



“Deep Impact Comet on a Stick”



Educator Page

Created for Deep Impact, A NASA Discovery Mission
Maura Rountree-Brown and Art Hammon
Educator - Enrichment

The "Comet on a Stick" activity can be used with a wide age range. Students will see that modeling is continuous on a NASA mission as is evaluation of those models. Younger students will learn the basic characteristics of a comet. Older students will practice evaluation and improvement of the comet model shown. The importance of this activity is not the initial model or its exercise, but the fact that it will put students in the position of emulating a process that scientists and engineers follow on all missions.

The activity:

["Comet on a Stick"](#) - Activity for students

Supplies are shown within the activity. Gather household and art supplies for the students to improve or build new models.

Background materials for this activity:

[Background on the Deep Impact mission](#)

[Consider This](#) - This page shows the history of perceptions about comets.

[A Comet's Place in the Solar System](#) - A little history about where comets came from

[Ten Important Comet Facts](#) - A quick review of comet facts

[C-O-M-E-T-S - A comet acrostic](#) - Good for younger students or comet quick fact reference

[Deep Impact - Interesting Mission Facts](#) - Some fun facts about the Deep Impact mission

[Small Bodies Missions](#) - Learn more about Deep Impact and about other missions to comets and asteroids.

National Science Education Standards related to this activity:

Science as Inquiry:

- Identify questions that can be answered through scientific investigations
- Think critically and logically to make the relationships between evidence explanations
- Develop descriptions, explanations, predictions and models using evidence
- Recognize and analyze alternative explanations and predictions

Tips for materials to improve or build comet models:

- Find fruits and vegetables that might look like a comet nucleus.
- Get different “surface” coverings like chocolate cake mix or icing, chocolate shell (you’ll need to freeze the object you cover
- Paper or streamer of different kinds
- Paints or other coloring solutions
- Any kind of textured covering that you think would be useful
- Netting or other fabrics
- Bulk cushion stuffing fiber or cotton balls
- Tin foil
- See what else you can come up with

Tips for the Teacher:

1. A hairdryer only sends heat from one side while the Sun would be sending out solar wind from all sides.

2. This model does form a tail with the solar wind but it fails to show that the material that outgases from the comet mostly shoots forward. This is why we see the nucleus area of the comet glow but do not directly see the nucleus of the comet which is hidden further back inside the comet's coma.
3. The Deep Impact observing spacecraft must maintain a path beneath the comet, as the nucleus passes overhead. This helps the spacecraft to avoid coma debris from the comet tail as it passes. Coma debris is the dust, gas and rocky material that burst from the comet nucleus in jets as its surface is heated by the Sun.
4. This model does not show that the tail of a comet appears curved because in space we see a "history of the tail". At any point in time, particles move directly away from the Sun (as in this model). Over time, as the comet curves around the Sun on its orbit path, the particles leave a tail that is curved (not shown in this model).
5. As the comet moves away from the Sun, the model tail droops. In space, the particles and debris continue to be swept away from the nucleus, but the production rate of debris decreases. Note that the tail does not shoot out from the nucleus but is the trail that is left behind much like that of a jet plane.
6. Comets are not white since the rock and debris being out gassed clings to the surface of the comet in a crust that is blacker than toner for a copy machine or charcoal. Comets also appear in different irregular shapes and are not round "balls". They are shaped more like potatoes. Scientists are not sure how rough or smooth the surface of a comet might be and will get that information from the missions currently planned by NASA.
7. Comets can have three tails although scientists usually only talk about the dust and ion tail: the largest is the dust tail produced by radiation light pressure from the Sun and it carries most of the debris and gas and is easiest to see. The ion tail, produced by "solar wind" can show as a bluish glow and a neutral sodium tail produced by solar wind is very hard to see.

Questions: Maura Rountree-Brown at Maura.Rountree-Brown@jpl.nasa.gov



Deep Impact Comet Modeling



Created for Deep Impact Mission, A NASA Discovery Mission
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Modeling is an important part of any space mission and begins earlier than most people think. Before any piece of hardware is built or software is designed, in fact, before anyone begins to make calculations for the size and shape of the spacecraft, intensive research must be done and certain questions must be asked.

- What do we want to find out?
- Where should we go in space to find this information?
- In the case of the Deep Impact mission, what do we know about Comet Tempel 1?
- Learn more about the [Deep Impact mission](#).

Obviously, it isn't possible to visit Tempel 1 to get all the information we need in order to design a mission so scientists and engineers perform exercises to "model" our comet. They ask themselves questions like:

- What other comets do we have information on?
- What has that information told us?
- If we build a model for a comet we know better, will it tell us what we need to know about the one we will visit?

