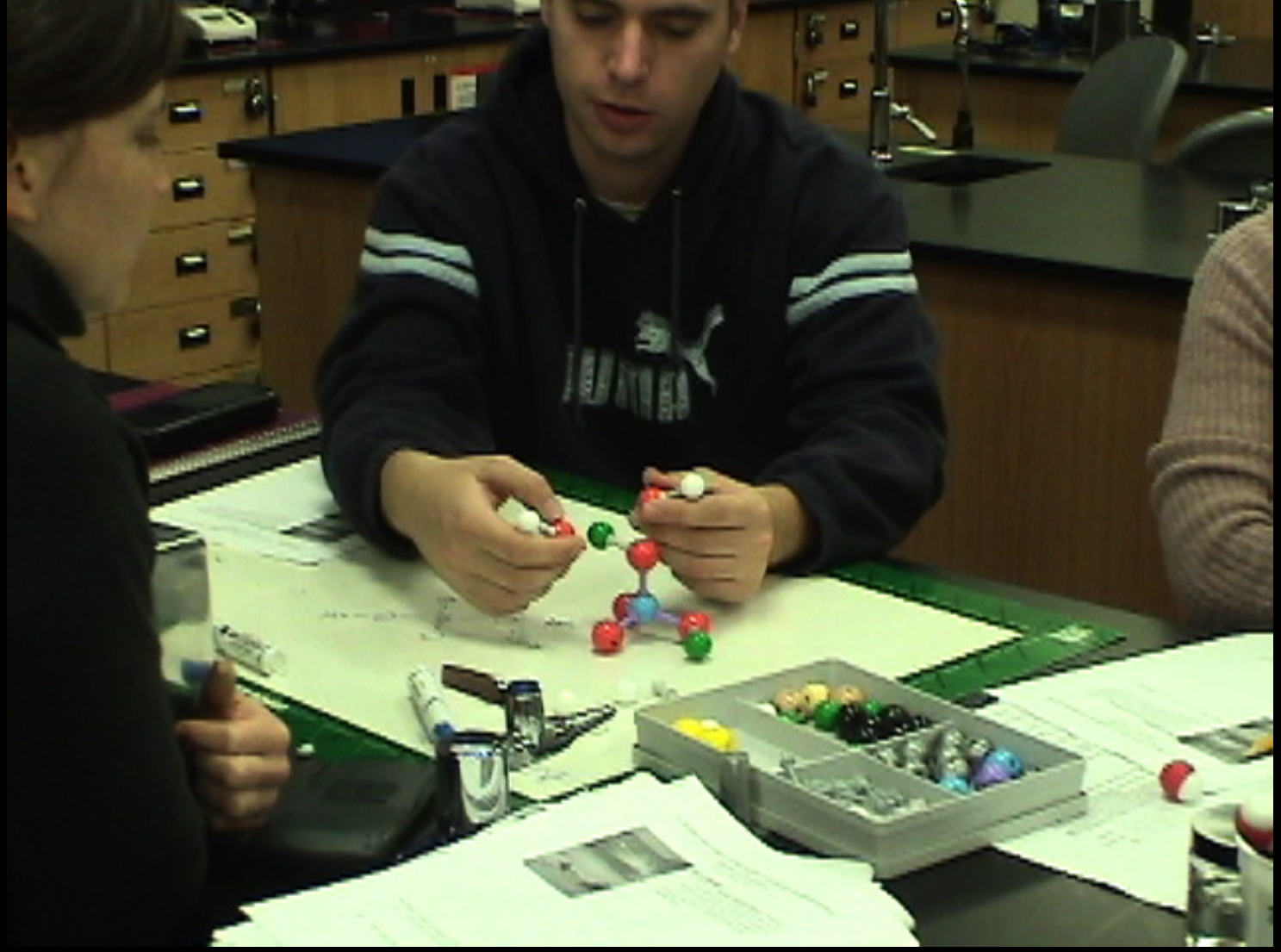
William: Because sulfate is a minus 2.

Kalyn: Sulfate takes two counter ions to have a neutral salt.

Liz: Besides the fact that it has H_2O molecules around it, what keeps it from reforming as a salt, since it has that charge that it would want to be attracted to?

