National Aeronautics and Space Administration

NASA Helio Club

Session 3

Parker Solar Probe Engineering Challenge

NASA Heliophysics Education Activation Team

Materials Needed for this Session

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Basics
- Writing tools (pens or pencils)
- Art supplies (markers or crayons)
- (1) pair of scissors
- (1) roll of tape

Prior Knowledge/Evaluate
- (1) Handout_KWL

Engage
- Handout_Structure of the Sun

Explore: Activity 1
- Handout_Engineering Challenge 1: Speed
- (1) dry erase marker
- (1) piece of transparent Plexiglas (8.5” x 11”)
- (2-3) strong round magnets of various sizes
- (2-3) steel ball bearings of various sizes
- (4) small, equally sized books or other objects to serve as corner supports for the Plexiglas baseboard (learner provides)
- (1) Index Card
- Tape
- Scissors
- Ruler

Explain: Activity 2
- Handout_Engineering Challenge 2: Heat
- Spoon
- Aluminum baking pan
- (4) larger clear plastic cups (~16 oz)
- (4) smaller “Dixie” cups (~3 oz)
- (1) styrofoam cup (8-16 oz) (tear apart)
- (1) 10” x 10” piece of aluminum foil (tear apart)
- (~10) cotton balls (tear apart)

Extend: Activity 3
- Handout_Eclipse Chalk Art
- Handout_2023 & 2024 Solar Eclipse Map
- White, yellow, or orange chalk
- (1) piece of black construction paper
- (1) piece of cardstock
- Scissors

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Use a notebook or the extra paper in the Helio Club Youth Guide to record observations, collect data, and organize ideas.

Session 3: Notes

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What do you already know about the challenges of studying the Sun ?

Session 3: KWL		
K - what do we already know?	**W- what do we wonder about?**	**L- what did we learn?**
What do we already know about the challenges of studying the Sun? • *Why is it challenging to study the Sun?*	**Record questions you have about the challenges of studying the Sun in this column.**	**Record what you learned about the challenges of studying the Sun in this column.**

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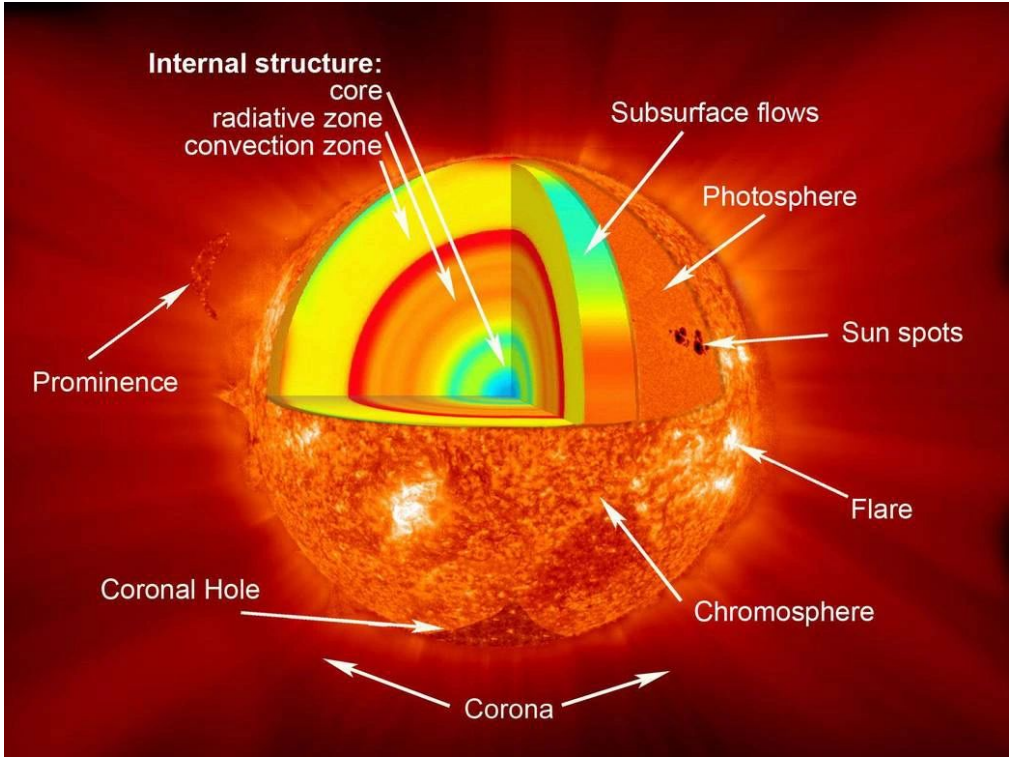
The Biggest Mystery of the Sun



