

Happy Landings: A Splash or a Splat?

Lesson Summary

Pupils will design their own Huygens spacecraft using Playdoh to investigate how different atmospheric densities will affect the speed of Huygens' descent through Titan's atmosphere. The "atmosphere" will be modelled using glycerol. Pupils then drop their spacecraft models down through the "atmosphere" and time how long it takes to land on the "surface."

Prior Knowledge & Skills

- Data collection and measurement
- Graphing

AAAS Science Benchmarks

The Nature of Science

Scientific Inquiry

The Physical Setting

Motion

NSES Science Standards

- **Science as Inquiry:** Abilities necessary to do scientific inquiry
- **Physical science:** Motion and forces, properties and changes of properties in matter
- **Earth and space science:** Structure of the Earth system

NCTM National Mathematics Standards

- **Data Analysis and Probability:** Formulate questions that can be addressed with data and collect, organize and display relevant data to answer them
- **Algebra:** Analyze change in various contexts

Teaching Time: One 45-minute period

Materials

Each student will need:

- Transparent measuring cylinder
- Playdough to create model Huygens
- Glycerol
- water
- stopwatch
- graph paper

Advanced Planning

Preparation Time: 30 minutes

1. Gather materials
2. Review the lesson plan

Why Do We Care?

The Huygens probe gave scientists their first look beneath the thick clouds of Saturn's moon Titan. The probe charged through Titan's atmosphere and landed on its surface on January 14, 2005. Scientists analyzing Huygens' impact found that the probe didn't slam into a hard surface, but also didn't splash down into an ocean. Instead, it landed in a Titanian mud puddle that some scientists describe as having a thin crust like cr me brulee. Scientists aren't yet sure what the mud is made of.

Suggested background reading

Image shows Huygens landing site

Huygens Landed with a Splat

Cassini-Huygens Mission to Saturn

Cassini Spacecraft and Huygens Probe

Titan fact sheet

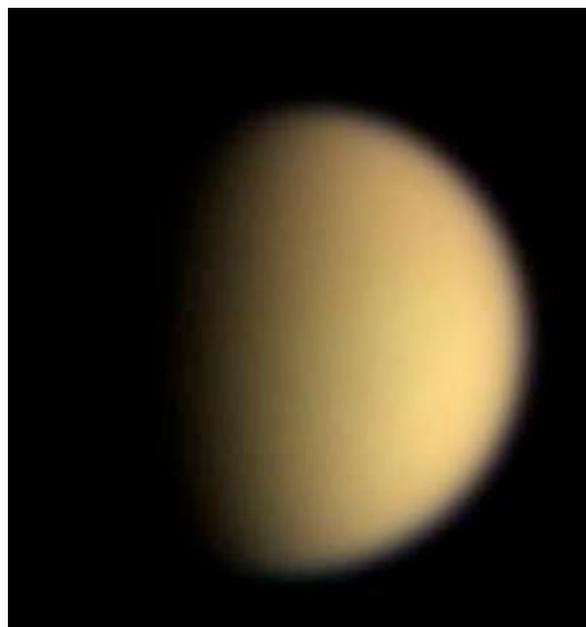
Source: British National Space Centre

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Introduction

The mission objectives for Huygens include:

- To find out the type of chemical reactions occurring in Titan's atmosphere.
- To discover the source of methane, a compound associated with biological activity on Earth, which is so abundant in Titan's atmosphere.
- To confirm whether there are any oceans on Titan.
- To find out whether more complex organic compounds and 'pre-biotic' molecules exist on Titan.