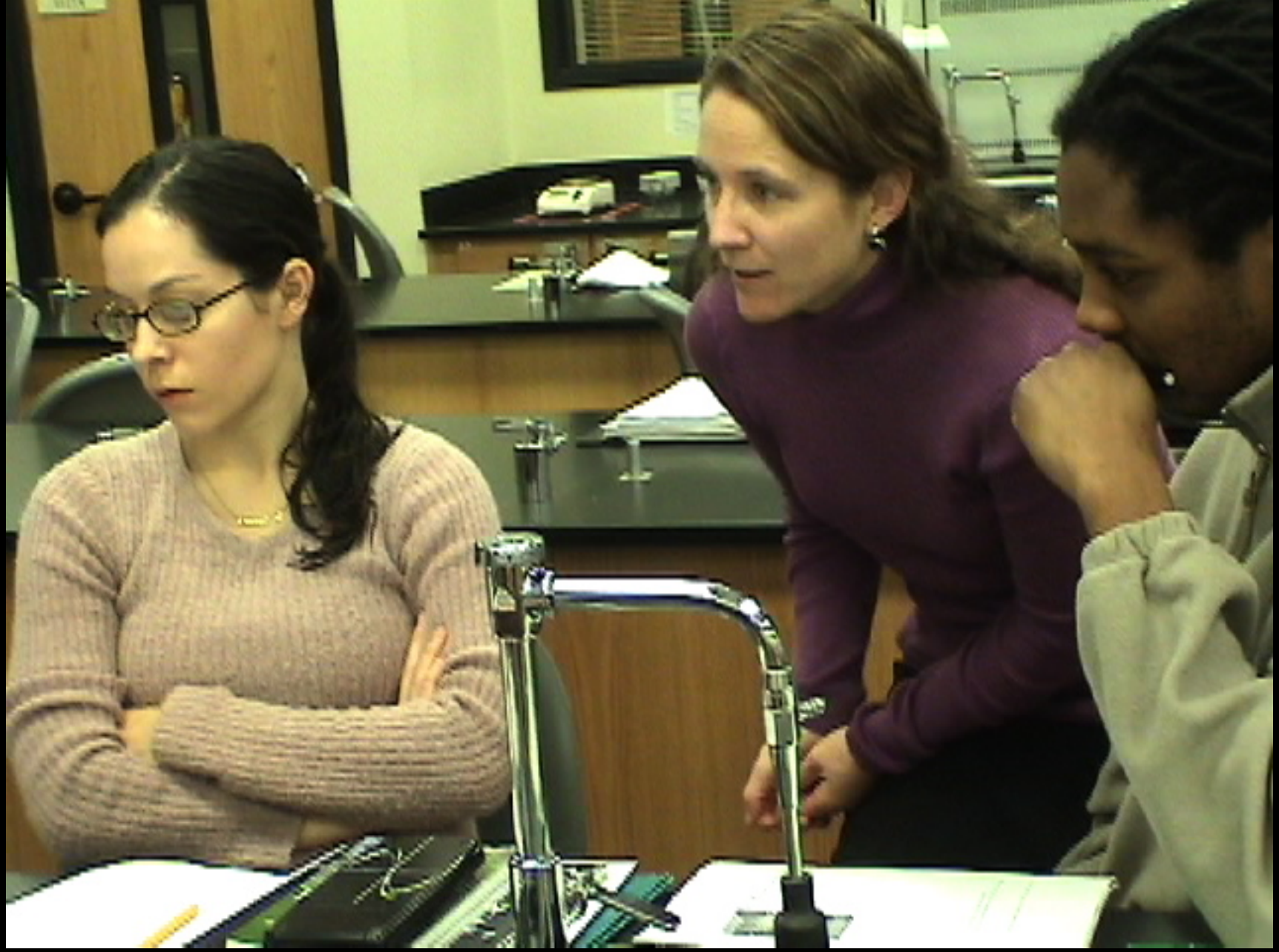
Nathan: OH! I get it.

Kalyn: What do you think?



Nathan: It is basically surrounded enough by all these polarized water molecules; any external magnetic pulls are not as noticeable.