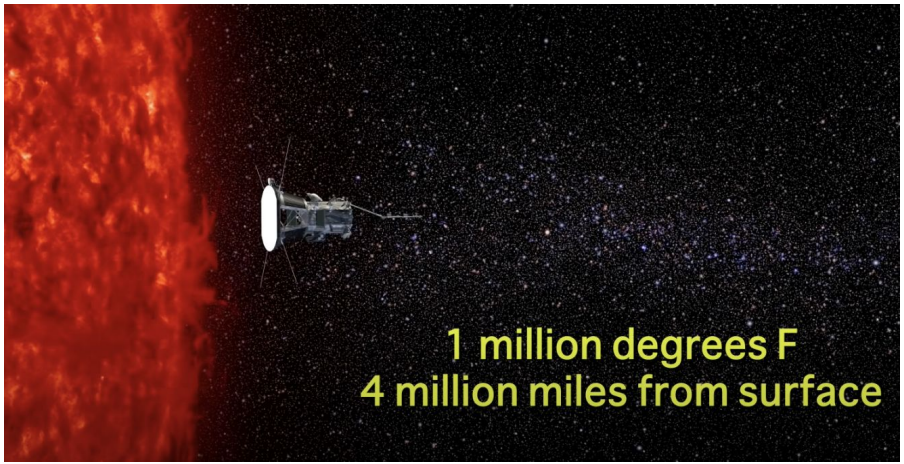
Why is the the outer layer of the solar atmosphere, the **corona**, hotter than the **chromosphere** and the **photosphere**?

Parker Solar Probe

[Parker Solar Probe Mission Overview Video]

As you watch the video, consider the following questions:

- What question is the mission trying to answer?
- What are the major challenges this mission needs to overcome?
- What types of solutions have NASA engineers developed to overcome these challenges?



Animation of PSP *Credit: NASA GSFC*

★ **The mission that touches the Sun!**

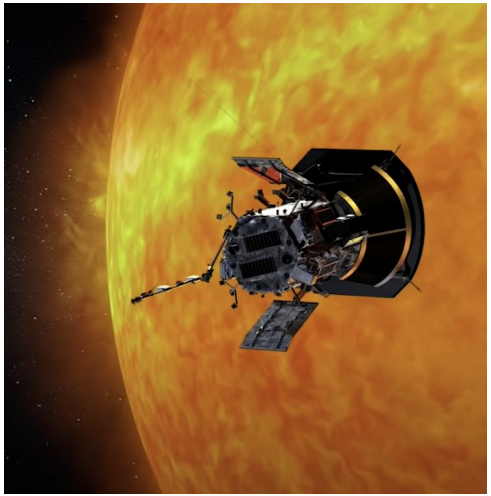
★ **Fastest human-made object in the Solar System.**

Challenge 1: Getting to the Sun

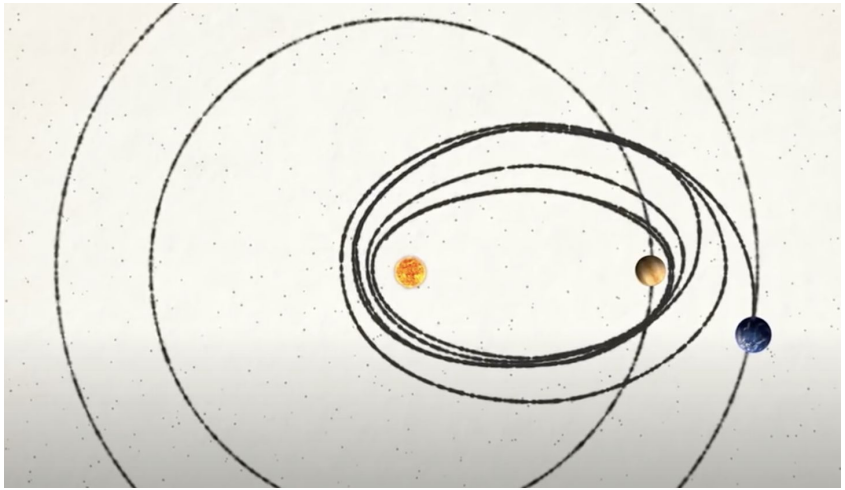
Parker Solar Probe: Getting to the Sun Video