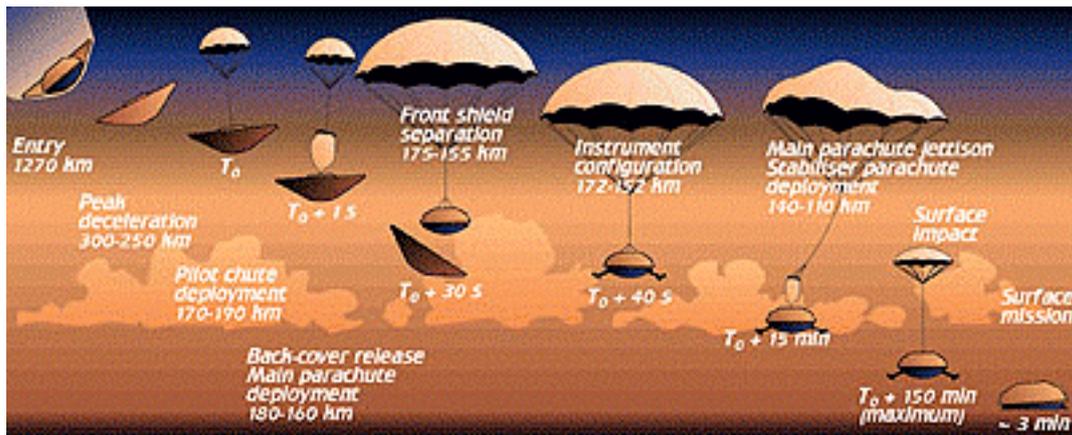
Titan image taken by Cassini

Scientists hope that Huygens will achieve all these objectives, after it separates from the Cassini spacecraft and travels down through Titan's atmosphere.

The images of Titan that have been captured already do not give a lot of information about the surface of the moon, in fact some scientists were reminded of the first images of Venus, showing thick cloud cover. Titan also has clouds, and scientists believe that it may have a thick, planet-like atmosphere. The atmosphere appears to be about thicker than that of Earth, with an atmospheric pressure 60% greater than on Earth.

Titan's atmosphere seems to have an eerie orange hue. Like Earth, the atmosphere on Titan is made up mostly from nitrogen, but unlike Earth, methane is the second most abundant gas. This detail has excited scientists, since one of the mysteries surrounding Titan is the source of the methane gas – could it be produced by living organisms?

Another mystery is what the surface of Titan is like. Since images of Titan show only the thick cloud cover, scientists have not yet been able to observe the surface.



Huygens was released from Cassini in December 2004 to begin its 22-day journey to Titan. In January 2005 it entered Titan's atmosphere and descended via parachute to the surface of Titan.

Huygens will take about 2 ½ hours to dive through Titan's dense atmosphere, analysing its components and answering questions about the chemical reactions taking place there.

Do you think the dense atmosphere of Titan affected the speed of the Huygens probe as it descended towards the surface of the moon? Do you think the little spacecraft landed with a splash in an ocean filled with life? Or did it fall with a splat on a hard, rocky surface?*

*This text edited for accuracy by LASP.

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Teacher's notes

This lesson will consider the effect that Titan's atmosphere will have on the speed of Huygens' descent. It will answer QCA questions:

- 7K "What does friction do?"
- 9K "How do forces affect speed?"
- 9K "How do parachutes work?"

Pupils will design their own Huygens spacecraft using playdough; they can use images from the worksheet to come up with the shape that they will use. This lesson would link well to the exercise on how parachutes work.

The focus of this practical is to investigate how different atmospheric densities will affect the speed of Huygens' descent through Titan's atmosphere. The 'atmosphere' will be modelled using glycerol. Pupils then drop their spacecraft models down through the 'atmosphere' and time how long it takes to land on the 'surface'.

Progression

Pupils record times taken for their model to travel through different densities using varying amounts of glycerol and water, expressing results as a graph of speed vs density/specific gravity.

Pupils then use particle theory to explain their results. Why does the spacecraft move more slowly through a denser atmosphere?

This could be linked with the theory that in December 2003, Beagle 2 travelled more quickly through the Martian atmosphere than scientists expected.

Key Stage 3
Activity sheet

Happy Landings – a splash or a splat?

I am learning:

How the density of a liquid affects the speed of a falling object.

Activity

This activity will help you to think about the effect that Titan's atmosphere might have on the speed of Huygens' descent. In the activity you will investigate the speed of a 'spacecraft' falling through two different 'atmospheres'.

Look at drawings / photos of the Huygens spacecraft and design two cone-shaped models using playdough. Use different liquids with different densities to represent different atmospheres; glycerol is a thick, dense liquid, while water is less dense.

I will need:

Transparent measuring cylinder

Model Huygens spacecraft

Glycerol (more dense 'atmosphere')

Water (less dense 'atmosphere')

Stopwatch

After filling the measuring cylinder with water, time how long it takes your model spacecraft to fall to the bottom of the cylinder.

Things to think about:

How will you make this a fair test?

What do you need to keep the same?

How can you ensure accurate values for timings?

Repeat the test using glycerol instead of water.

How did the timings for water and glycerol compare?

Can you explain why the timings may be different in a less dense liquid (or atmosphere) compared with a denser one?

Things to think about:

Kinetic theory - solids, liquids and gases are made up from particles.

What causes the force of friction?

How does friction affect speed?

How might friction in a less dense atmosphere compare with friction in a more dense atmosphere?

Find out how **Galileo's** thermometers work.