Liz: Aren't as strong.



Kalyn: It can't form any bond with other ions; it can't find them.

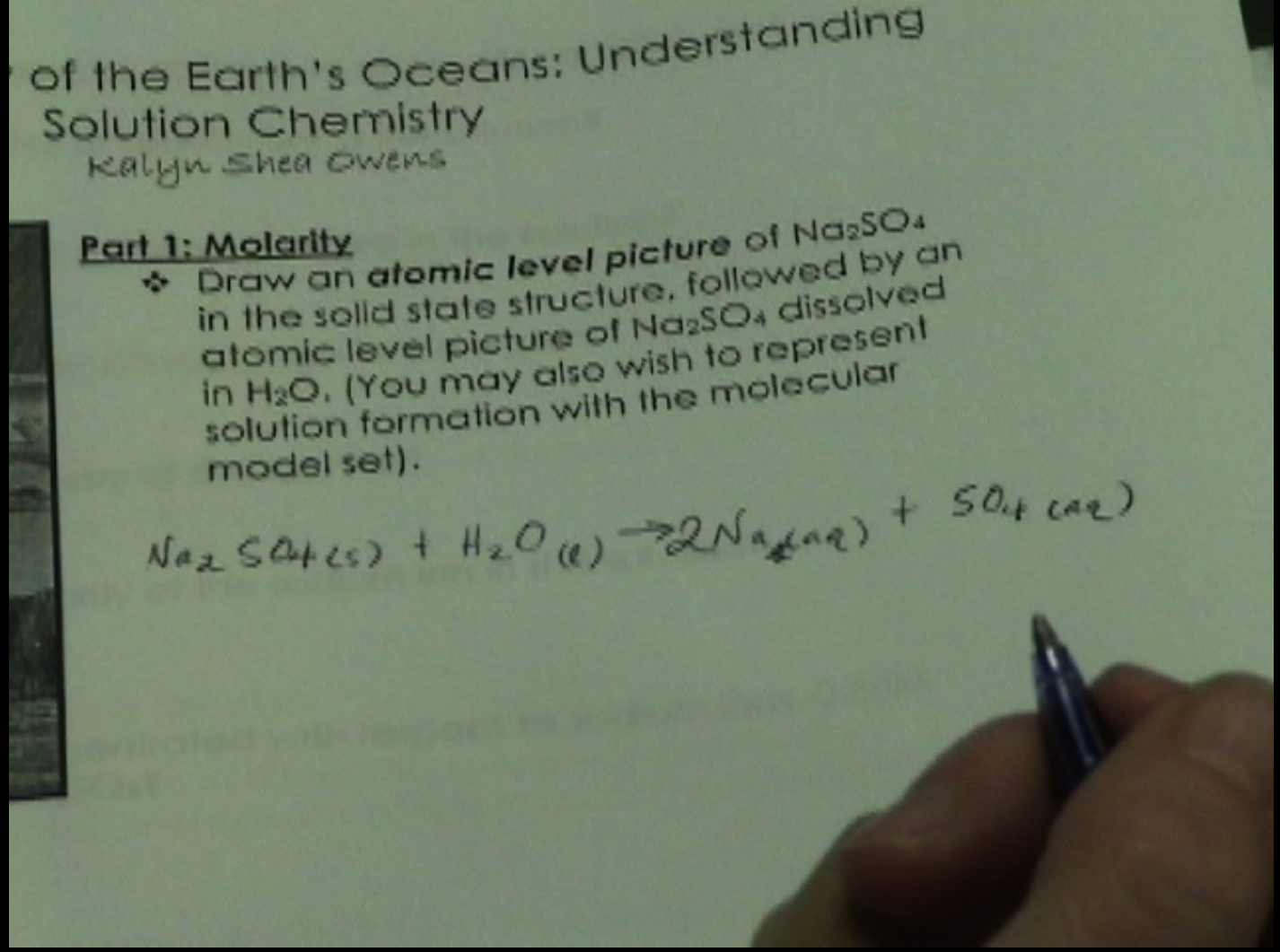
Anna: So in your actual reaction, is the end product Na_2SO_4 in aqueous solution, or is it the actual ions in aqueous solution?