As you watch the video, consider the following questions:

- Why is it so hard to fly to the Sun?
- What solutions will NASA use to get Parker Solar Probe to the Sun?



Animation of PSP
Credit: NASA GSFC



Animation of orbital path of PSP from Earth to Sun with 7 gravity assists from Venus *Credit: NASA GSFC*

Engineering Challenge 1: Model a Gravity Assist

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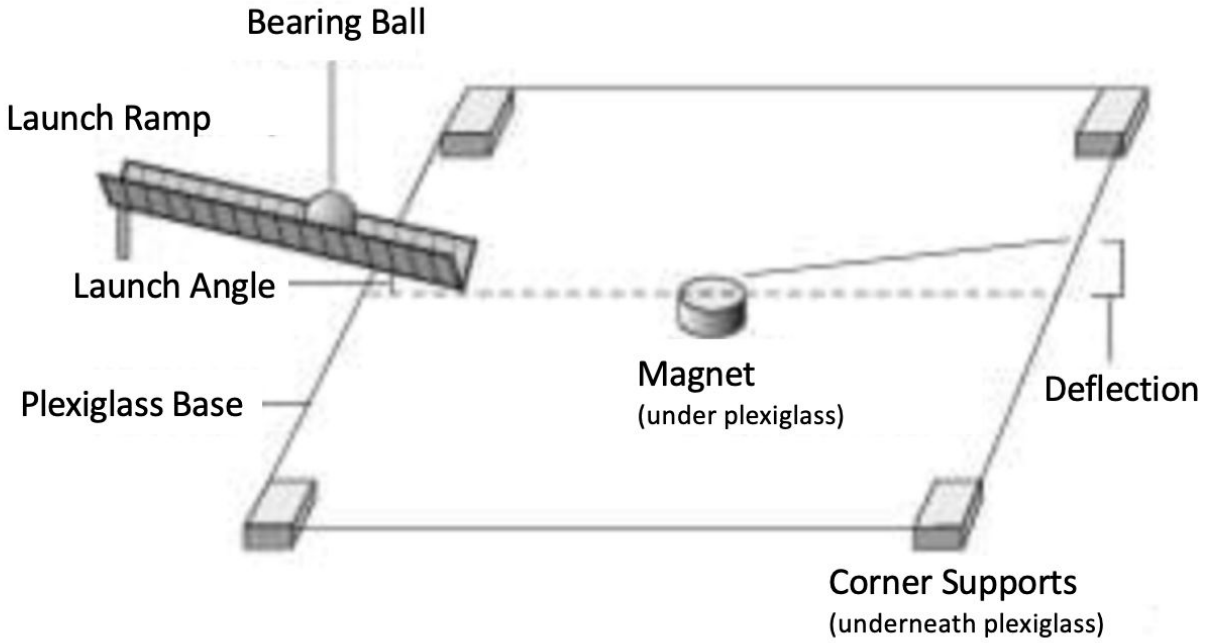

