DOINGWHATWORKS

Video
FULL DETAILS AND TRANSCRIPT

Science in Motion

Hillcrest High School, Texas • November 2007

Topic: Encouraging Girls in Math and Science

Practice: Sparking Curiosity

Highlights

- This Pre-AP physics lab about conservation of momentum begins with an overview of the concept and the basic formulas for calculation. Conservation of momentum is defined as mass X velocity.
- Students will use cars and tracks to simulate elastic and inelastic collision. The mass of the cars is known (0.5 kg each). Velocity will be measured using motion sensors.
- Momentum is a concept used in everyday life in a number of professions. For example, it is used in investigations of car accidents scenes.
- Students learn how to interpret data plotted by a computer program. For example, they learn how to correctly report negative and positive signs of the data.
- The lab lesson ends with a discussion of what students learned today, including good questions raised by students during the lab time.

About the Site

Hillcrest High School
Dallas, TX

Demographics
53% Hispanic, 29% Black
59% Low-SES
33% Limited English Proficient
52% Females

Hillcrest High School, an urban school that serves a primarily ethnic minority population, has been recognized for its efforts to promote students' enrollment in Advanced Placement (AP) courses. For example, this school ranked in the top 5% of high schools in the country, according to Time Magazine, for AP exams proctored. They encourage girls by:

- Active recruitment of girls to AP classes
- AP physics teacher trained by the Center for Gender Equity
- Technology grants pursued to enrich school labs
- Encouragement of hands-on scientific inquiry in the classroom

Full Transcript

Teacher: Momentum is not the force that you're moving with, okay, but that's all right. It very much has to do with motion, and a lot of times people will say if something has momentum, it wants to keep on moving. And they'll make references to Newton's laws of inertia and Newton's second law, f=ma, in that way. Momentum is certainly related to Newton's second law we're going to find out. But it's actually something much simpler. It's just mass times velocity, and that's what we're going to be measuring in the lab today. We're going to be taking these cars—and the cars are fairly frictionless on this track, okay—and we're going to be rolling these cars down this track. And the masses of the cars are known. They're a half a kilogram each, and we're also going to have additional masses we're going to weight some of the cars down with. And we're going to be using motion sensors to gather the velocity data. These are the same motion sensors that we used during the lab when you were walking back and forth across the classroom and we were trying to match that graph—when we were doing kinematics and velocity and acceleration at the time.

Momentum is very, very practical and very applicable to every day life. There are a lot of professions in which you have to have a really thorough understanding of momentum. Many people who would even be something as simple as a police officer who would go and investigate an accident scene. They have to use the momentum of the cars, by looking at the evidence and the skid marks, and they can work backwards and find out exactly how fast those cars were going. Also, momentum is extremely important in the kinds of collisions you have. All of you that have had Driver's Ed have probably learned, what is the worst kind of collision you could possibly get into? Gracie?

Student: Intersection.

Teacher: When two cars are doing this, what would you call that? A head on collision. I like that. A head on collision is the very worst accident you could ever get into, and we're going to see why that is in the lab today. It's because the exchange of momentum is the highest. Okay? And so you have the greatest risk of getting hurt as you come to a stop, sometimes much more quickly than you would like. Okay? What is another really bad thing to hit if you're in a car wreck?

Students: A wall.

Teacher: Okay.

Student: A brick wall.

Teacher: An immovable object. A wall would be a good one, but anything that's not moving—a telephone pole—those are really not good to hit because they're not going to give. And we'll talk about that impulse, and we'll talk about that exchange between the time of impact and the amount of momentum that you receive as a driver. So even if you're simply designing these cars—if you want to be an engineer who's designing these vehicles—we're going to find out that vehicles are very carefully designed. Not just with airbags, but the entire vehicle itself is a structure to allow all that momentum not to pass into the passengers when they're in a traffic accident.

Okay, now what do you want to do to get a better look? Yes. So we have an initial and final region with linear. This one's a little stickier. We definitely have an initial, and I would just treat that as final, but before it jumps up again, right? And be very careful about your negative signs. Okay, just because it's negative on the computer screen we're not going to put a negative right?

Students: Right.

Teacher: Okay, so think about the direction. Think about what happened last time with the data and how are you going to keep the negative signs straight this time. Okay, I'll come back and ask you that in a minute okay. So talk amongst yourselves and figure out what you're going to do.

Student: So this one was both-

Teacher: Sometimes when cars collide, Maddy, what will happen is the bumpers get interlocked and so cars will often skid off together. So in this case, this will be a collision that we're going to call perfectly inelastic, where two objects stick together. Okay?

Student: Okay.

Teacher: And we want to observe what kind of velocity they have afterwards.

Student: We need to do perfectly—we need to do inelastic, elastic and—we need to do all of those?

Teacher: Correct.

Student: Okay.

Student: And we pick one side, we pick like you said. We pick one sensor?

Teacher: Yes.

Student: That's negative. And so when we write this down will that be positive?

Teacher: Very good question. Let's talk about it. Which—even though we see two positive slopes beforehand and two negative slopes afterwards, obviously you had two cars colliding head on here. Okay? So, what are you going to choose to call positive and negative as you record the data?

Student: Left is our negative.

Student: Right, which is the red.

Teacher: Okay. So initial velocities, they're listed as .56 and .51. Are you going to record one of those as negative or both positive, both negative, what are we going to do?

Student: One would be negative.

Student: So it would be left.

Teacher: Okay.

Student: Left side.

Teacher: Okay, so one's negative because it's just direction.

Student: It's just direction.

Teacher: Okay

Student: So just decide left or right negative.

Teacher: So let's decide that now.

Students: Left equals negative and right equals positive

Student: Okay, slow down I...

Teacher: Push the car. If that's positive, so is that.

Student: Okay.

Teacher: You got it?

Student: Yeah.

Teacher: Make sense, Elizabeth? Everything going toward Ben is going to be a positive number. All right? And so this one's going to be positive before it hits, if it's positive after it hit, and this one's positive after it hit because it also went this way.

What we were looking for today is we were trying to measure two different quantities about the cars. We wanted to know the mass of the cars and we wanted to know their velocity of the cars. We wanted to see that before and after a collision. There were different collisions that you were simulating today. We were simulating perfectly inelastic collisions, where cars stuck together; we were simulating elastic collisions, where they were bouncing off each other with hopefully little to no loss of kinetic energy; and then we were simulating just inelastic collisions, where they were just kind of hitting and bouncing a little more abruptly. And hopefully we'll see within these that momentum is conserved in each one of these types of collisions, by measuring the velocity before and after and taking the mass of the cars with it.

There was also one or two really good questions asked by students and they said, "Oh, Mister Brown, what about the velocity? Isn't the velocity supposed to be the same afterwards as it is in the beginning?" And the answer is emphatically no. Velocity is not conserved in these collisions. It's mass times velocity, which is not the same thing. Okay?