Kalyn: What do you think?

Nathan: The Na^{+} is in aqueous solution and the SO_4^{2-} is in aqueous solution.

Anna: It's the ions.

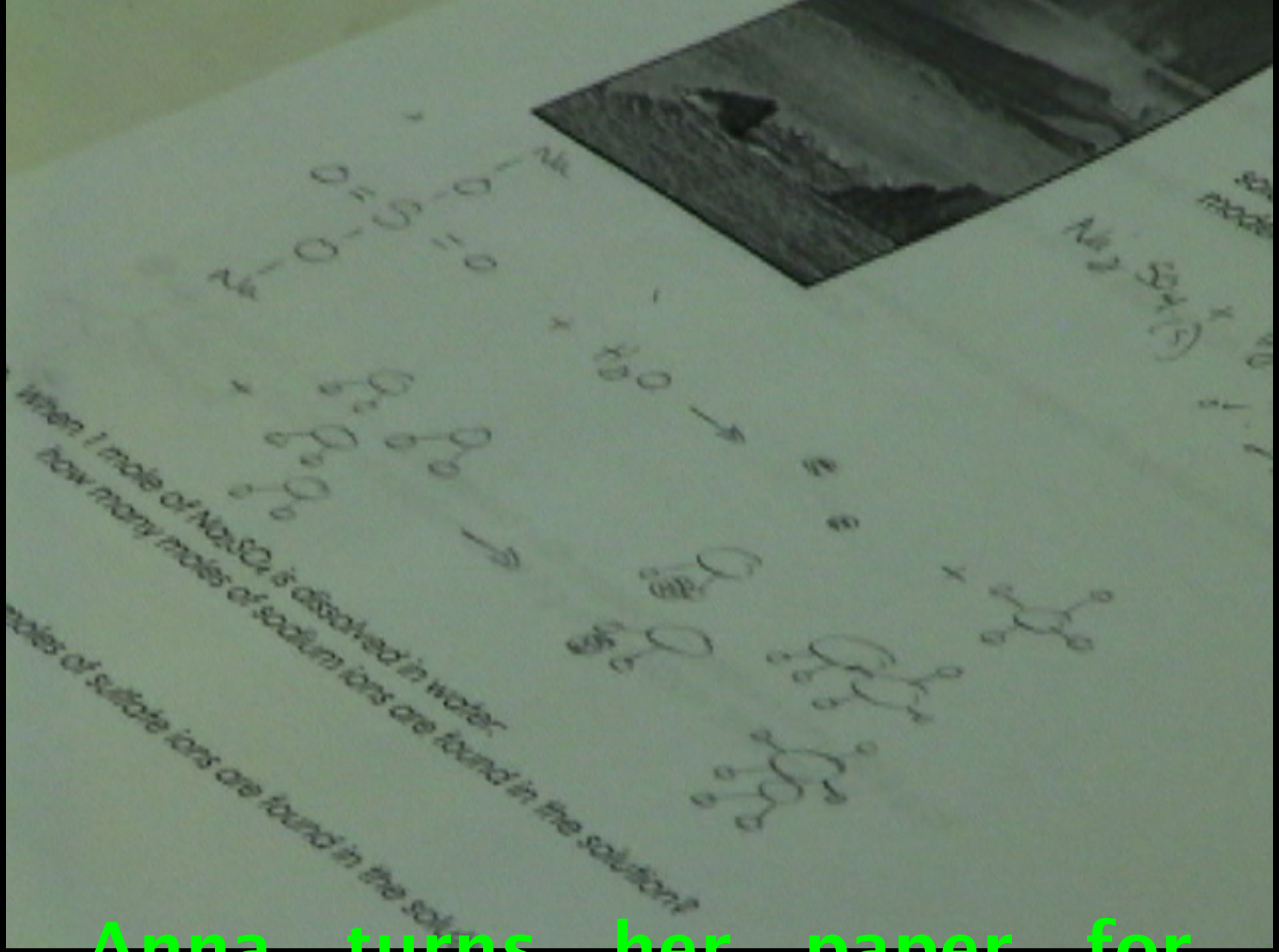
Kalyn: So you might show that.



