

Honors DU: Crime Scene Investigation



The Challenge

In this assignment, you will apply your understanding of momentum and collisions to a forensic investigation.

You are the expert witness asked to provide testimony in order to help the court understand what physics can reveal about a crime scene.

Choose any **ONE** of the crime scene scenarios below. Apply your understanding of physics to explain what happened. You might find the following questions helpful to your investigation:

- Can concepts of momentum and impulse be used to support your explanations?
- Are there tests that could be performed to help explain the situation?
- Does a sketch or diagram help to clarify the situation?
- Can you recreate the collision using the [PhET Collision Lab](#) or [Physics Classroom Collision Lab](#) to test your ideas?
- Can you separate certainty from speculation? Are your conclusions based on sufficient evidence, or can you identify important gaps in the evidence?

What to include with your analysis:

Apply concepts of **momentum, impulses, elastic collisions, inelastic collisions, or conservation of momentum** as appropriate to explain the physics of the scenario. Your work will be assessed on the following:

- Use **physics terms** correctly
- A **qualitative** explanation – use words to describe what happened.
- **Quantitative Evidence:** Quantitative support might include working with the values provided from the crime scene, modeling a possible mathematical solution with estimated values, or modeling the situation using a modeling tool such as the [PhET Collision Lab](#).
- Create a google doc with your explanation and screenshots from the [PhET Collision Lab](#) or calculations and share it with Mr. Mont.

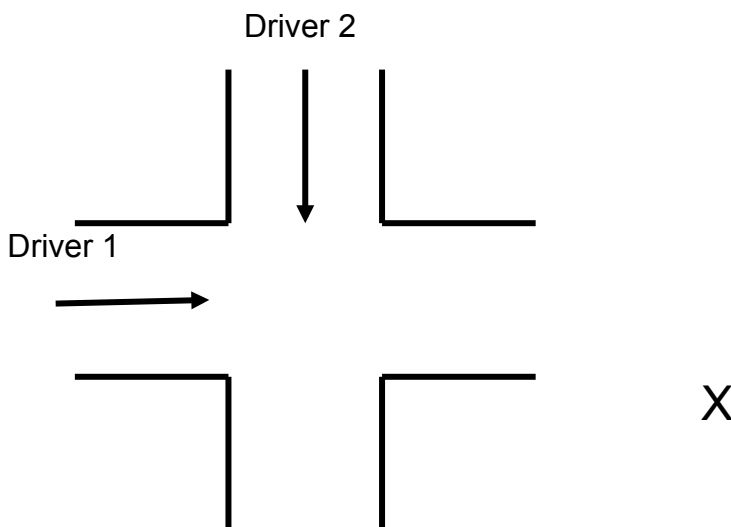
Crime Scene Investigation Case 1- Red Light



Explore the crime scene data below, and apply your understanding of physics to explain what happened. Be prepared to share your expert testimony with the class. You might find the following questions helpful to your investigation:

- Can concepts of momentum and impulse be used to support your explanations?
- Are there tests that could be performed to help explain the situation?
- Does a sketch or diagram help to clarify the situation?
- Can you recreate the collision using the [PhET Collision lab](#) and test your ideas?
- Can you separate certainty from speculation. Are conclusions based on insufficient evidence?

Two cars had an inelastic collision at a two-way intersection. The accident occurred at night, and there were no witnesses. Driver 1 was driving a Honda Civic with a mass of 1000 kg. Driver 2 was driving a Ford Explorer with a mass of 3000 kg. Driver 1 claims that driver two ran a red light at a speed greater than the 30 mph speed limit and hit his car. Driver 2 claims that driver 1 ran the red light and was speeding. The crime scene is shown below, and the position of the wreckage is marked with an x.



Crime Scene Investigation Case 2 - Mrs. Smith's Window

Explore the crime scene data below, and apply your understanding of physics to explain what happened. Be prepared to share your expert testimony with the class. You might find the following questions helpful to your investigation:



- Can concepts of momentum and impulse be used to support your explanations?
- Are there tests that could be performed to help explain the situation?
- Does a sketch or diagram help to clarify the situation?
- Can you recreate the collision using the [PhET Collision lab](#) and test your ideas?
- Can you separate certainty from speculation. Are conclusions based on insufficient evidence?

Mrs. Smith has a broken window. One of her flowerpots is on her living room floor with the broken glass. The flower pot had been sitting outside her window on the window sill. She has called the police and reported the two neighbors who she had seen shooting a bb gun earlier that day in their own backyard. She is sure that they shot the flower pot through her window. Can you support her claim?



Crime Scene Investigation Case 3 - Hit and Run

Explore the crime scene data below, and apply your understanding of physics to explain what happened. Be prepared to share your expert testimony with the class. You might find the following questions helpful to your investigation:

- Can concepts of momentum and impulse be used to support your explanations?
- Are there tests that could be performed to help explain the situation?
- Does a sketch or diagram help to clarify the situation?
- Can you recreate the collision using the [PhET Collision lab](#) and test your ideas?
- Can you separate certainty from speculation. Are conclusions based on insufficient evidence?

