Travelling Through Space

Unit 2

This slide deck is intended to help guide you and your students through the sequence of this unit. While you may choose to use these slides as a helpful tool to prompt and facilitate students, all detailed information for each unit is in the student and teacher unit booklets.

Unit Essential Question

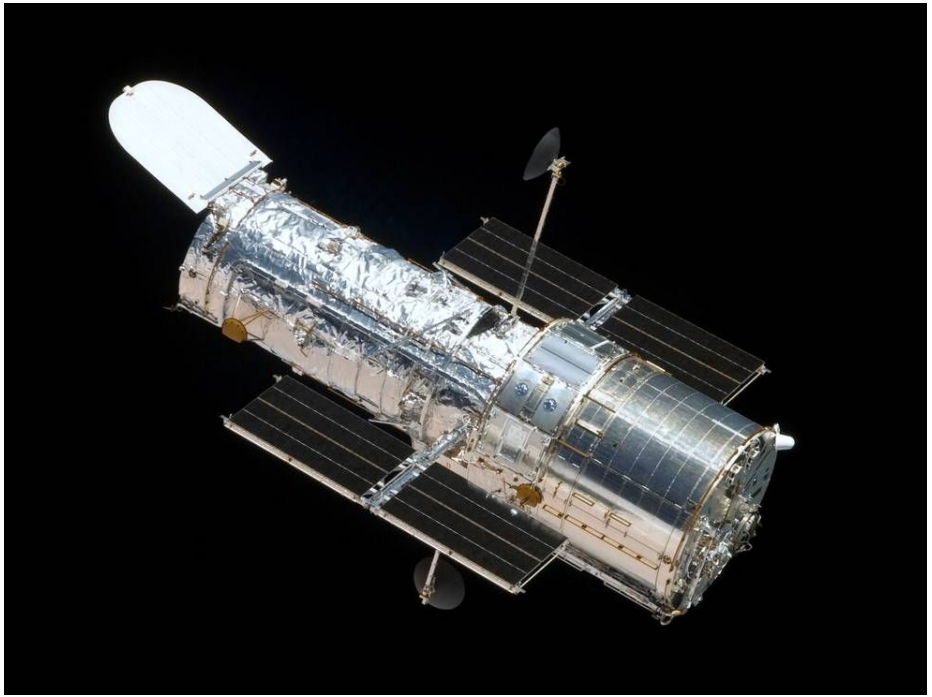
What forces keep the parts of our solar system together and how can we use this knowledge to plot a telescope route through space?