Liz represents what it yields.

Liz: Do you need to put a charge on that?

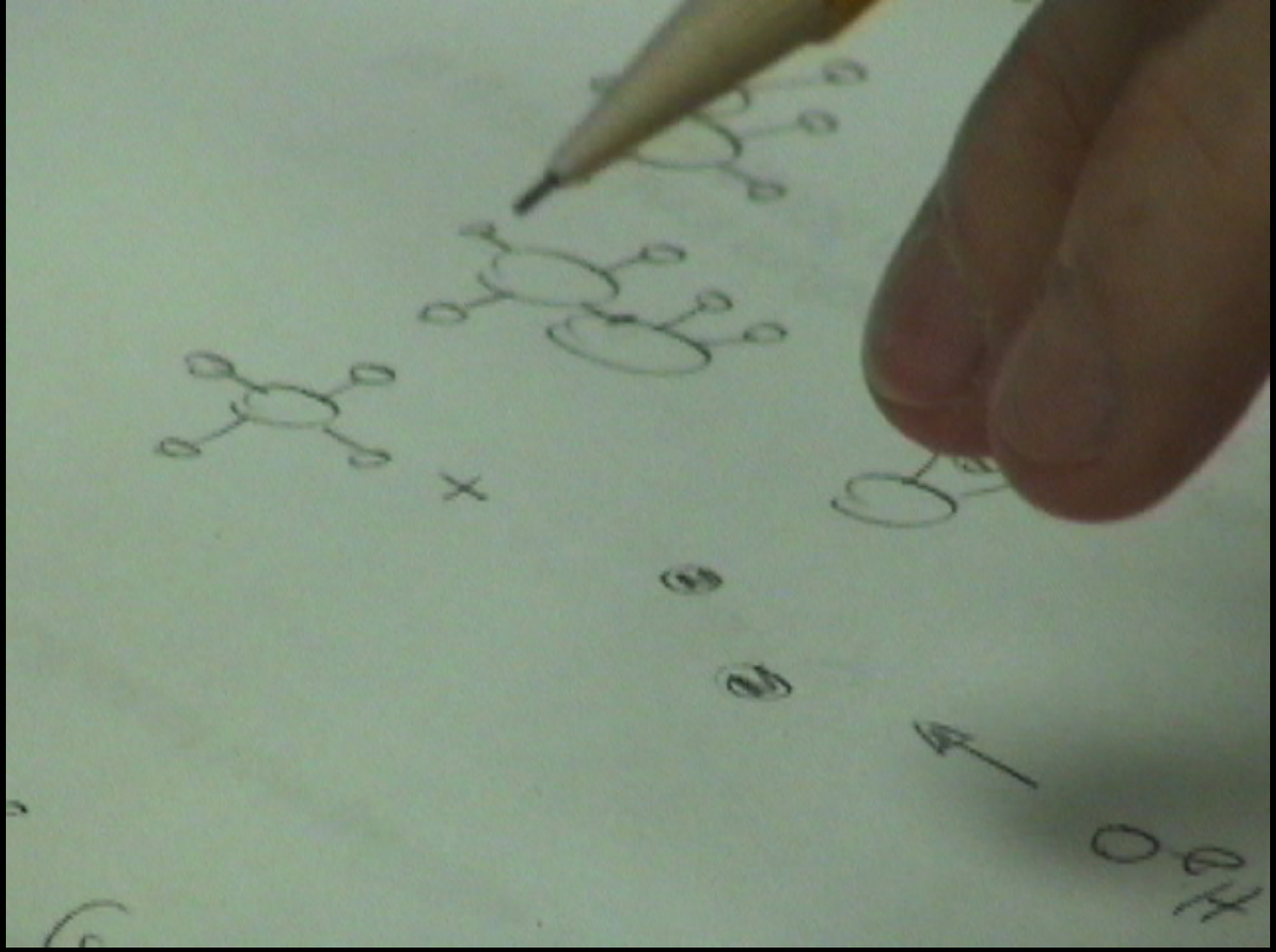
Liz: How are you drawing that?
Putting two water molecules?



