

PBIS



ASTRONOMY

As a Student Scientist, you will...

**Ask
QUESTIONS**

**APPLY
MEANING**

Pursue
ANSWERS

Make
MEANING

Share
ANSWERS



What's the Big Question?

How Can You Know if Objects in Space Will Collide?

You have spent every day of your life on the planet called Earth. Without leaving Earth, you wake up, go to school, sleep, work, and play. Every day the Sun appears to move across the sky and then moves below the horizon as night approaches. You know that the Sun is very important to life on Earth. But Earth and the Sun are just two of the many important objects in our **solar system**. The solar system is like Earth's neighborhood. This neighborhood includes the Sun, eight planets and their moons, and all the other bodies that **revolve** around the Sun.

solar system:
a Sun and the planets, comets, asteroids, and other bodies that revolve around it.

What other solar-system objects do you know about? What do **astronomers**, the scientists who study space and objects in space, know about the movements of these objects, and how do they predict these movements? How can they use their predictions to learn more?

revolve: to move in a curved path determined by gravity of another object.

Scientists learn about the solar system by making observations and collecting data. Astronomers, and other scientists, are gaining exciting new knowledge every day through the use of powerful telescopes and space probes speeding through the solar system.

astronomer:
a scientist who studies space and objects in space.

Whenever scientists collect data, they are trying to answer questions. One question for astronomers today is how the objects in our solar system formed. In space, beyond our solar system, scientists have learned about stars. They have also observed places where stars and other planetary systems form.

Many movies, television shows, and books have featured the idea of objects from space colliding with Earth. In some of these stories, people and countries unite to stop a collision with Earth, and the world is saved. In others, the results of these collisions are disastrous and life on Earth is forever changed. All of these movies, television programs, and books are *science fiction*, or made-up stories that describe possible events resulting from advances in science or technology. Other stories are set in imaginary environments, such as alien planets or other solar systems.

Are collisions with objects from space a real threat? If so, can anything be done to prevent these collisions from happening? What objects have the potential to collide? To answer these questions, you must be able to separate science fact from science fiction. Facts are evidence that can be used to support or oppose a hypothesis or explanation. Fiction is invented in someone's imagination. The purpose of fiction is to entertain people. Scientists work only with facts.

In this Unit, you will gather facts and perform investigations to help you answer this *Big Question: How Can You Know if Objects in Space Will Collide?*

*Welcome to Astronomy.
Enjoy your journey as a student scientist.*

Think About the *Big Question*

On Friday, October 9, 1992, at 7:50 PM, Michelle Knapp, a high school senior in Peekskill, New York, heard a loud crash outside her home. Rushing out of her house to investigate the noise, Michelle found that the trunk of her car had been demolished by a football-sized rock.

This photograph of the 1992 Peekskill meteorite was taken by a reporter at a football game in Altoona, Pennsylvania. Witnesses all over the East coast described the meteorite as having a greenish color and as being bright as a full moon.

Notice the football-sized rock under the damaged car. The rock weighed 12 kg, had a melted appearance, and was warm to the touch when found.

The front edge of the 12-kilogram rock had a melted appearance. When Michelle touched the rock, it was still warm. Red paint from her car was embedded in the rock. There was also a 15 cm (6 in) deep crater in the driveway under the rock.

The evidence in the previous paragraph suggested that the rock was a **meteorite**. A meteorite is a rock that travels from space through Earth's atmosphere and strikes Earth's surface. When a meteorite plows through Earth's atmosphere, the heat generated produces a thin, glassy coating on the outside of the meteorite called the *fusion crust*. The warmth of the rock, when Michelle touched it, was another good clue that the rock had heated up traveling through Earth's atmosphere. The crater under the car was further evidence that the rock had fallen from the sky.

meteorite: an object that enters Earth's atmosphere at high speed and reaches the ground without burning up.

