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3.091SC Introduction to Solid State Chemistry, Fall 2010
Transcript – Exam 2 Problem 5b



PROFESSOR: So now we're going to start Part (b). First we're going to read the question. To which does an atom of argon form a stronger bond: another argon atom or an atom of krypton. Justify your choice with an explanation, using narrative or cartoons or both that makes reference to the operative chemical bonding. So again, he's not just asking you for one or the other, but that you give an explanation to show that you understand the concepts that are being tested. Here we're asked: does argon bond stronger with another argon or krypton. And some students were confused by the usage of the term bond here. But remember that bond doesn't necessarily mean a covalent or an ionic bond, it can also mean intermolecular bonds, which we have been using in Part (a), so it might seem logical that we would think about intermolecular bonds in Part (b).

Now we need to look at the specific species we are asked to consider here. Argon and krypton are both Nobel gases, and what do we know about Nobel gases? They have complete octets; they don't bond very often, and so, especially to each other. Therefore. we will probably be looking at intermolecular bonds, as I said before, but also the weakest form, which is Van der Waals. We're looking at Van der Waals, because each of these are a mono-atomic species. That is, they just are gases as one atom of argon and one atom of krypton. And so, Van der Waals is the only type of interaction they can have. As I said in Part (a), Van der Waals has to do with the movement of electrons in an induced dipole. And what does that mean? So, we're going to talk a little bit about polarizability. And polarizability is basically how easy is it to induce a dipole into the atom or molecule.

And because these are non-polar atoms, obviously, we want to think about what can cause a difference in polarizability between argon and krypton. So if you think about it, we're going to do a very simplistic model of the atom. We have a cloud of electrons, and to get intermolecular interactions, we want to have a partial negative and a partial positive induced in the atom. And this can be due to just spontaneous fluctuations in the electron density or to an external charge or another molecule or something. But here we have two non-polar atoms, so we want to see which one will inherently be easier to polarize.

And so if we go back to our two species here, we have argon, which has 18 electrons and krypton, which has 36 electrons. So based on our discussion of polarizability, we can see that krypton is going to have a greater amount of polarizability, because it has a larger cloud of electrons. Those electrons are bound less strongly. As we know from our periodic trends, krypton is a larger atom, and so we are going to say that the polarizability of krypton is greater than argon.

As we talked about in Part (a), even though these had the same type of intermolecular bonds, if one of them exhibits a higher difference in partial charges as krypton will, then it results in a stronger bond. And so the answer here would be that krypton has a stronger interaction because it is more polarizable. And that because is important. Remember, when you're answering a question, you don't just want to put down the answer, you want to show that you know why that's the answer, and that you understand the concepts.