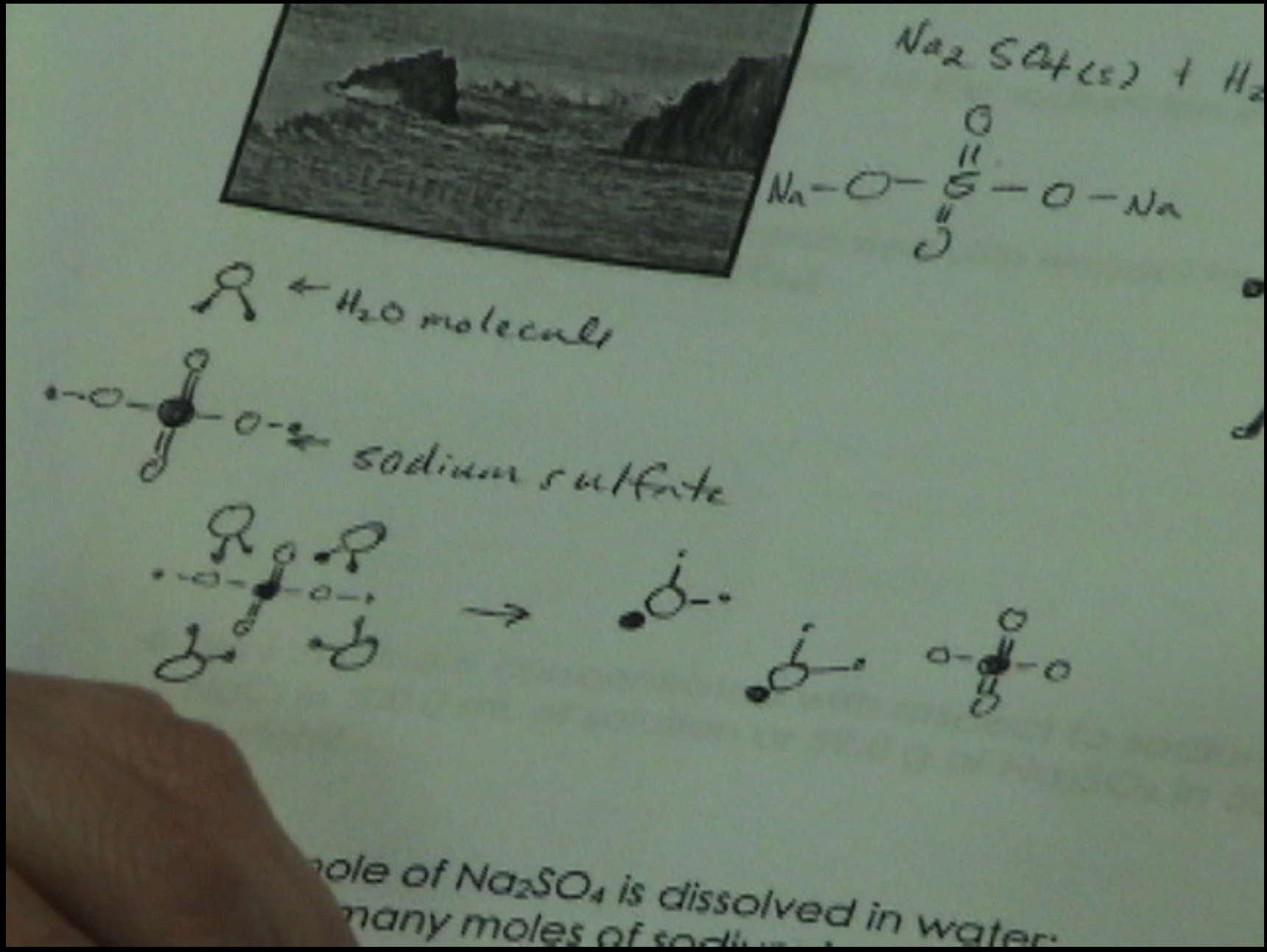
Anna turns her paper for Liz to see.

Liz: They look like little aliens.