That evening, several video cameras at high school football games shifted upward and recorded glimpses of an object streaking across the night sky. Later that evening, local television stations broadcast the videos of this unusual object. The videos showed a fireball breaking up into pieces. Scientists estimate that the original object may have been up to one meter in diameter with a mass as great as 25,000 kg (55,000 lb). Michelle's car was hit by the meteorite only moments after videos captured images of the object streaking through the night sky. The object that struck the car is now known as the Peekskill meteorite.

This story is a rare, firsthand account of a collision with an object from space. To answer the *Big Question* in this Unit, you will start by thinking about some more common types of collisions. To help you get started, you will watch some different collisions in action. As you make observations, think about how these crashes happen, what happens to the bodies that are colliding, and what you might be able to do to stop the collisions from happening.

Get Started

You will watch a short video. As you watch the video, pay close attention to the collisions and the effect the collisions have on the objects involved. Watch carefully as objects of different speeds collide with each other. What is the result of these collisions?

Conference

Share your ideas about the collisions in this video with your group. Describe what you saw when the objects collided with each other. Focus on the damage the collisions caused. What do you think would happen if the two objects were of very different sizes? What do you think was the effect of speed on the damage done by each collision? Could some of the collisions have been prevented? If so, how? Make a short list of questions and ideas about collisions that this video made you think about.

Also, think about what you know about objects in space. Would any of the objects you know about be likely to collide? Why or why not? Think about what you know about how these objects move to determine if they could collide, and what you still need to learn.



Communicate

Share Your Ideas

Share your questions and ideas about collisions with the class. Make a list of questions so that you will be able to remember them. Share your ideas and questions about objects from space that might collide. List those as well so you will remember them clearly.

Tennis Ball Demolition Derby

Cars in a demolition derby crash into each other, resulting in loud noises, dented metal, and jolts to the drivers. These collisions differ depending on how fast the cars are moving and how they strike one another. To help you answer some of your questions about collisions, you will explore the motion of tennis balls as they collide.

Materials

- tennis balls, 1 per student

You will consider two types of motion: *random motion* and *ordered motion*. Each person in your class will roll a ball and you will make observations about the differences in the collisions when the motion is random and when it is somewhat organized. Each time you roll the balls, they will have a chance to collide. As you watch each type of motion, pay attention to how predictable the collisions are.

Predict

Before doing the activity, read the entire procedure and predict which trial will have more collisions. Make predictions, too, about where collisions will occur and which trial might have more violent collisions.

Procedure

1. Each person in your class will get one ball. With your classmates, sit in a large circle. Without speaking or letting anyone know where you are going to roll the ball, choose a person in the circle, and prepare to roll the ball to them. When you hear the count, “Three, two, one, go!” all the balls should be rolled at the same time. Observe the movement of your ball and count the number of collisions your ball makes as it rolls along the floor. Write this number on a piece of paper and label it “Trial 1.”

2. Then, repeat the same exercise, but this time you will roll a ball to one specific classmate, and *another* classmate will roll a ball to you. To start, each person will be given a number. You will count that number of places away from you, moving clockwise (left) around the circle. For example, if you were given the number *ten*, you would count ten places away from you, starting with the person on your left. You would roll the ball to the tenth person. Be sure the correct person knows he or she is receiving the ball from you. A different person will be rolling the ball to you. Check with that person, too. On the count of *three*, all the balls should be rolled at the same time. Observe the movement of your ball and count the collisions your ball makes as it rolls across the floor. Write this number on a piece of paper and label it “Trial 2.”



Communicate

Share Your Results

Record on the board each student’s count of the number of collisions in Trial 1 and Trial 2. As a class, compare the total number of collisions that occurred in Trial 1 with the total number in Trial 2. Also, look at the data to see if there are any trends. Discuss any differences in the timing or nature of the collisions during the two rolls.

Reflect

Use the results of your investigation to answer these questions with your group. Be prepared to share your answers with the class.