The Deep Impact mission has used images of Halley's comet as well as the more recently collected images of comet Borrelly and Wild 2. Using what we know about those comets, and combining that information with images of Comet Tempel 1 taken from Earth, the Deep Impact team has created models for researching the following challenges:

- How fast is our comet rotating and is that rotation slow enough to allow us to see the crater we make?
- When sunlight falls unevenly on the comet, can we design software that will help our impactor find the best lit area to target?
- Based on what we know about cometary dust environments, will our impactor and spacecraft arrive safely to impact? How large a dust particle can the twin spacecraft survive before the images they are collecting are blurred or the spacecraft themselves are damaged?

Questions for students: If you were building a model of a comet out of odds and ends around the house, what two characteristics about a comet would you choose to show and

what materials would you find to build it? If you were designing a mission, how would you use your comet model to test some of your challenges and bring them to solutions?



“Deep Impact Comet on a Stick”



Student Activity

Created for Deep Impact, A NASA Discovery Mission

Maura Rountree-Brown and Richard Shope

Advisors: Bill Smythe (science)

Student - Inquiry

Questions?? Contact Maura.Rountree-Brown@jpl.nasa.gov

Purpose:

Develop a model of a comet and use the same thought processes as a science and engineering team do to design and build missions. Use it to test your theories about comets and then evaluate the strengths and weaknesses of your comet model. The importance of the activity is not the initial model, but the model you improve or design and your evaluation of the initial model. During the second part of the activity, you will work with a team to decide what kind of new model you would like to build.

Project:

The **Deep Impact** mission launched in 2004 and encountered Comet Tempel 1 on July 4th of 2005. Before launch, scientists and engineers used modeling to research and test some of their theories about comets. They also used modeling to find solutions to some of their mission challenges. Modeling takes place throughout the life of a mission as challenges arise. You can try modeling by making a "Comet on a Stick." Use it to test the influence of the Sun on these small bodies. Discuss as a class some theories about comets. Then try to communicate them with the stick comet. This is a good model for some of the attributes of a comet. For others, it is not. During the activity, you will have the opportunity to decide the strengths and weaknesses of this comet model. You will also get to improve this model or build an entirely new one. If you need to know more about comets, visit <http://deepimpact.jpl.nasa.gov> to learn more about the Deep Impact mission.

Before you start:

As a class, discuss what is or might be true about comets. Build one list. Add to that list the things you wonder about comets or don't know. Build a model to study the following question: If you have to send a spacecraft to a comet, what will you need to consider about the way the Sun affects a comet? Now, build a "Comet on a Stick".

Materials:

One 2" styrofoam or other ball or an 8 ½ X 11 piece of paper

Two 1 - 2 ft lengths of mylar gift strips, raffia or ribbon

One 5" strip of tape

One wooden skewer (shish kabob type)

An electric hairdryer/electrical power available

One marker pen

Gather household or art supplies for students to use to design their own comet models.

Directions:

1. Make a tiny hole in the ball so it can be mounted on the skewer (the fit of the skewer should be tight). Mount the ball on the skewer. If you use paper instead, mold it to the shape you believe should represent your comet nucleus.
2. Place the mylar strips on top of the ball or paper nucleus so the two pieces cross each other in an "X" and the lengths of all sides of the strips hang down evenly. You can also use light ribbon.
3. Attach the strips to the ball or paper with the 5" strip of tape or narrow masking tape wrapped over the strips and around the circumference of the nucleus.
4. With a marker pen, assign a "front" for your comet and represent it with the letter "H" for head. On the opposite side, mark the letter "T" for tail of the comet.

Here's what you do:

Use a hairdryer to simulate a portion of the Sun's solar energy as it meets the comet. The heat from the Sun warms the surface of the comet nucleus. This causes gas, ice, particles and rocky debris of various sizes to burst from the comet in all directions (called coma) and the solar wind causes these substances to flow back behind the nucleus to form a "tail" behind the comet. Have someone be the "Sun" and stand in place with the hairdryer. The hairdryer simulates the solar wind causing the comet "tail" to form and trail behind the comet. Aim the hairdryer at the comet and keep it trained on the comet as it approaches and as it moves away. Have a second person hold the comet by the stick and walk in an elliptical (elongated or oval) orbit around the Sun. As the comet gets closer to the Sun, the Sun's solar influence affects the comet so that the gas and debris forms a tail that is pushed toward the back of the nucleus. This tail flows in opposition to the Sun so that the nucleus is between the Sun and the tail. As it travels away, the lost influence of the Sun causes the tail to diminish or in this case, fall. The solar wind from the Sun, which is made of electrically-charged particles, uses electrostatic attraction and electrical transfer to form the comet's gas and debris into a tail.

Questions: Use the materials you gathered to have students improve or build new models.