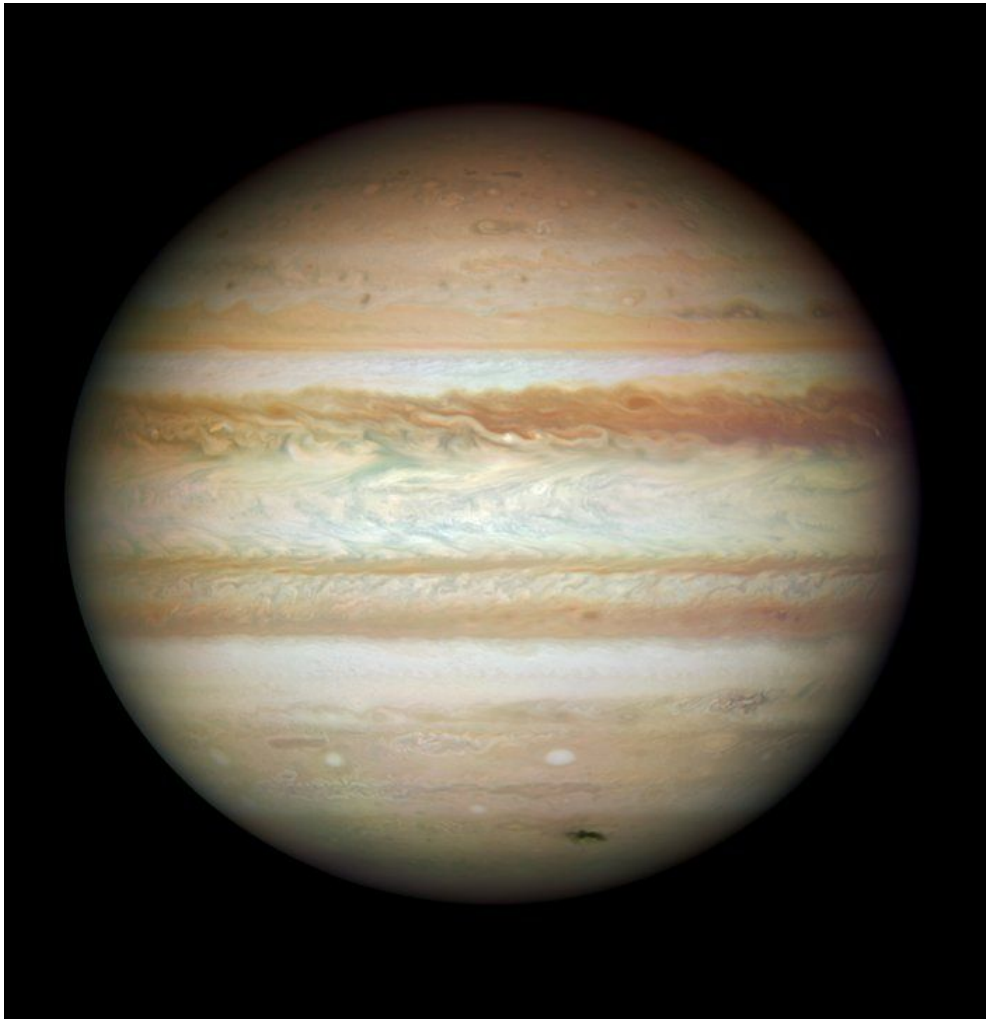
Our Solar System

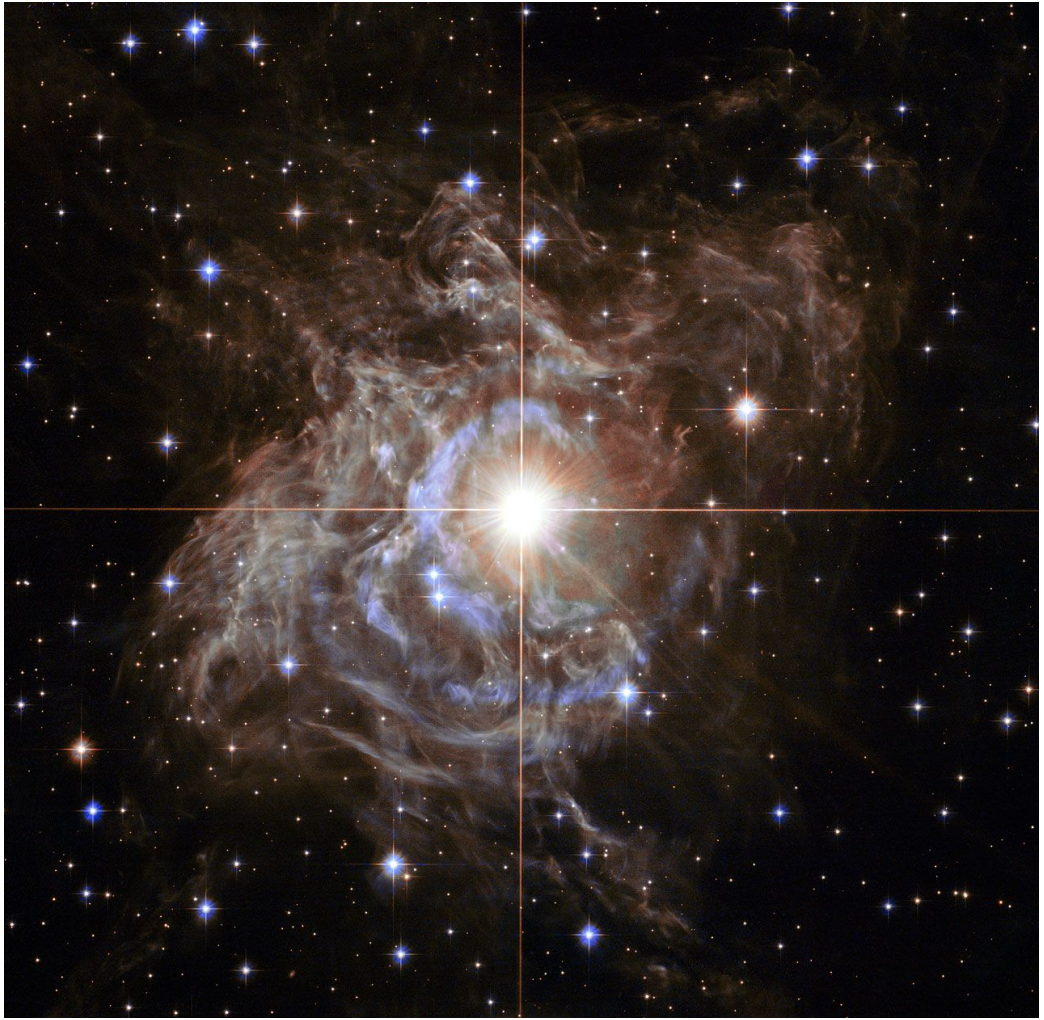
Lift-Off Task

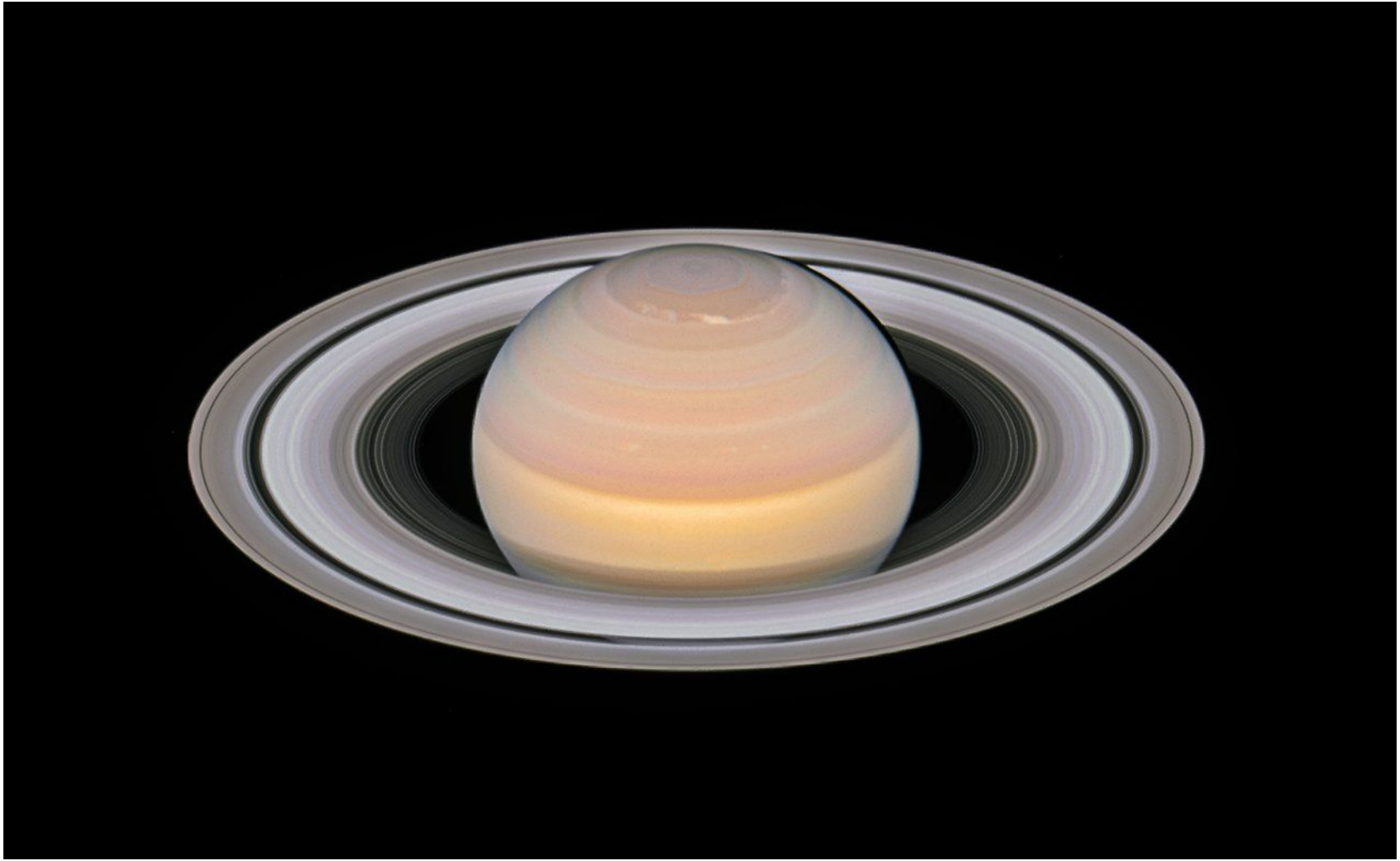
Now we have telescopes that can take pictures to help us learn more about the solar system!

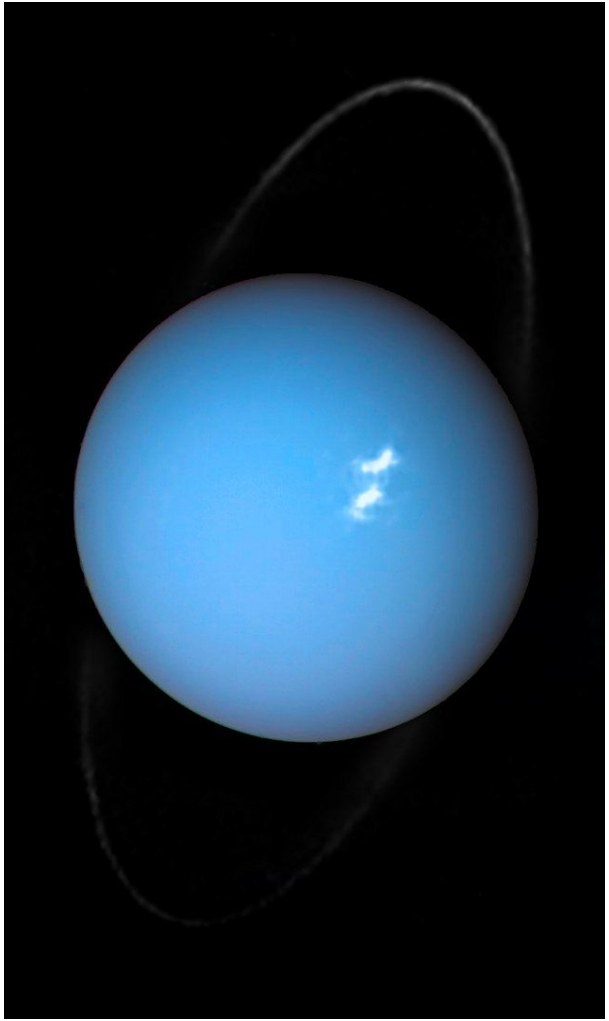
Make observations about the following images from the Hubble Space Telescope

