MARK HARTMAN: This exit sign. So those are our important observations. Let me introduce to you-- I'm going to tell you how we're going to change the particle model of light. We're going to add this in. Remember, before we had-- this is what I want. Before, we said that light is a bunch of particles that are traveling outward from a source at all directions in straight lines moving at the same speed.

So what I want you to do now, is we're going to say addition of color to particle model. Remember, we also said that those particles we're going to call photons. Now, we're going to say each photon can be a different amount of energy.

Before, we said those photons that were traveling outward were particles of energy. We're going to refine our model a little bit. We're going to say each photon can be a different amount of energy. Not all photons have to be bundles of the same amount of energy. Remember, a photon is our particle of energy. And we're just going to say that humans experience photons with different energies as different colors.

Humans experience photons with different energies as different colors. So color is a word that we've made up to talk about how our brain interprets photons of different energies. So if I again draw my model, here's my light bulb or light source. Before we just said that there were photons, these particles of energy coming out in all directions. Now we're going to say each photon is a different amount of energy.

So we're going to say there are some photons that have an amount of energy that when those photons are received by our eyes, we interpret them as the color blue. All right. So there are some blue photons, there are some green photons, and there are some red photons.

Now, right now I'm just kind of telling you that red, green, and blue, but there's every possible imaginable color. Each one of these photons is a bundle of energy that's a different amount.

For instance, red photons carry smaller amounts of energy; green photons carry larger amounts of energy; and blue photons carry even larger amounts of energy. So this is our addition of color to the particle model. So let's think about how we can use this to interpret or to build a model, not just of color in general, but let's build a model of how the filters work.

So what I want you to do with your group for just a couple of minutes, I want you to think about how could I make a drawing that if I put a red filter here, red filter-- based on our observations here I want you guys to make a model of if we had a detector over on this side, which we're going to say is just our eye, what's going to happen if we look at this object, which is a light bulb, which puts out all of these different colors?

What would we see over on this side based on the fact that there are photons of all different colors coming out of there? So just for a couple of minutes think with your group, how could you represent what's actually going to get over here? Bring a couple of ideas floating around. Does anybody want to come and volunteer to tell us what they think. Asith. Go ahead.

ASITH: [INAUDIBLE].

MARK HARTMAN: OK. So that was great. Would somebody like to come and draw a picture of that? How could we represent this on our diagram? Somebody else from your group? Nicky, Island?

STUDENT: I can try.

MARK HARTMAN: Yeah. Try for it. So let's represents in our diagram here, which I know you guys don't have color to put in your notebooks, but maybe you have different shapes. You could represent the red, green, and the blue by different shapes.

OK. So explain to us what you drew and why you drew it that way.

STUDENT: The red light goes through the filter. So it goes through. You can see it. But the blue and the green light doesn't go through the filter as much, so we can't really see it. And it stops there.

MARK HARTMAN: OK. That's great. This is a great representation, this is a great model of what filters do. If you have a red filter it lets the photons of red light through, just like when we looked at the exit sign we look at the exit sign through the red filter, it lets that red light through. But if you put a green filter up you can't see the red light. Why not, Jalen?

JALEN: Because it blends in with the background.

MARK HARTMAN: Well, it blends in with the background. But why? Why in terms of our particle model?

JALEN: You can't see the red, that you can see like how it says exit. You can barely see it.

MARK HARTMAN: You can't see the word exit because does the red light get through a blue filter?

JALEN: No.

MARK HARTMAN: No. So the blue filter only lets through blue light. So if you look at the red exit sign with blue and green filters, it's going to block the red and only let blue and green through. But since there's no blue light or no green light coming from the exit sign, you don't see anything.

OK. So we've now built this model. Let's actually say this is a model of how filters work. So let's say they block all photons except the color of the filter.

So are light and color two different things? No. Color is a property of light. Color is describing the energy of those different photons. It's not that color is a separate thing from light, but color is a property of light.

So what we're going to do now is we're going to use this model. We took some observations, we developed a model of how this works. Let's test the model out. Let's make some predictions with this model, or at least your understanding. And if we make some predictions in a new situation, if it still works out, hey, that's great. Then our model works because we only did a couple of observations.

Maybe this isn't the real way it works maybe it's not quite exactly like this. So we need to make some predictions based on this model. So Peter or Shaqib, could you turn on our projector here without any filters?

So a lot of you probably have seen this before. What we have on the front of this-- go ahead and turn it on just so we can see. On the front of this projector we're just projecting a line of straight, plain old white light. We have a light bulb down there. The light photons are traveling up, being focused through this lens up here. And then it's actually making an image of what's on the top of this overhead projector.

Here we have a diffraction grating. A diffraction grating is kind of like a prism, in that it takes that light and it takes white light, which is all of those different colors of photons traveling together and it spreads them out, so that on this side over here only the red photons go this direction, only the green photons go in the middle, and only the blue photons and purple photons go off to the left.

So what we're doing is we're taking a stream of light and we're breaking it up depending on what the energy the photons is, with the energy of the photons are. So what I want you to do with your group, I have a red filter here just like the one that you have, if I put this red filter in front of this diffraction grating, I want you to predict what we're going to see on, let's just say on this side, of the board.

It actually splits it up in two ways. So we've got the same rainbow on both sides, the same spectrum. So what I want you to do-- can you guys grab the colored pencils? So we have covered pencils, and I want you to actually draw in your notebook, I want you to predict what you're going to see if we take the red filter and we put it right there. What's going to happen over on this side of the board?

So I want you to predict based on this idea that-- now, if we put this on, move it over a little bit, that's what you see. So let's turn the lights down a little bit. Let's go ahead and turn them off.

So this is normal. That's with the red filter. So if you want to come up and look at it up close and come flip this up and then flip it back down. OK. So come up and look, then I want you to represent what you're seeing here on your paper.

So that's regular. That's with the red filter. So I want you to represent that again in another drawing. And then I want you to think about, how is your prediction different from that? And then I want you to discuss with your group why you think that's different. Discuss with your original group.

So this is the original and then that's what you see with the filter.