Engineering Challenge #1 Set Up
Credit: TeachEngineering.org

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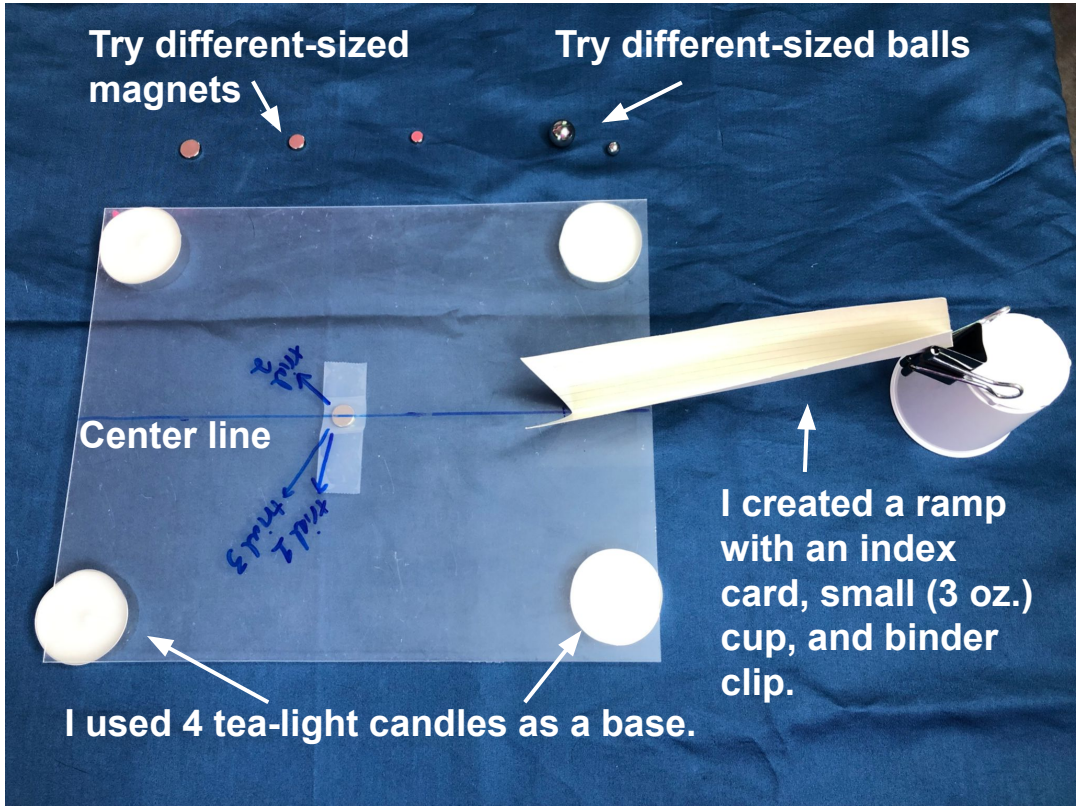
Engineering Challenge 1: Experimental Set-Up



The base doesn't need to be high, just enough to be able to tape the magnet underneath the Plexiglass.

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Engineering Challenge 1: Make a Prediction

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What will happen to the steel ball when it travels toward the magnet?

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Engineering Challenge 1: Larger Ball Bearing, Smaller Magnet

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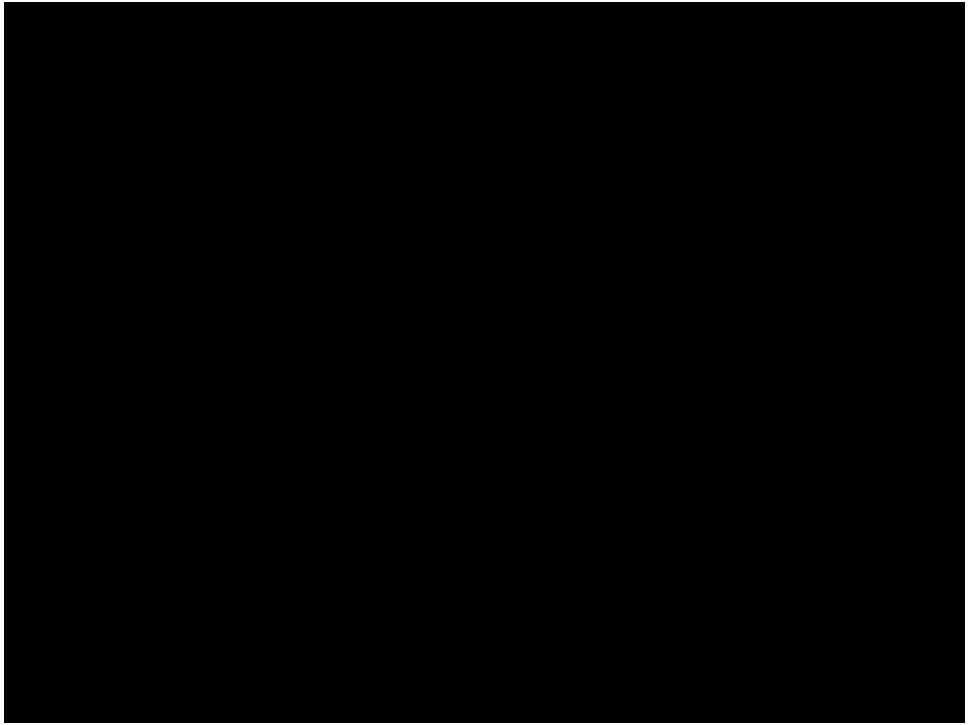