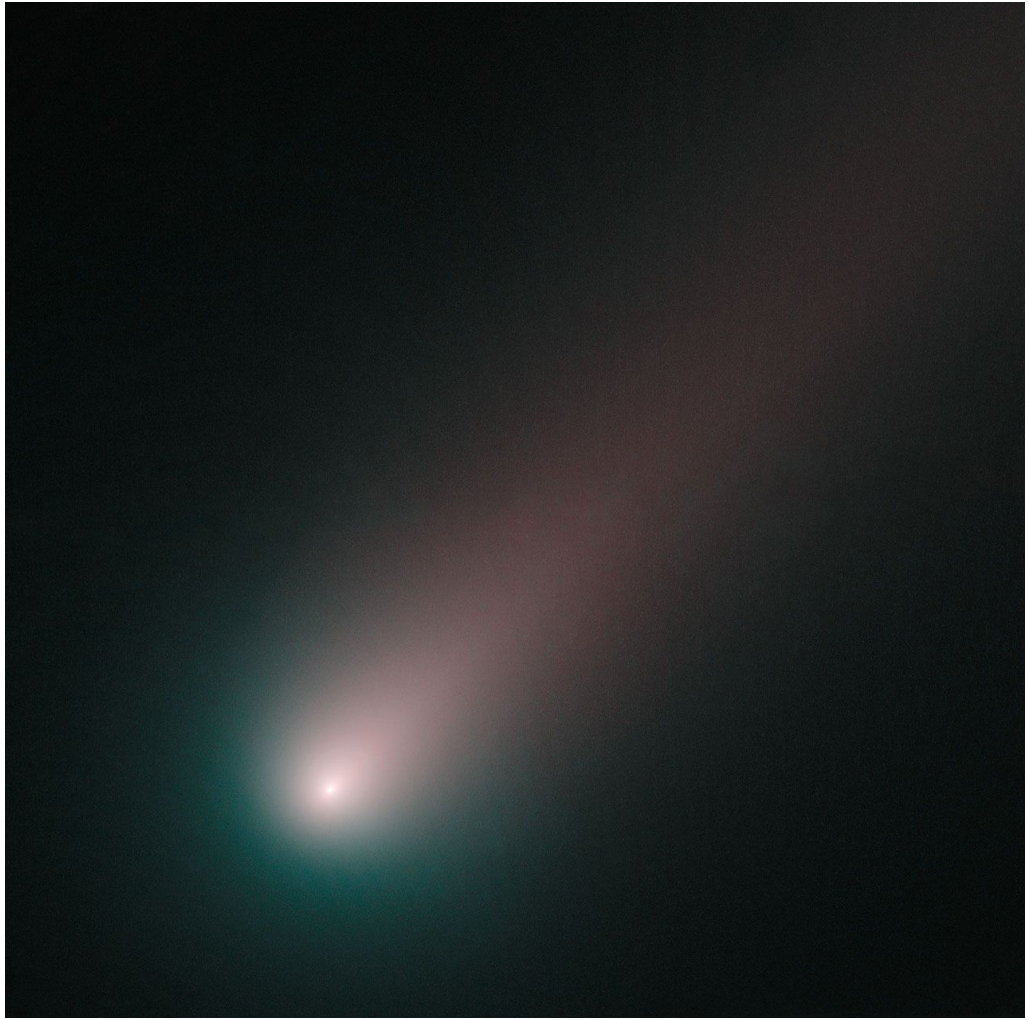


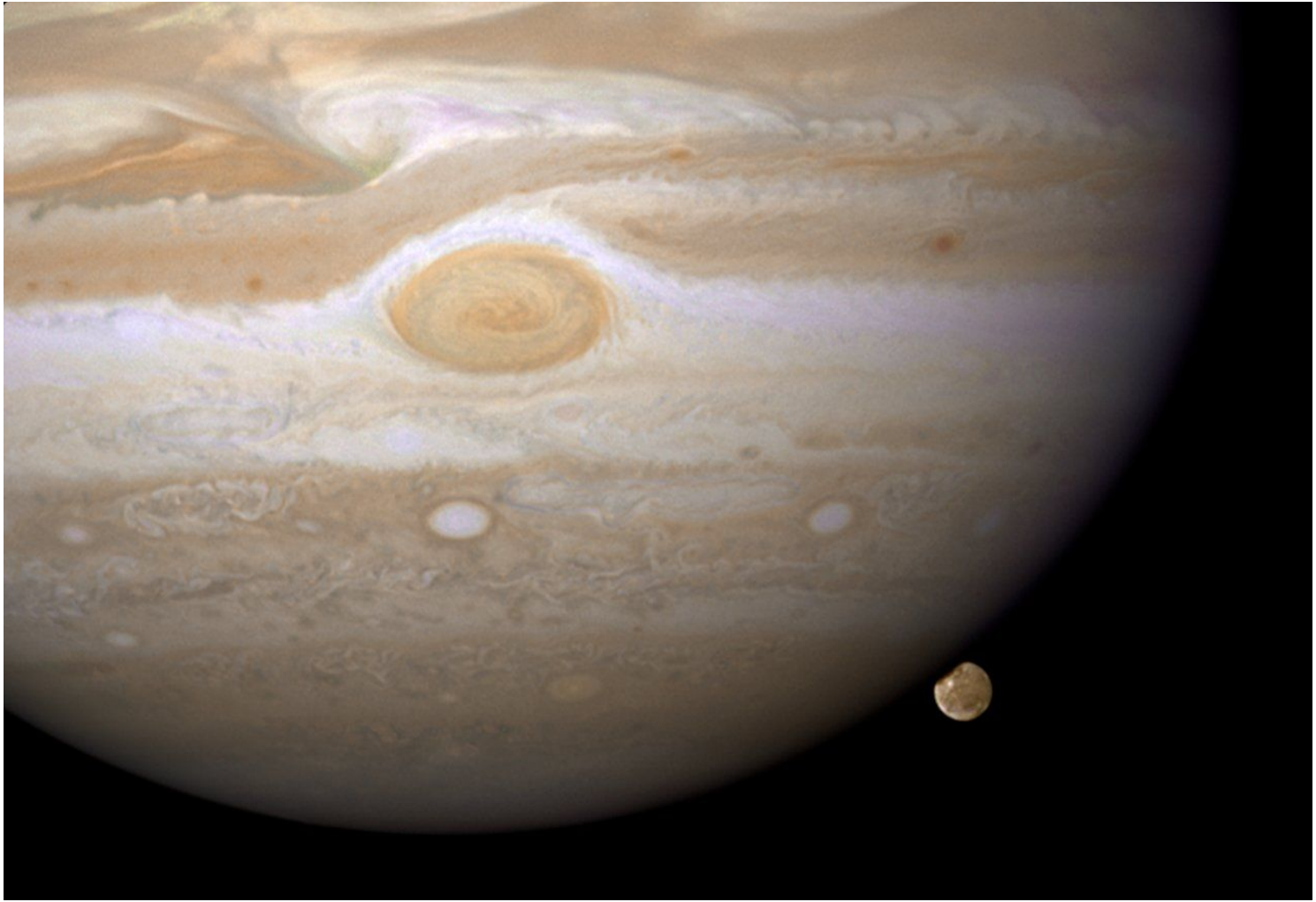






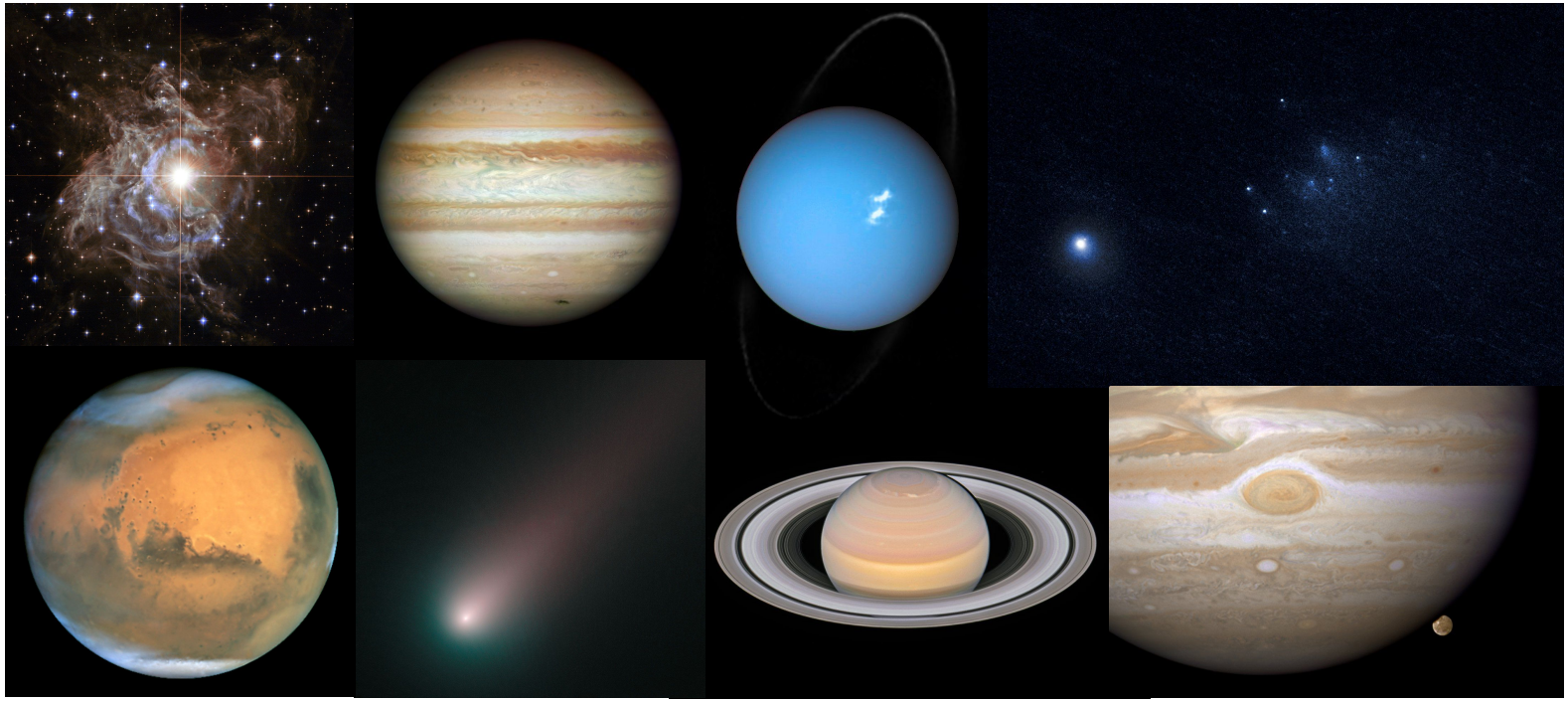






Generate Questions!

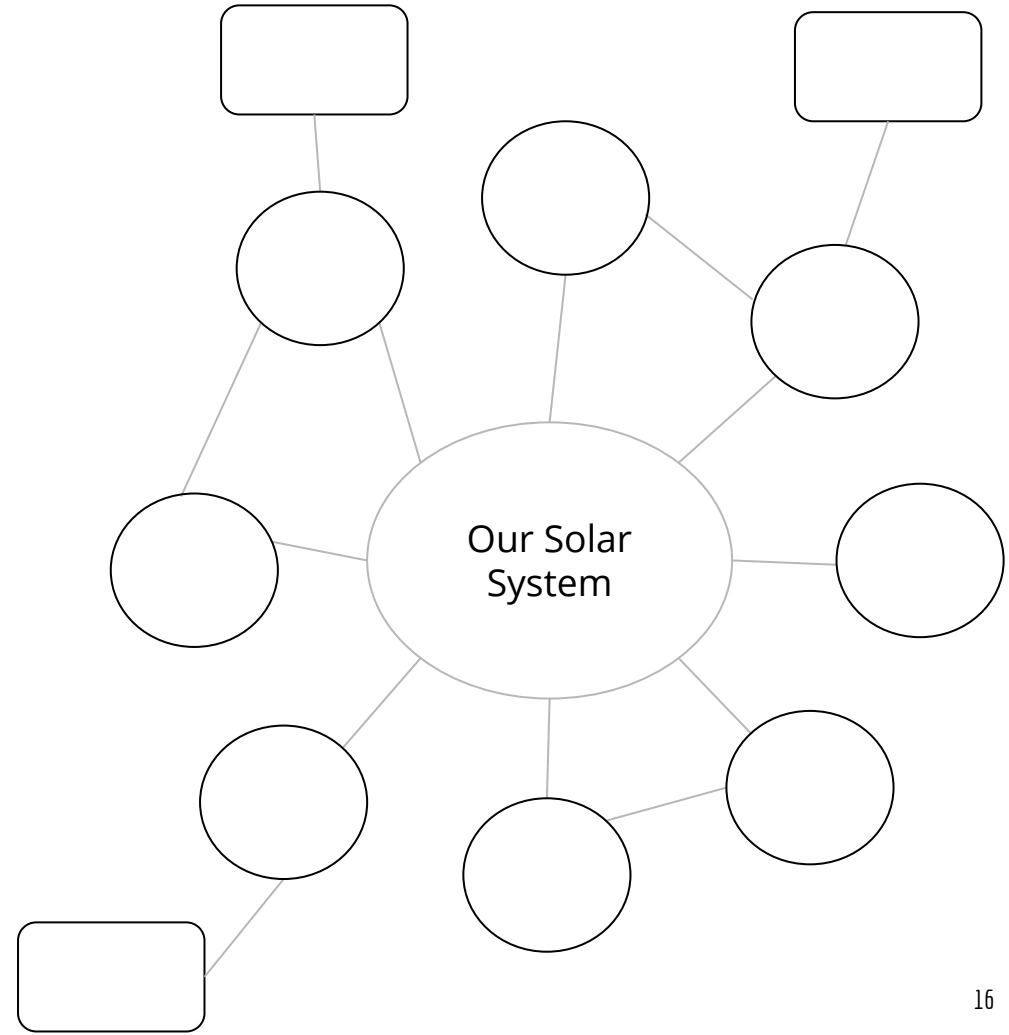
If you wanted to know more about our solar system, what questions would you ask?