1. Did the results match your predictions? Why or why not?
2. Compare the collisions of the two trials in more detail. How were the collisions in the two trials similar to each other? How were they different? Were the collisions more violent in one trial? Where did most collisions occur in each trial? In each trial, how did early collisions affect later collisions?
3. What do you think would happen to the number of collisions if everyone had rolled two tennis balls each time?
4. What do you think would happen to the number of the collisions if the number of balls stayed the same but people sat in a circle that was three times bigger?
5. Is there any way to predict when specific collisions will occur in either trial? Why or why not?
6. How do you think the motion of the balls might compare to the way in which objects move and collide in the solar system?
7. Now that you know more about collisions, answer this question again: Are any of the objects you know about in space likely to collide? Why or why not?

Introducing the *Big Question*

The Big Question for this Unit is: How Can You Know if Objects in Space Will Collide? To answer this question you are going to have to understand how objects in the solar system move, how likely they are to collide with one another, and what happens when objects collide. You will also investigate objects outside the solar system to see if they could possibly collide with objects in our solar system. You will start by examining the evidence as Michelle and others did after the meteorite struck her car. Besides looking at past collisions, you will explore the motion of objects in space to investigate the likelihood of collisions in the future.

When you have completed this Unit, you will use what you have learned about how scientists know if two space objects will collide to develop an idea for a movie. To interest a movie producer in making a realistic movie about the possible collision of two space objects, you will need to put together all the information you gather in the *Learning Sets* as well as the results of all your investigations.

In your “pitch” to the movie producer, you will suggest space objects that might realistically collide, support your suggestion with an explanation of what makes the collision realistic, and a description of what such a collision might look like. You will also need to describe how such a collision would affect Earth, or other space object. The best idea will be one that is realistic, dramatic, and could affect Earth, or our Sun and Moon.

Reflect

Discuss the answers to these questions with your group. Sharing your answers with the class will prepare you to begin a *Project Board* for this Unit.

1. What do you already know that might be useful in answering the *Big Question*?
2. Examine the list of questions your class made earlier. Which of those questions need to be answered to answer the *Big Question*?
3. What other questions do you need to know answers to so that you can answer the *Big Question* and write your report?

Create a Project Board

When working on any challenge, it is useful to keep track of your progress. It is also helpful to keep track of what you still need to do. Throughout this Unit, you will use a *Project Board* for this purpose. During classroom discussions, one person in the class will record ideas and questions on a class *Project Board*. At the same time, you will keep track of what has been discussed on your own *Project Board* page.

Recall that a *Project Board* has space for answering five guiding questions:

- What do we think we know?
- What do we need to investigate?
- What are we learning?
- What is our evidence?
- What does it mean for the challenge or question?

How can you know if objects in space will collide?				
What do we think we know?	What do we need to investigate?	What are we learning?	What is our evidence?	What does it mean for the challenge or question?

To get started on this *Project Board*, you need to identify and record the important science question you will address for this Unit: *How can you know if objects in space will collide?* Record this question at the top of the *Project Board*.

In the first column of the *Project Board*, record what you think you know about any objects in the solar system that may collide. You discussed this among your groups during your earlier conference. Use the ideas your group came up with to make suggestions for the *Project Board*. Perhaps you have studied or read about some of these objects before. Even if it is a small fact or idea, talk about it. Discuss any factors that you think might be helpful in working toward the completion of your project.

In the second column, record what you need to investigate. Again, you discussed these things in your conference and you made a class list. During your conference, you may have found that you and others in your group did not agree on some ideas. This second column is designed to help you keep track of things that are debatable, unknown, or need to be investigated to answer the *Big Question*.

Later in this Unit, you will return to the *Project Board*. For now, work with your classmates as you begin to record ideas and suggestions in the first two columns.



What's the Point?

Before starting on the exploration of any new idea, it is helpful to try to understand what the goals are for your investigations. You have discussed some general ideas about collisions. You have applied that knowledge to what you already know about the solar system. You have used your current knowledge to come up with more questions that need to be answered. You know that the goal of your investigations is to learn how scientists can know if objects in the solar system will collide. If you keep this goal in mind as you make your explorations, you will stay on track all the way to answering a big and important question for us all.