You will have to adjust the setup and practice to get a successful launch.

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Engineering Challenge 1: Smaller Ball Bearing, Larger Magnet

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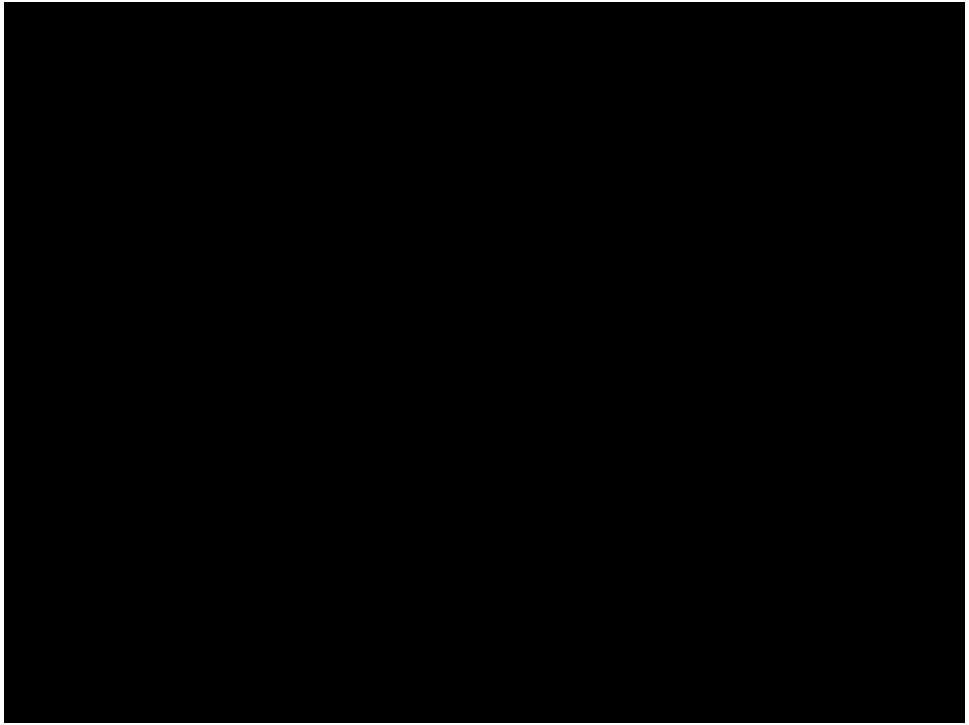

You will have to adjust the setup and practice to get a successful launch.