Group Concept Map

As a group, create a concept map that shows:

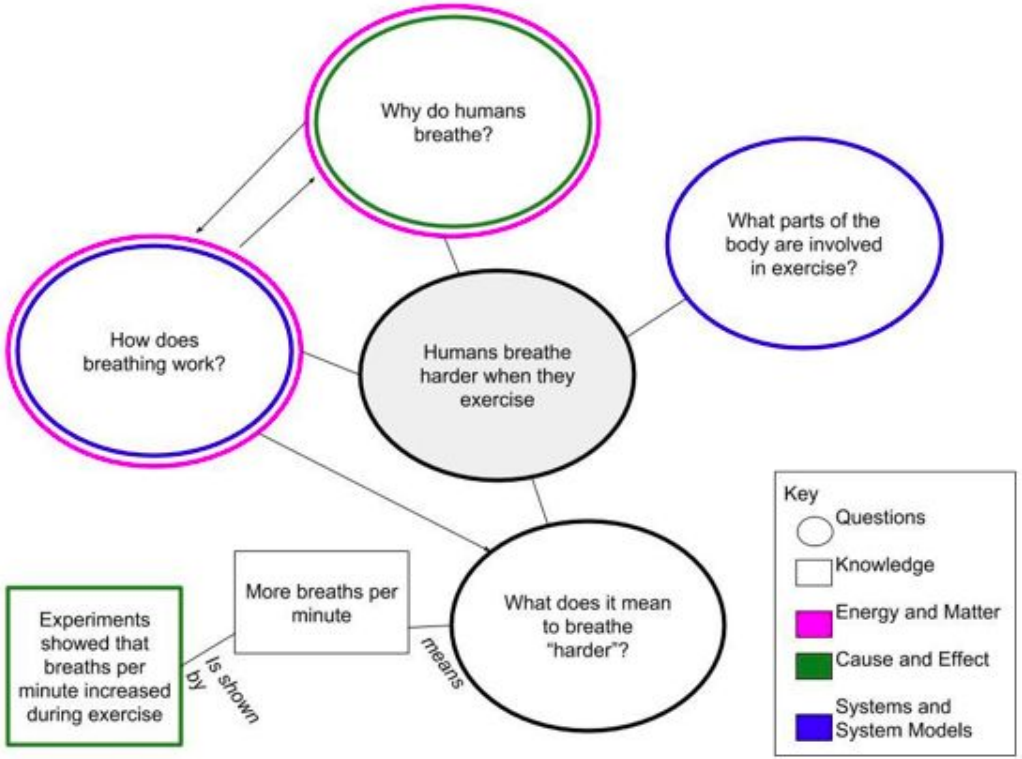
- Questions your group members had in common (circles)
- Possible answers to some questions (squares)
- Connections between related questions (lines)



Class Concept Map

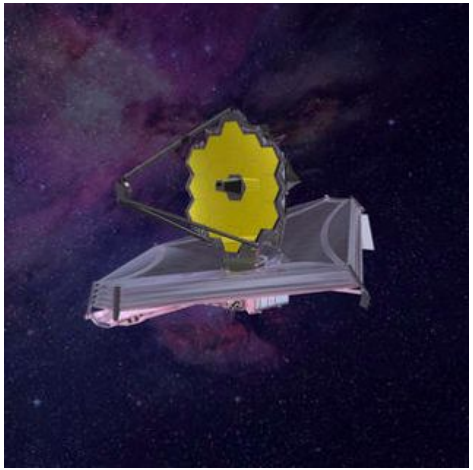
As a class, create a concept map that shows:

- Key questions (circles)
- Possible answers to some questions (squares)
- Connections between related questions (lines)
- Crosscutting concepts used (trace in color)



Introduction to the Culminating Project

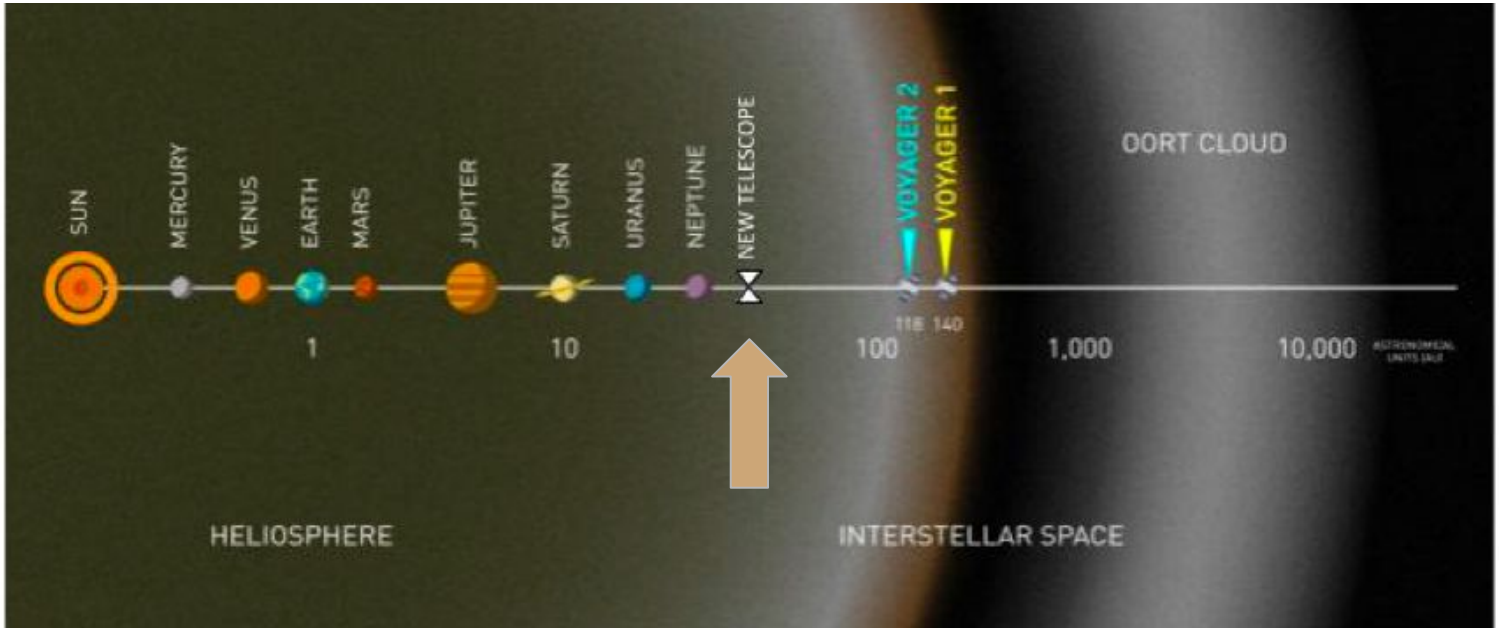
Plot a new telescope's route through space!



Group Project - A planet contribution to a class-wide solar system model and a presentation of your telescope route within the solar system model

Individual Project - A presentation in your choice of format that pitches your telescope route and describes the forces and energy involved

Background on the New Telescope



- Orbits the Sun, not Earth
- Needs to get to the outside edge of the solar system (see above)
- Must be protected from solar wind

Connecting to the Culminating Project

You will be developing a model of the solar system and proposing the best route a new telescope should take through space. You will be launching the new telescope into our solar system, so we need to know what is out there. What do you think our solar system consists of?

Complete this **individually** in your Project Organizer.

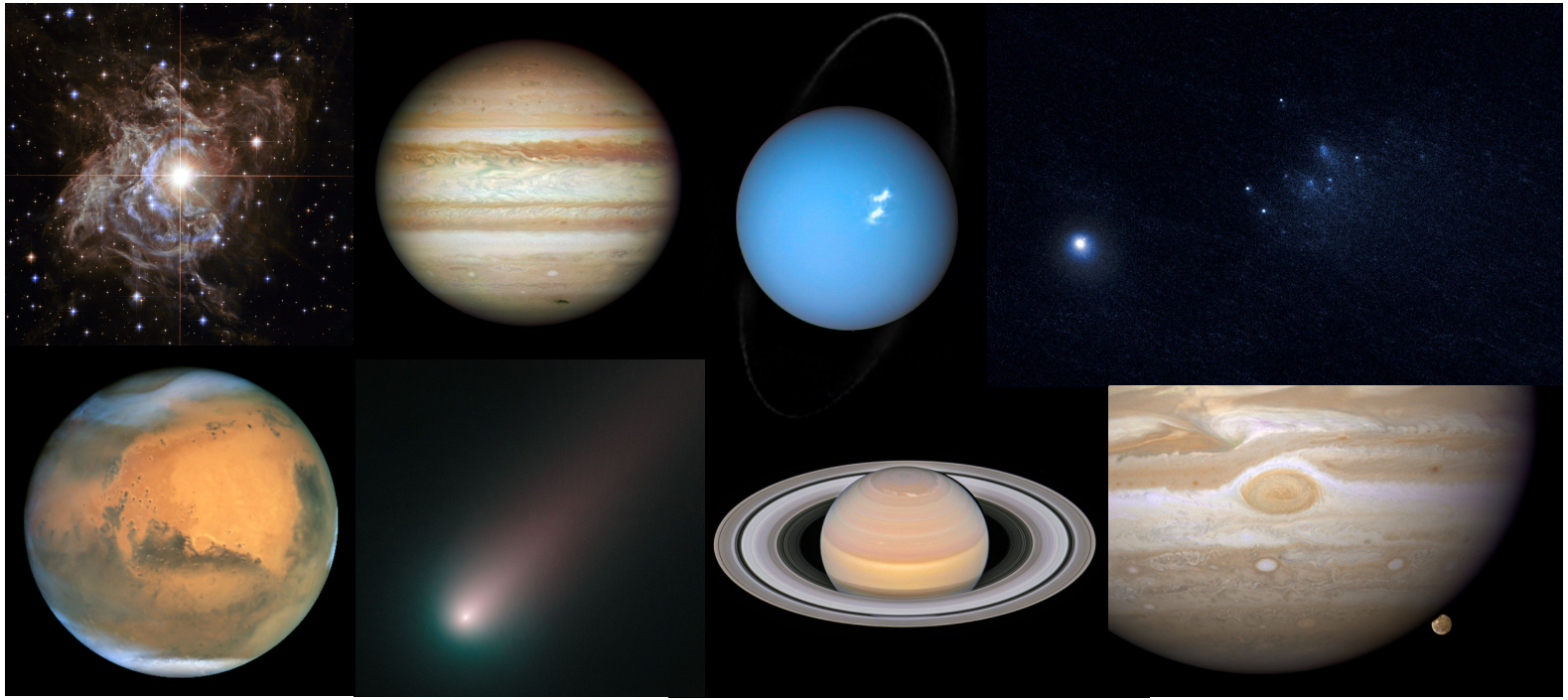
Reflection

Complete the questions at the end of your student guide to reflect on what you have learned in the Lift-Off Task.