You have witnessed a hit and run accident. The victim suffered a broken leg, but was fine otherwise. He claims that the driver was going faster than the speed limit of 20 mph (10m/s). The driver claims she was only going 10 mph (5m/s) and the victim ran out into the road without looking. As a witness and physics student you have been able to determine the following:

- *The skid mark from the car was 20 meters long.*
- *The car came to a stop in 2 seconds.*
- *The mass of the car was 1000 kg.*
- *The weight of the car was 10,000 Newtons.*
- *The coefficient of friction between the car tires and the road was 1.0.*

Who should you believe?



Crime Scene Investigation Case 4 - Projectile Motorcycle

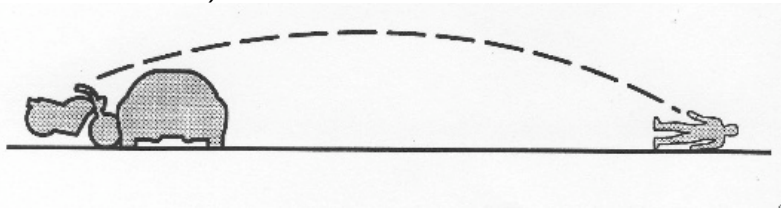


Explore the crime scene data below, and apply your understanding of physics to explain what happened. Be prepared to share your expert testimony with the class. You might find the following questions helpful to your investigation:

- Can concepts of momentum and impulse be used to support your explanations?
- Are there tests that could be performed to help explain the situation?
- Does a sketch or diagram help to clarify the situation?
- Can you recreate the collision using the [PhET Collision lab](#) and test your ideas?
- Can you separate certainty from speculation. Are conclusions based on insufficient evidence?

A motorcycle rider and a car have a head on collision on the highway. Each driver says the other was speeding and swerved into the wrong lane. The car was traveling west on the north side of the highway, and the motorcycle was driving east on the south side. In court, the following crime scene information was introduced. A witness from a nearby yard could not see the highway lanes, but did see the accident from a distance.

- *the car and motorcycle had an inelastic collision and the wreckage was found to be 25 meters west of the crash location.*
- *the speed limit on the highway is 45 mph (40 m/s)*
- *the car has a mass of 2400 kg*
- *the motorcycle has a mass of 400 kg*
- *the driver of the car has a mass of 100 kg*
- *the driver of the motorcycle has a mass of 100 kg*
- *the motorcycle driver was thrown from his bike, and landed (miraculously without serious injury) a distance of 50 meters east of the wreckage.*
- *the observer saw the motorcycle driver leave the bike at a 45 degree angle after the collision*
- *the observer saw the wreckage come to a stop in 5 seconds (from the time of collision).*



Crime Scene Investigation Case 5 - Late Night Crash



Explore the crime scene data below, and apply your understanding of physics to explain what happened. Be prepared to share your expert testimony with the class. You might find the following questions helpful to your investigation:

- Can concepts of momentum and impulse be used to support your explanations?
- Are there tests that could be performed to help explain the situation?
- Does a sketch or diagram help to clarify the situation?
- Can you recreate the collision using the [PhET Collision lab](#) and test your ideas?
- Can you separate certainty from speculation. Are conclusions based on insufficient evidence?

Two cars had a head on inelastic collision on the highway in the middle of the night. There were no witnesses. Each victim claims the other driver swerved into the opposing traffic lane and was speeding and driving erratically. The following data was recorded at the crash scene.

- *The first car was a Lexus with a mass of 2500 kg traveling North.*
- *The second car was a Subaru with a mass of 2000 kg traveling South.*
- *The skid mark shows that the cars moved 50 meters South after the collision.*
- *The coefficient of friction between the cars and road is 1.0.*
- *The damage to the vehicles shows that the Lexus sustained much more damage than the Subaru.*



Crime Scene Investigation Case 6 - Road Rage?



Explore the crime scene data below, and apply your understanding of physics to explain what happened. Be prepared to share your expert testimony with the class. You might find the following questions helpful to your investigation:

- Can concepts of momentum and impulse be used to support your explanations?
- Are there tests that could be performed to help explain the situation?
- Does a sketch or diagram help to clarify the situation?
- Can you recreate the collision using the [PhET Collision lab](#) and test your ideas?
- Can you separate certainty from speculation. Are conclusions based on insufficient evidence?

Two cars collided near the on ramp to the expressway. The merging traffic enters the highway from the right side at an angle of 30 degrees relative to the moving traffic. This collision occurred between a Hummer and a Volkswagen Jetta. The Hummer was on the highway and claimed that the Jetta merged onto the highway at high speed and slammed into the right side of the Hummer. The Jetta driver claims that he was observing the speed limit and trying to merge safely, while the Hummer driver aggressively prevented the Jetta from merging into moving traffic. The following data was recorded at the scene:

- *The mass of the Hummer is 4000 kg*
- *The mass of the Jetta is 2000 kg*
- *The speed limit on the highway is 55 mph*
- *The collision was inelastic*
- *The damage to the Hummer was limited to the right side rear half.*
- *The damage to the Jetta was the left side and front of the car.*
- *The wreckage was observed to be 100 meters further down the road, and in the ditch on the left side of the road, approximately 10 meters to the left of the road.*