Engineering Challenge 1

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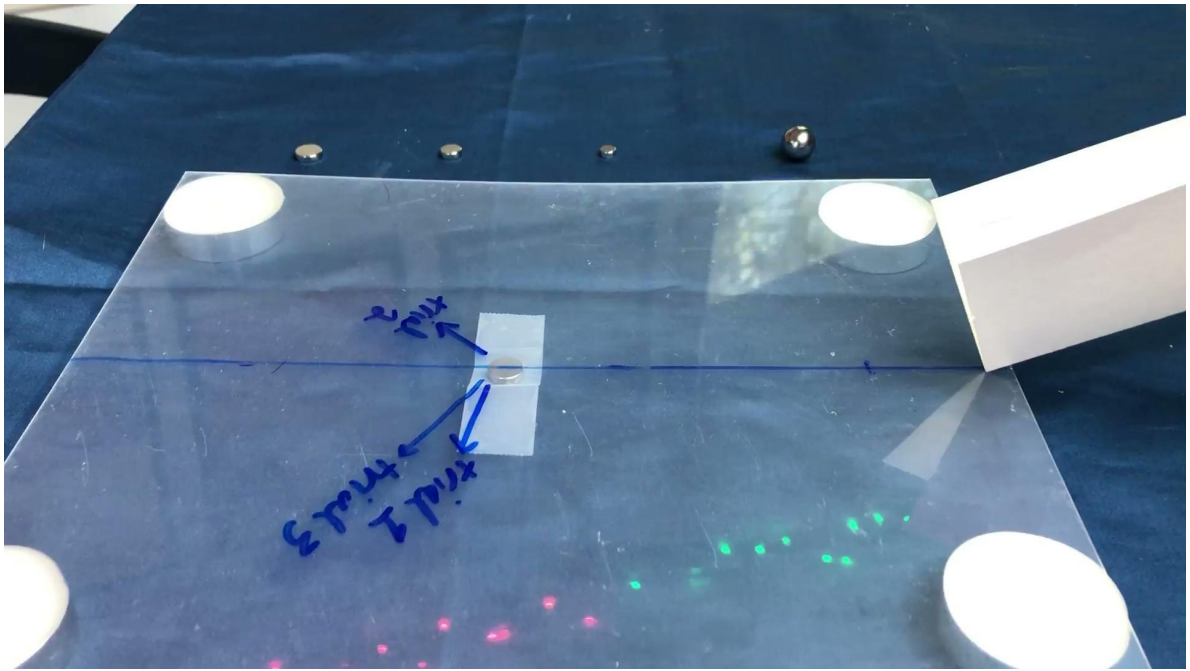

Adjust the ramp angle to make sure the ball doesn't get stuck on the magnet.

You may need to adjust the ramp angle for different-sized ball bearings and different-sized magnets.

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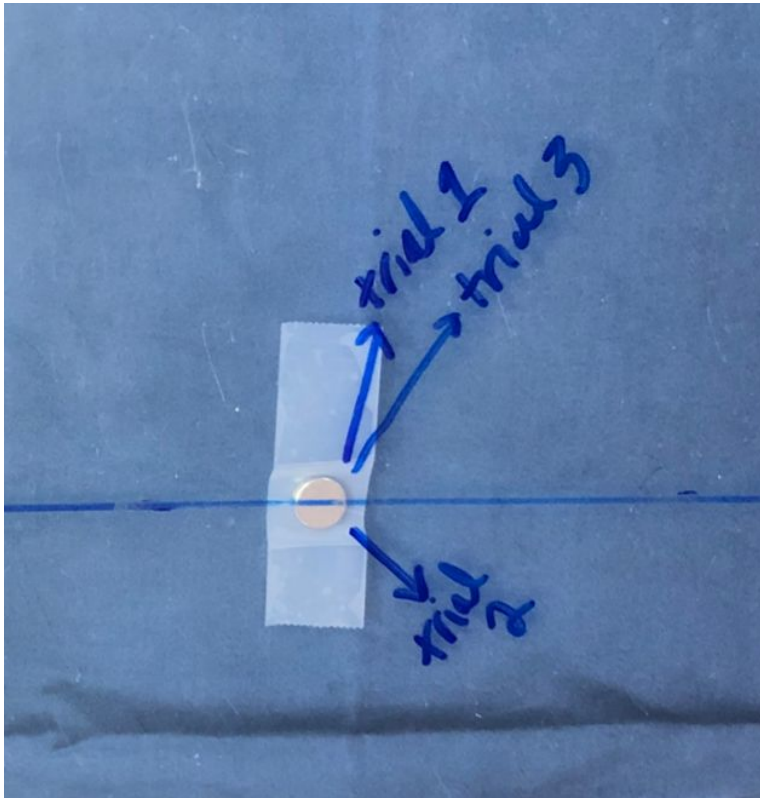
Engineering Challenge 1



Use the dry erase marker to mark the trajectory of the ball for each trial.