A Sun-Earth-Moon Model

Task 1

What questions do you still have?



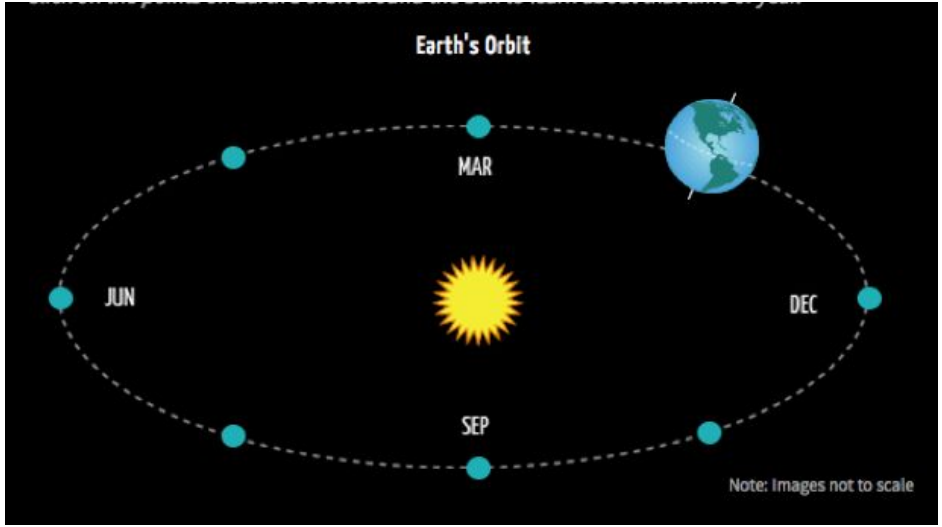
Engage

Think-Pair-Share: Make Predictions

1. Why does your shadow grow shorter and then longer throughout the day?
2. Why is it colder in winter and warmer in summer in California?
3. Why does the moon appear as a different shape in the sky on different nights?
4. Why can we see some stars for only a portion of the year?
5. How is it possible that an area of the world can go temporarily dark in the middle of the day?

Explore

Using Models to Understand the Sun-Earth-Moon System



As a group,

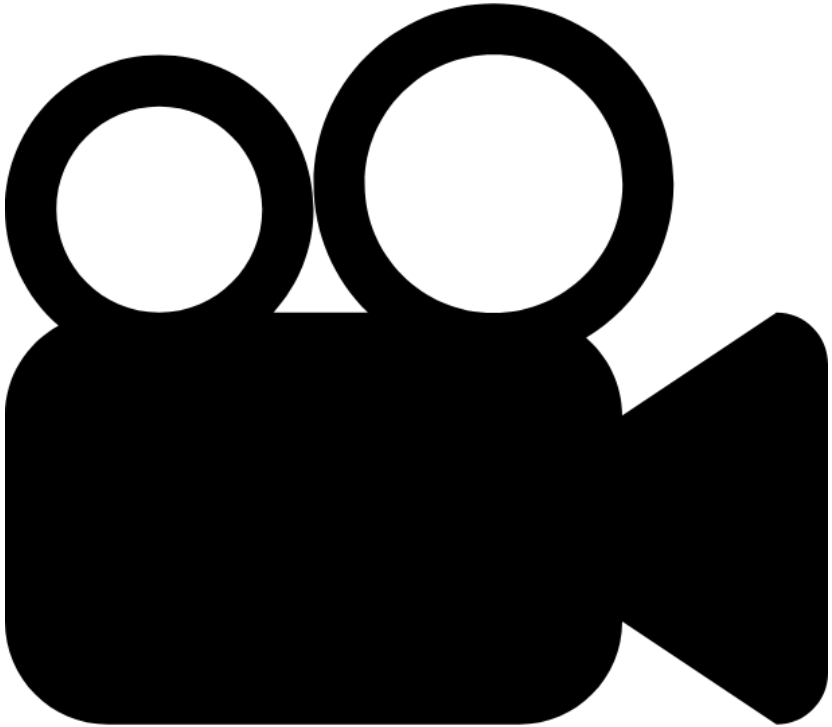
1. Use the models at each station to investigate the phenomena from the *Engage*.
2. Discuss and record observations about the Sun-Earth-Moon system.
3. Discuss and record responses to the discussion questions in your student guide.

Explain

Make Your Own Sun-Earth-Moon System Model

- Styrofoam balls of varying size
- Skewers/Toothpicks
- Light sources of varying brightness
- Rubber Band
- Marker

Make a Mini-Movie!



1. Pick one of the phenomena from the *Engage*:
    a. Sun moving through the sky
    b. Changing shadows throughout the day
    c. Seasons
    d. Changing stars in the sky
    e. Eclipses
2. Make a mini-movie explaining why this phenomenon happens, using the model you made.

Elaborate

Use What You've Learned to Help a Friend

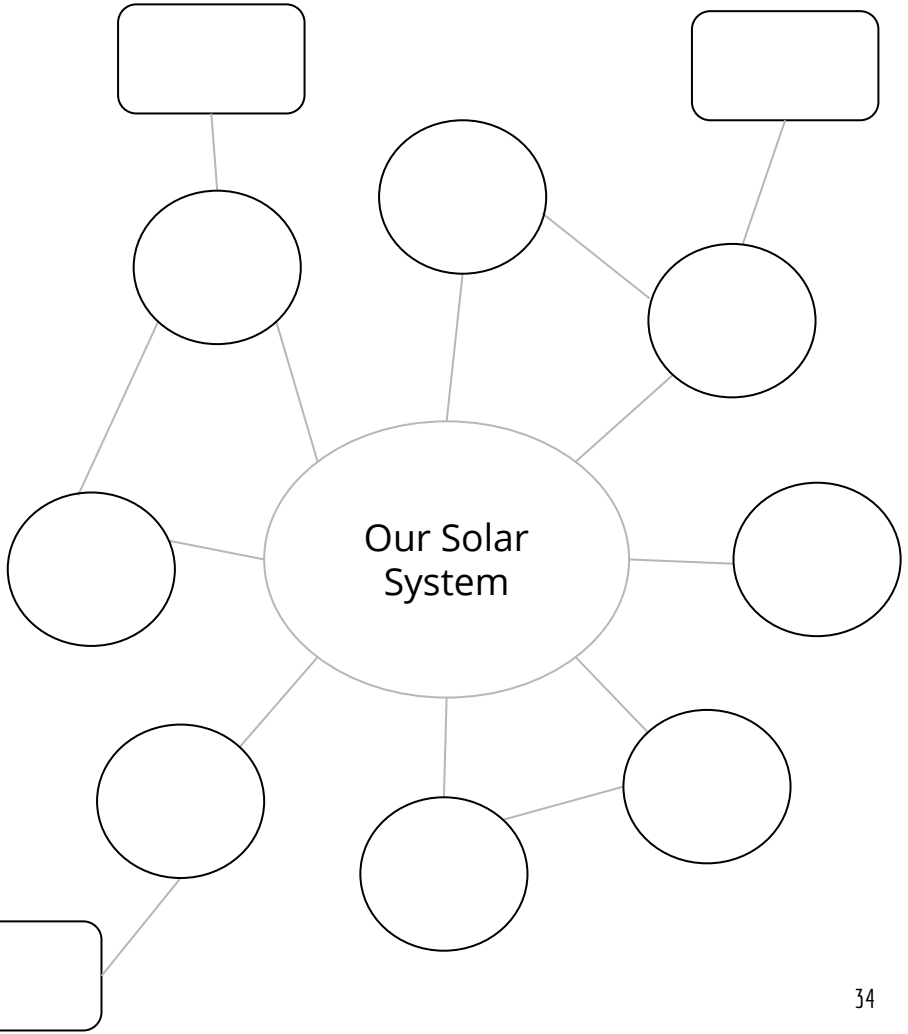
A friend from California is planning her winter break vacation in December. She decides that she wants to visit New Zealand to go skiing. Why is this a bad idea?

Individually explain to your friend why she should not go to New Zealand to ski in December. Use information or diagrams from the task to support your reasoning.

Class Concept Map

Add to your class concept map:

- New questions (circles)
- New ideas learned (squares)
- New connections (lines and connector words)
- Crosscutting concepts used (trace in color)
    - Patterns



Evaluate

Connecting to the Culminating Project

You will be developing a model of the solar system and proposing the best route a new telescope should take through space. In order to plan a route through the solar system for the new telescope, you will need to know what it looks like. The best way to imagine what it looks like is to create a model. To prepare you to construct a full solar system model, you have practiced this skill by creating a Sun-Earth-Moon system model. In the process, you have discovered the science behind many things you experience on Earth!

