SAL: Hi. I'm Sal. Today we're going to solve problem number two of test three of fall 2009.

Now before you attempt the problem, there are certain things that you need to know to solve the problem. One is mechanical properties of metal and also the properties of amorphous metals, which are known as metallic glasses, and how to draw crystal structures given to you.

The problem reads as follows-- for a given alloy composition, explain why the yield strength of the amorphous form, the metallic glass, is greater than that of the crystal form.

Now in order to answer this question, you want to start thinking about the mechanical properties that these two raw materials have. So if I look at a metal, I know that the way a metal deforms before it reaches classic deformation-- it deforms the planes sliding past one another-- so it's known as slip. So I know that metals-- they form via slip and slip is facilitated by dislocations and you should know what a dislocation is by now, which is just a line imperfection in your crystal. So slip is facilitated by dislocations. So I know that my metal has planes that are arranged because it's a nice crystallographic structure-- and that the slip-- when it undergoes deformation, that this is actually assisted by dislocation. So having dislocations helps to form our metal. So now I want to start thinking about what a metallic glass has-- so the amorphous form.

So if I look at the metallic glass-- and all I'm doing here is comparing the basic properties between the two-- so this is going to get me metallic glass. I know that for metallic glass, there's no long range order. So the fact that there's no long range order means that these metallic glasses don't form a perfect crystal array. And that lack leads to metallic glasses having no dislocations. So if a metal slip is facilitated by dislocations and if a metallic glass doesn't have dislocations, then I would assume, just by comparison between the two, that the threshold for one of the materials to yield would be due to the fact that-- whether or not I have dislocations. So with this argument, I would say that the metallic glass has a higher yield strength than my metal because of this property. So that-- if you did that-- if you went ahead and wrote all that out for your answer in part A, you should be able to get most of the points for this problem.

Now part B-- it asks, on each of the following separate drawings of one face of an FCC unit cell-- FCC stands for face centered cubic-- indicate one of each of the following. So now we're going to move on to part B-- and part B wants-- there's three scenarios.

One-- it wants us to indicate on a face of a crystal, a substitutional impurity-- so substitutional impurity. So if I look at-- if I draw a face-- here. I can-- so to find out what the definition of a substitutional impurity is, I know that it's not going to be anything that can be just embedded in between atoms-- like an interstitial. I know that it's going to be a substitutional impurity. So if this is one of the faces of your crystal-- and it's FCC, which is face centered, from the face-- the face is centered on the center of an atom on your face. Then I would say that if I substitute this out for a different atom of type B compared to these atoms, then that's a substitutional impurity because that atom is not the same as the other. It's like having silver and gold, for example, in composition. And then it also asks for the second part. So that's number one. For number two, it wants us to demonstrate a vacancy.

Now a vacancy is simply an atom missing from a normal lattice site on your crystal array. So if I draw again another face, then I can leave that blank and I can go ahead and I can point and I can say that the vacancy is actually-- sits right here. So this is my vacancy. There's no atom that's there. It moved out of its place. So that's another defect that we put in there.

And for three, it asks, an interstitial impurity. So what's interstitial? Well, an atom that can fit in between two atoms that are different than the one that fits. So if I draw again an FCC face, I notice that there's certain spots where an atom of a different composition can fit and I can go ahead and I can just put a-- that's an atom of different composition and that can very simply be your interstitial. So that's your interstitial impurity.

So knowing the definitions, you're able to answer this problem very simply. There was no math involved in this and all you needed to know was knowledge of our mechanical properties of metals versus amorphous metals, which are known as metallic glasses. And knowing that information, you're able to answer a question like this, which is pretty simple after you finish and you think about it. And if you didn't know what FCC was-- which stands for face centered cubic, you could have probably lost a lot of points on this problem. But if you know that, if you know how to draw it, then you're good to go.