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Engineering Challenge 1: Gathering Data

Trial	Size of Magnet	Size of Ball Bearing	Height of Ramp	How did the ball behave?
1				
2				
3				
4				
5				
6				

Gather data!

Try using a data table like this one.

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Engineering Challenge 1: Results

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- How did the launch angle (vector) affect the deflection of the ball (spacecraft)?
- How did the size of the magnet (planet) affect the deflection of the ball (spacecraft)?
- How did the size of the ball (spacecraft) affect the deflection of the ball (spacecraft)?

Remember! This is a model.

We are using magnetism to model the effects of gravity.

Magnetism is not involved in a gravity assist in space.

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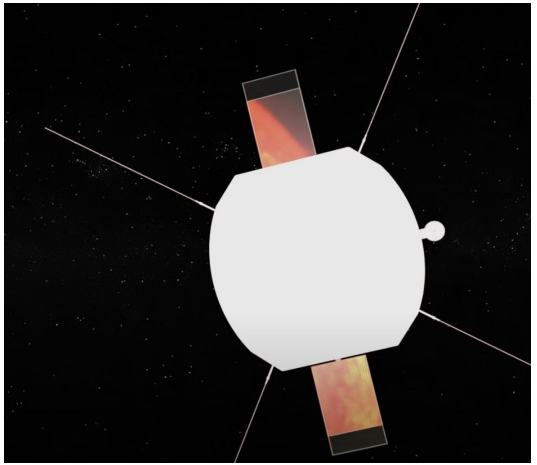
Challenge 2: Insulation

Parker Solar Probe: Why won't it melt? Video
As you watch the video, consider the following questions:

- What are the properties of Parker's heat shield?
- How does the density of the corona affect heat transfer?



Animation of Parker Solar Probe's heat shield
Credit: NASA GSFC

Engineering Challenge 2: Experimenting with Insulation

Aluminum Foil

Styrofoam

Cotton

Air

Make a prediction:

Which cup will freeze first?

Which cup will melt first?

Engineering Challenge 2: Experimenting with Insulation

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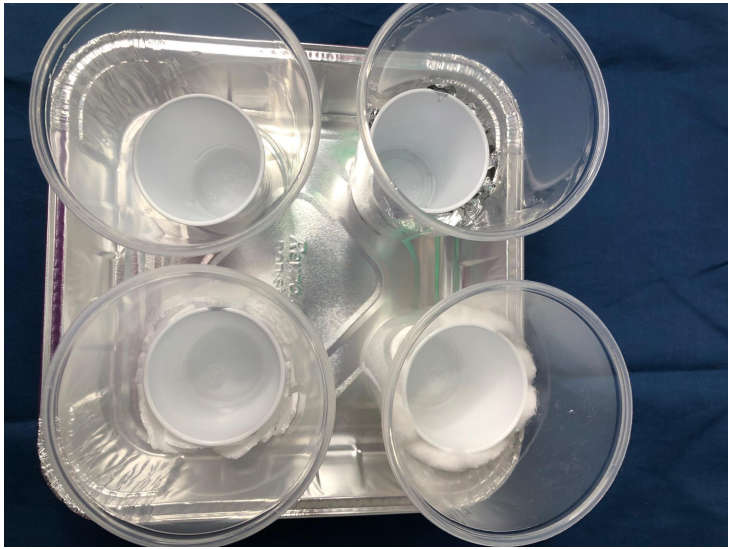

(1) Remove the cups from the freezer and place them in an aluminum tray.

(2) Pour hot water into the tray.

(3) **Make a prediction.** Which cup will melt first?

(4) Record your observations.

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Engineering Challenge 2: Results

- Which cup froze first?
- Which cup melted first?
- Which materials are the best insulators and why?