- Draw a sketch of your Sun-Earth-Moon model with labels.
- Use your model to describe at least two of the phenomena explored in this task.
- What are the limitations of the model you have drawn? In other words, how does it not accurately represent the Sun-Earth-Moon system?

Complete this **individually** in your Project Organizer.

Reflection

Complete the questions at the end of your student guide to reflect on what you have learned in Task 1.

A Solar System Model

Task 2

What questions do you still have?

Engage

In Task 1, we built a model to help us explain the science behind phenomena.

In this task, we will build a model to show us the layout of a system at a smaller *scale*.

Let's explore this idea of *scale*!

Individually,

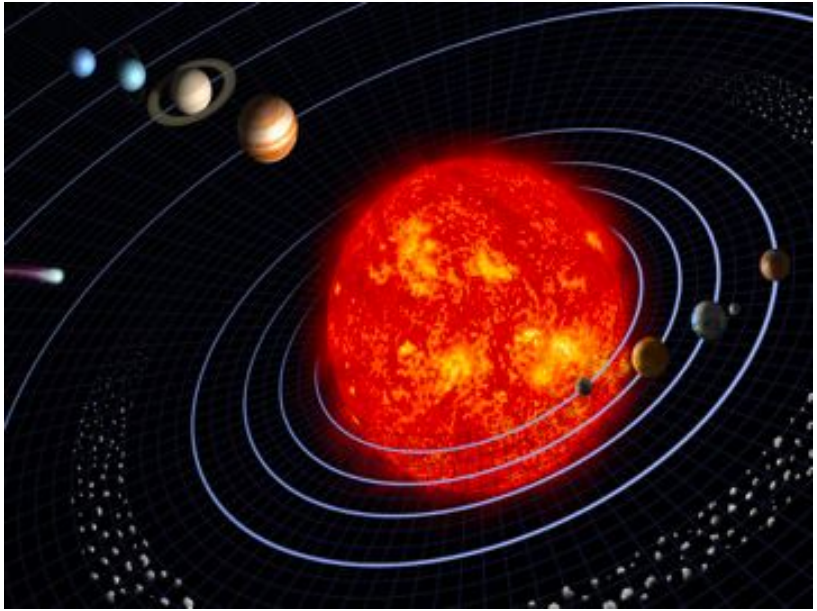
1. Put a dot on your student guide that represents you and where you are right now.
2. Pick a friend or family member who lives somewhat nearby.
    a. Now put a dot somewhere below representing where your friend or family member lives.
3. Now think of someone who lives far away.
    a. Given the distance between you and your "close" friend/family member, where on the paper would you put your "far" friend/family member?

Scale Model:

A model that shows real objects with all the sizes reduced or enlarged by a certain amount (known as scale).

Explore

Analyzing and Interpreting Solar System Data

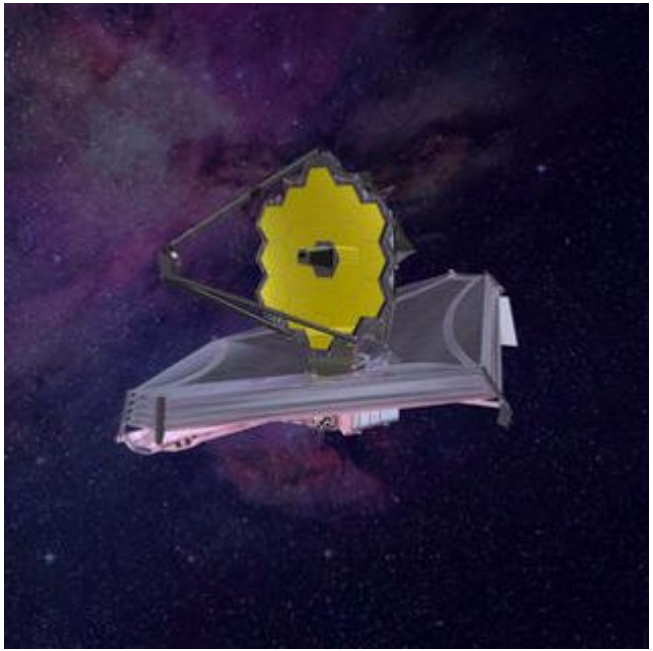


As a group,

1. Analyze the information about the parts of our solar system.
2. Discuss and answer the questions in your student guide to help you figure out what our solar system looks like.

Explain

We need to be able to visualize the different routes the new telescope can take through our solar system!



Challenges to Making a Scale Model of Our Solar System

Sizes of the Planets - Measured in Kilometers

Distance Between Planets and the Sun - Measured in Astronomical Units

(1 AU = 150 million kilometers)

Why is this a problem?

Our Solar System Model - 2 Scales

Size of Celestial Body (Planet or Sun): 1000 km = 1 cm

Distance from Sun: 1 AU = 10 cm

In your group, use the data from the *Explore* and mathematical thinking to calculate the proportions of your solar system model. Record in your student guide.

Example - Mercury

Size of Celestial Body (Planet or Sun): 1000 km = 1 cm

Distance from Sun: 1 AU = 10 cm

Diameter (km): 4879	Math: 4879/1000 =	Size in model (cm): 4.879
Distance from Sun (AU): 0.39	Math: 0.39 x 10 =	Size in model (cm): 3.9

Make a class solar system model

Your group will be assigned one planet to contribute to the class solar system model. With your group,

1. Create a physical model of the planet, using materials provided.
    a. Remember to use your calculations!
    b. Label your planet with its name and actual size.
2. Place your planet model in the correct location in your class solar system model.
    a. Cut a string to model the correct distance from the Sun - Use your calculations!
    b. Label your string with the actual distance from the Sun.

Elaborate

A Truly Scaled Solar System Model

https://www.youtube.com/watch?v=zR3Igc3Rhfg

With a partner, discuss and respond to the questions in your student guide.

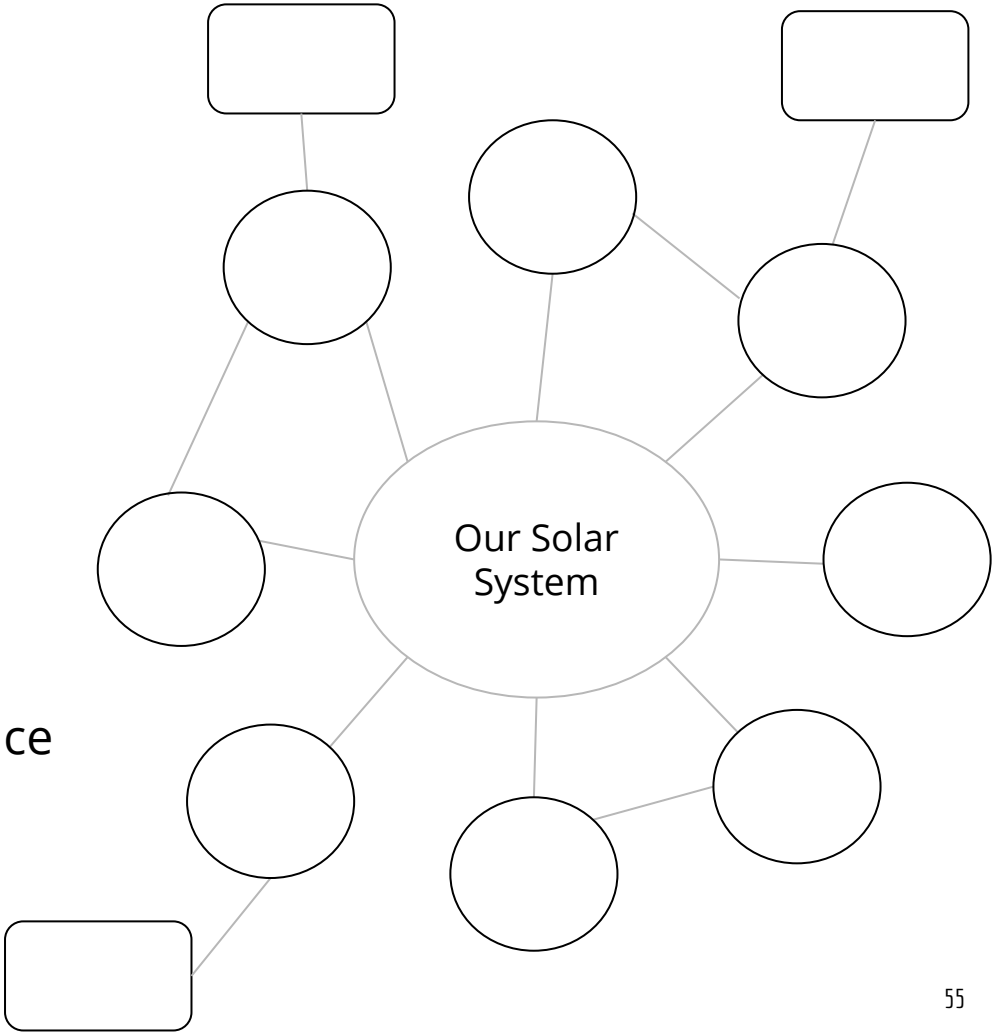
Class Debrief

1. Why don’t we often see true scale models of the solar system?
2. How was the group in the video able to create the first truly scaled model of the solar system?

Class Concept Map

Add to your class concept map:

- New questions (circles)
- New ideas learned (squares)
- New connections (lines and connector words)
- Crosscutting concepts used (trace in color)
  - Scale, Proportion, and Quantity



Evaluate

Connecting to the Culminating Project

You have begun developing a model of the solar system so you can propose the best route a new telescope should take through space. To plan a route for the new telescope, you will need to know more than just the Sun-Earth-Moon System and more than just a list of total parts; you will need a specific layout. Draw a sketch of your class solar system model, including where the new telescope needs to arrive.