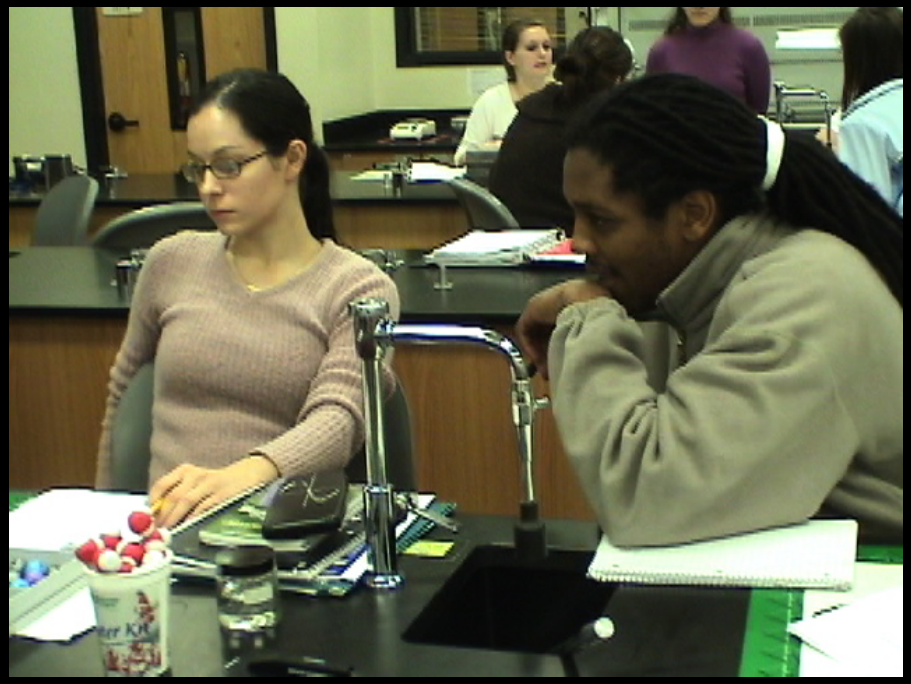
Anna: It's not scientific at all.

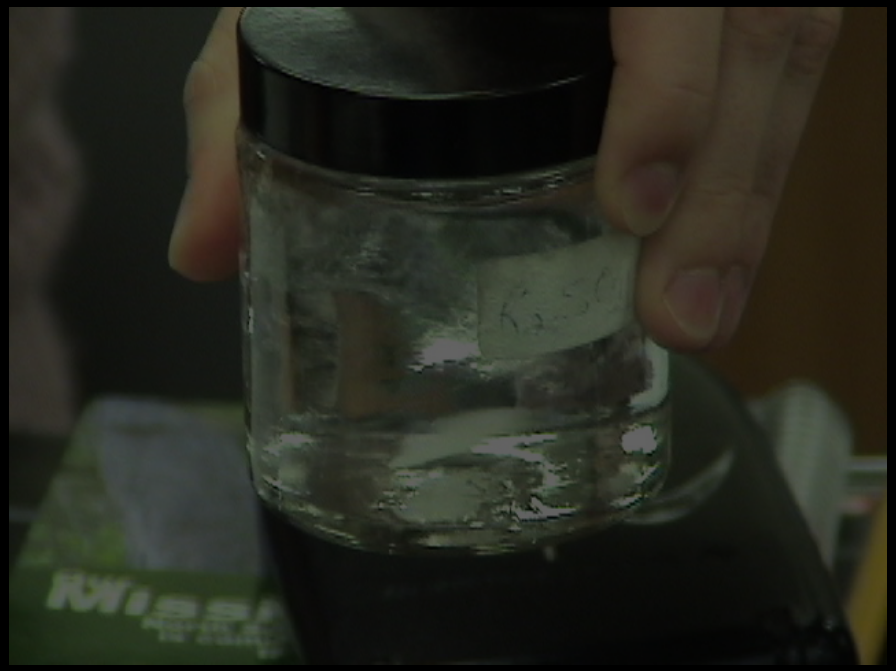


Anna: I am putting water molecules near each individual ion.


$Na_2SO_4(s)$ + H_2
H_2O molecule
sodium sulfate
mole of Na_2SO_4 is dissolved in water:
many moles of

Liz' drawing.





Representing Dissociation

Sodium Sulfate in Water

Dr. Kalyn Shea Owens

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