1. What are the strengths of this model for showing the influence of the Sun on a comet?
2. What are the weaknesses of this model for showing the proper influence of the Sun?
3. What other facts or theories about a comet can be seen using this model?
4. Which facts or theories of a comet are not well shown by this model?
5. Can you improve the model by changing it or making an entirely new model?
6. Can you build a model that shows what a comet does in space as opposed to what it is?
7. The Deep Impact mission makes a crater in the nucleus of Comet Tempel 1 with a copper projectile. A sister spacecraft nearby takes optical and spectrometer data during the encounter and for 14 minutes after impact. What do they need to consider about a comet in order to successfully gather their data?
8. Form teams and choose three facts, theories or characteristics about comets you would like to show through modeling. Make a new model or improve your current model.
9. Or, as a team, decide what kind of comet mission you would design. Take one of the challenges you will face and try to create a model that will help you find a solution for your challenge.
10. Once your team has designed your comet model, show it to the other teams without explanation. See if they can identify what you were trying to show about a comet. How well did you collaborate as a team to build a clear and accurate model?

Questions? Contact: Maura.Rountree-Brown@jpl.nasa.gov



“Paper Comet Model With a Deep Impact”



An option to the “Comet on a Stick”

Created for Deep Impact, A NASA Discovery Mission

Maura Rountree-Brown and Art Hammon

Student - Inquiry

Purpose:

The Paper Comet is an option to "Comet on a Stick" using instead an 8 ½ X 11 piece of paper which is less expensive than the Styrofoam version. Develop a model of a comet and use the same thought processes as a science and engineering team do to design and build missions. Use it to test your theories about comets and then evaluate the strengths and weaknesses of your comet model. The importance of the activity is not the initial model, but the model you improve or design and your evaluation of the initial model. During the second part of the activity, you will work with a team to decide what kind of new model you would like to build.

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Before you start:

As a class, discuss what is or might be true about comets. Build one list. Add to that list the things you wonder about comets or don't know. Build a model to study the following question: If you have to send a spacecraft to a comet, what will you need to consider about the way the Sun affects a comet? Now, build a "Comet on a Stick".

Materials:

One 8 ½ X 11 piece of paper

Two 1 - 2 ft lengths of mylar gift strips, raffia or ribbon

One 5" strip of tape

One wooden skewer (shish kabob type)

An electric hairdryer/electrical power available

One marker pen

Gather household or art supplies for students to use to design their own comet models.

Directions:

1. Mold the sheet of paper into the shape your team believes should represent your comet nucleus and attach it to the top of the wooden skewer or straw.
2. Place the mylar strips on top of the paper nucleus so the two pieces cross each other in an "X" and the lengths of all sides of the strips hang down evenly. You can also use light ribbon.
3. Attach the strips to the paper with the 5" strip of tape or narrow masking tape wrapped over the strips and around the circumference of the nucleus.
4. With a marker pen, assign a "front" for your comet and represent it with the letter "H" for head. On the opposite side, mark the letter "T" for tail of the comet.

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3. What other facts or theories about a comet can be seen using this model?
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5. Can you improve the model by changing it or making an entirely new model?
6. Can you build a model that shows what a comet does in space as opposed to what it is?
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10. Once your team has designed your comet model, show it to the other teams without explanation. See if they can identify what you were trying to show about a comet. How well did you collaborate as a team to build a clear and accurate model?

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Comet Models

Based on the Deep Impact Mission



Created for Deep Impact, A NASA Discovery Mission

Maura Rountree-Brown and Art Hammon

Educator/Student - Inquiry

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Here are some comet models you can try to build. Then design your own model. You can also use these models to explore some of the facts, theories and concepts about comet science.

Comets have a dark surface we can't see through. From what is it made?

Make several ice cream balls or use baking potatoes and cover them with different materials:

- Is it a hard crust? – Use chocolate shell. (hardens into a layer)
- Is it a slushy crust? – Use chocolate syrup
- Is it powdery – Use cocoa powder or cake mix
- Is it rough and thick – Use broken cookies

Cover the surface of your “comet” so that the inner contents can't be observed. (The Deep Impact Mission will create a crater on the surface of a comet and visually observe how the impact is made to the surface of the crust to learn more about its makeup.) Try to have another team design an experiment to see what is beneath the surface of your comet? Which kind of surface do you think we will find on a comet and why?

What do you think we will find beneath the surface of a comet?

Look for a candy bar that you believe might show what it is like beneath the surface of a comet. Is it dark or light? Is it smooth or full of “debris” – peanuts, candy etc? Are there layers beneath the surface or not, and is it delicate or firmer in composition? Why do you think you have picked a good model?

How will you build and evaluate your own model?

Bring materials from home and have your team decide on a mission design, comet theory or comet question you would like to communicate. Design a model to communicate your question about a comet. Build it and design a test to try to confirm your theory or answer your question. Was it a good model and can you improve it? If there is time, work on an improved designed based on evaluation of the first model.