- In captions, explain the scale you used for your assigned planet within the model.
  - What data did you use?
  - How does it compare to other planets in the solar system model.

Complete this **individually** in your Project Organizer.

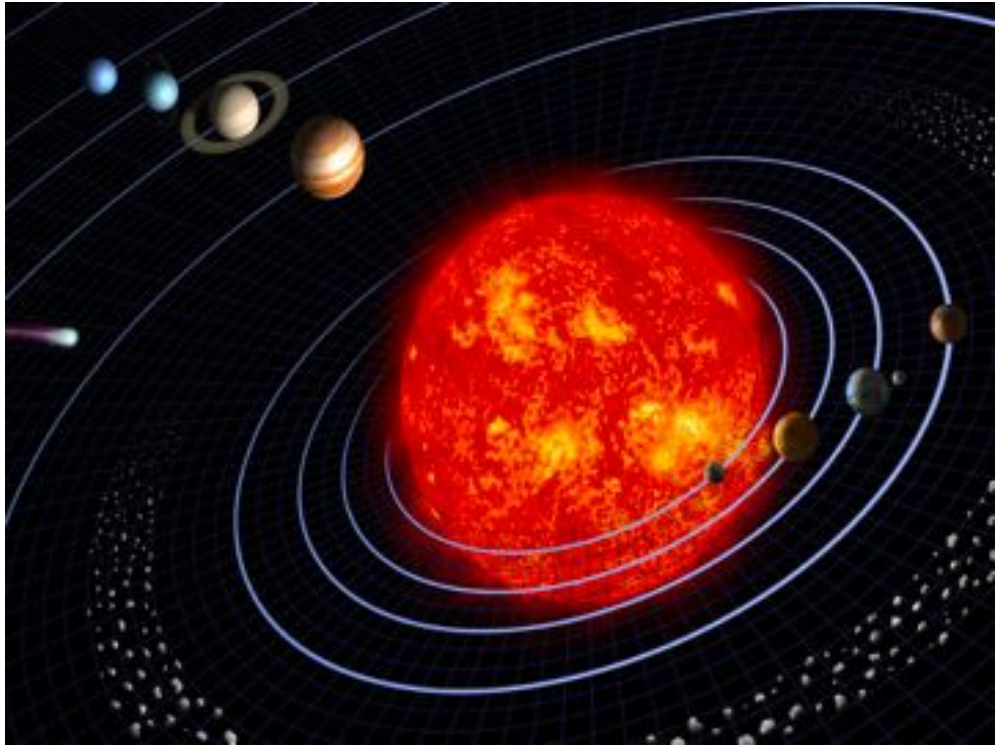
Reflection

Complete the questions at the end of your student guide to reflect on what you have learned in Task 2.

Gravity in the Galaxies

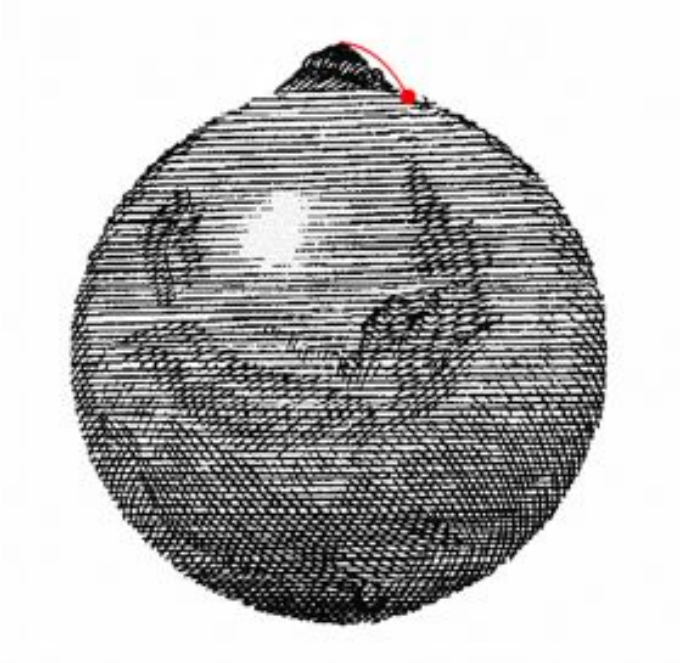
Task 3

What questions do you still have?



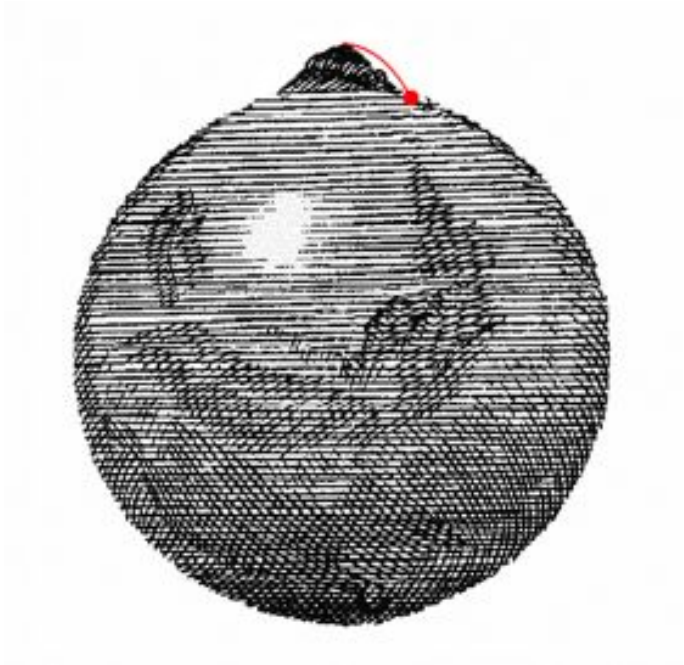
Engage

Newton's Cannonball



Newton presented a thought experiment in which he imagined a cannon on top of a very high mountain. He said that logically, the cannonball should follow a straight line away from Earth, in the direction it was fired, instead of falling. Do you agree? Why or why not?

Newton’s Cannonball



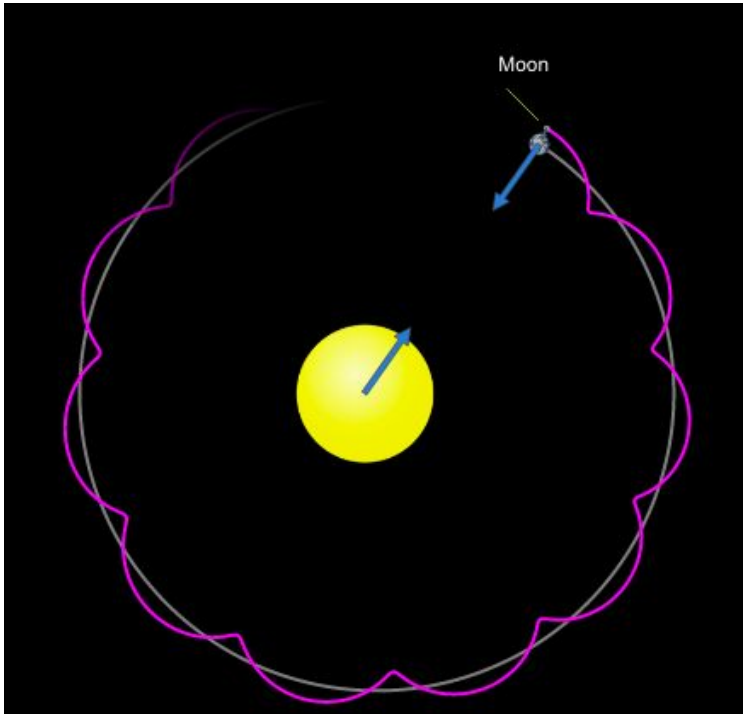
In pairs, run the simulation to engage with Newton’s cannonball thought experiment. Then discuss and answer the questions in your student guide.

Class Debrief

1. What happens to the cannonball at different speeds?
2. When it comes to orbits, what do you think is the relationship between an object's speed and the force of gravity?
3. Based on what you learned in Unit 1, what object in our solar system do you think has the largest gravitational pull?
    a. How does this explain the way objects move in the solar system?

Explore

Using Models to Understand Motion in Our Solar System

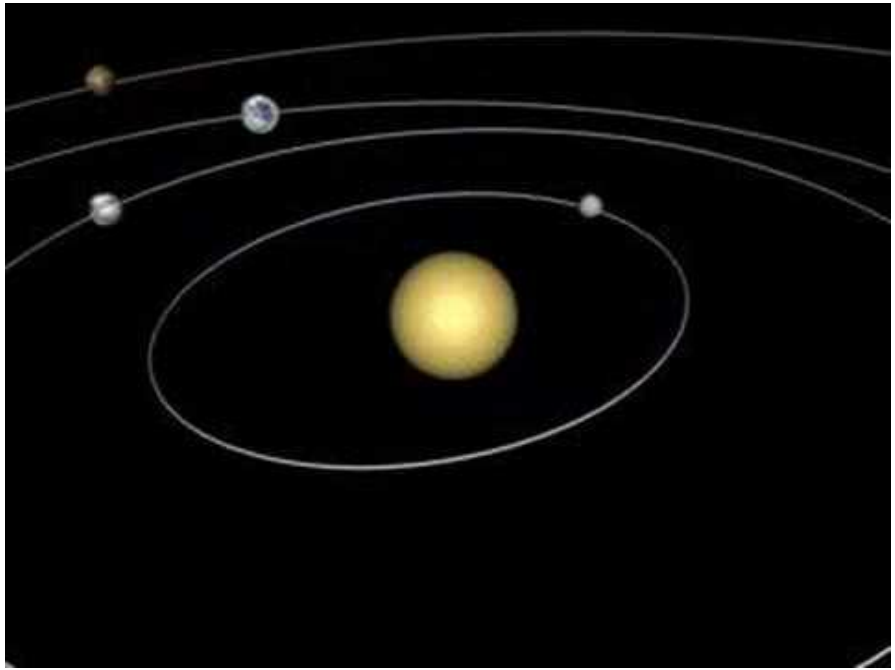


With your group,

1. Follow the instructions in your student guide to explore different models that show how parts of the solar system move and interact.
2. Discuss each model.
3. Discuss and answer the discussion questions in your student guide to help you describe each model.