Parker Solar Probe's WISPR Instrument

Video: WISPR Wide-field Imager

Credit: NASA / JHU APL

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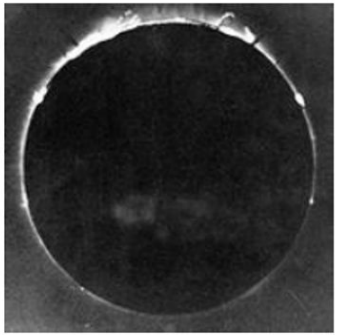
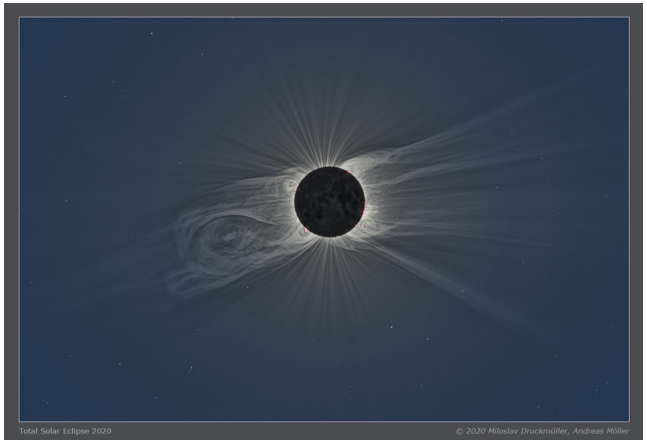
Methods for Viewing the Corona

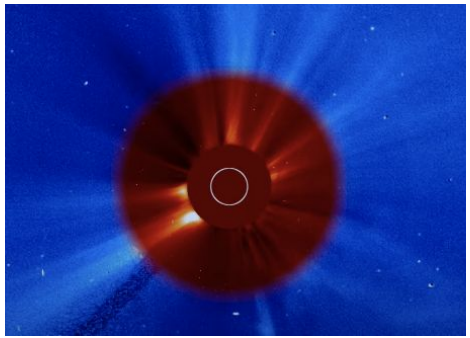
Left: Sketch of 1860 total solar eclipse showing a coronal mass ejection.
Image: G. Temple/NASA.

Right: First photograph of a solar eclipse, in 1860.
Image: C. Young/NASA.





Modern Image of a Total Solar Eclipse
Credit: Miloslav Druckmuller, Andreas Moller



Coronagraph
Credit: NASA SVS/GSFC

Parker Solar Probe WISPR Image of the Corona 1/31/21
Credit: NASA/JHU APL

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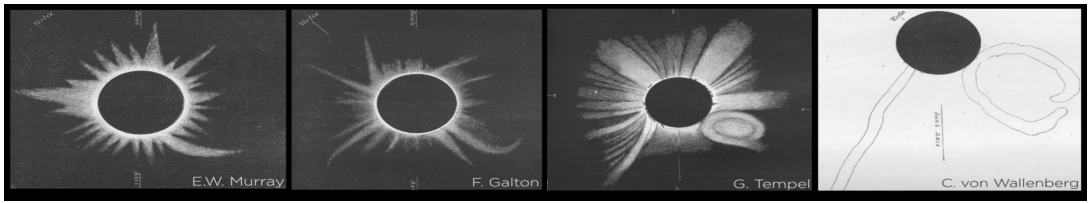
Eclipse Chalk Art

Credit: University of Alaska Fairbanks Museum of the North



Four scientists around the world draw what they see during a total solar eclipse in 1860. *Credits: mlso.hao.ucar*

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2023 & 2024 Solar Eclipse Map

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What did you learn about the challenges of studying the Sun?

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Session 2 Major Concepts

- ★ The Sun is a star and is hard to observe because it is so bright.
- ★ Eye safety is important when observing the Sun. **Solar eclipse glasses** and **pinhole projectors** are safe methods for observing the Sun.
- ★ The Sun gives off all types of light on the **electromagnetic spectrum**. Humans can only see **visible light**.
- ★ A **solar eclipse** provides a great opportunity to make observations of the Sun.
- ★ Scientists make observations of the Sun in multiple wavelengths of light, which gives them more detail of different features of the Sun, like **solar flares** and **sunspots**.
- ★ The Sun's atmosphere is called the **corona**.
- ★ It is challenging to study the Sun's corona, because the Sun is so bright, and the corona is dimmer than the Sun's surface.
- ★ NASA uses **coronagraphs**, which use an occulting disk to block the Sun's light so that scientists can view the corona.
- ★ Using a coronagraph, scientists can observe features of the Sun, including the **solar wind** and **solar flares**.

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