Explain

A Solar System Simulation



https://www.youtube.com/watch?v=9R5P9Y9gRYY

Explain the Solar System Simulation

Use the models from the *Explore* to individually explain the simulation you just saw, describing the role of gravity in the motions within the solar system. In your explanation, you may want to:

- Describe the orbits of the planets,
    - Including what they are all orbiting around
    - And why they are all in orbit
- Describe what factors affect these orbits
- Use evidence from the models to support your explanation

Stronger Clearer

1. **Individual Think Time:** What will you say to your partner without looking at your explanation of the simulation?

2. **Partner Discussions:**
   a. **Student A:** Describe your explanation of the solar system simulation.
   b. **Student B:** Listen and ask clarifying questions.
   c. **Student A and Student B:** Write down any notes to make your explanation stronger and clearer.

3. **Repeat with 2 more partners!**

4. **Revise your explanation of the solar system simulation.**

Elaborate

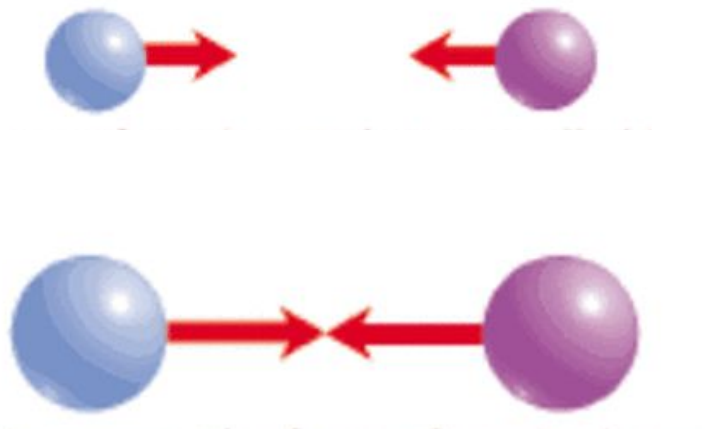
How does mass affect gravitational pull?

Body	Mass of the Body (kg)	Time it takes the same rock to impact the surface from 100 m away
Earth	$5.98 * 10^{24}$	4.51 seconds
Mercury	$3.30 * 10^{23}$	7.35 seconds
Venus	$4.87 * 10^{24}$	4.72 seconds
Mars	$6.42 * 10^{23}$	7.33 seconds
Jupiter	$1.90 * 10^{27}$	0.90 seconds
Saturn	$5.69 * 10^{26}$	1.38 seconds
Uranus	$8.68 * 10^{25}$	2.04 seconds
Neptune	$1.02 * 10^{26}$	1.97 seconds
Pluto	$1.29 * 10^{22}$	17.53 seconds
Moon	$7.35 * 10^{22}$	11.10 seconds
Sun	$1.99 * 10^{30}$	0.42 seconds

How does mass affect gravitational pull?

With your group,

- Calculate the rate at which the rock falls on different planets.
- For your assigned planet, label it with the mass and the rate it takes a rock to fall 100 meters

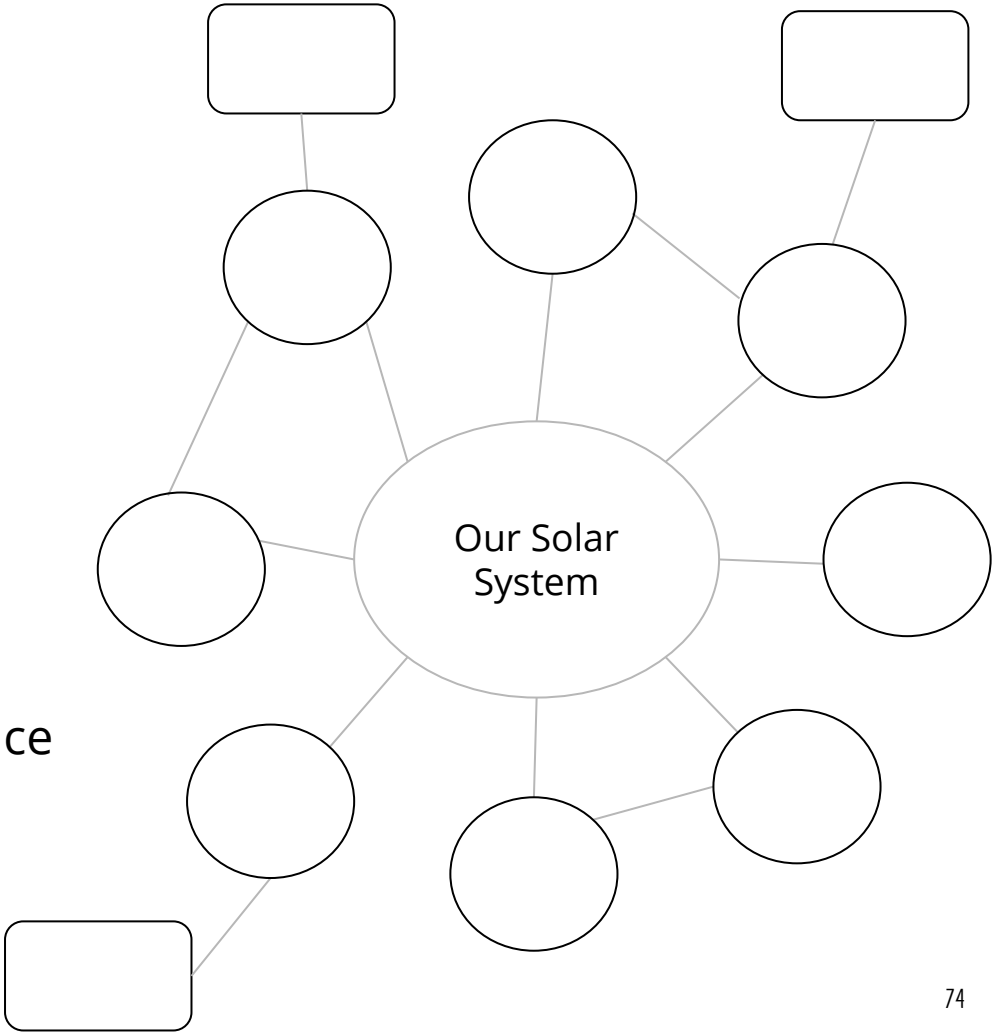


Individually, construct an argument explaining why knowing this information improves your model. Use data from the task to support your argument.

Class Concept Map

Add to your class concept map:

- New questions (circles)
- New ideas learned (squares)
- New connections (lines and connector words)
- Crosscutting concepts used (trace in color)
    - Systems and System Models



Evaluate

Connecting to the Culminating Project

You have developed a model of the solar system and will now begin to brainstorm the best route a new telescope should take through space. Even though you already have the layout of the solar system, you now know that these objects don't just remain stationary...they move because of gravity! Based on what you've learned about mass, gravity, and motion, draw a potential route for the new telescope on the sketch you made in the Task 2 section. Then in this section:

- Explain why the solar system is laid out the way it is: what is the role of gravity in the solar system?
- Use your model and data from the task to explain how gravity might affect the new telescope as it moves through space.
- Justify your route by explaining why you stay farther away from some planets, but not others.

Complete this **individually** in your Project Organizer.

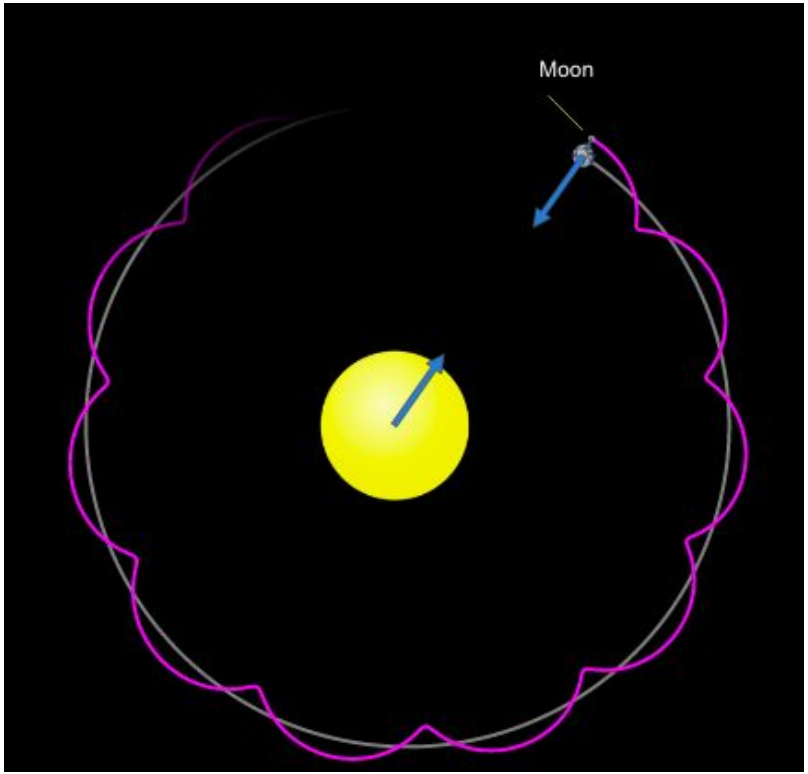
Reflection

Complete the questions at the end of your student guide to reflect on what you have learned in Task 3.

Invisible Forces

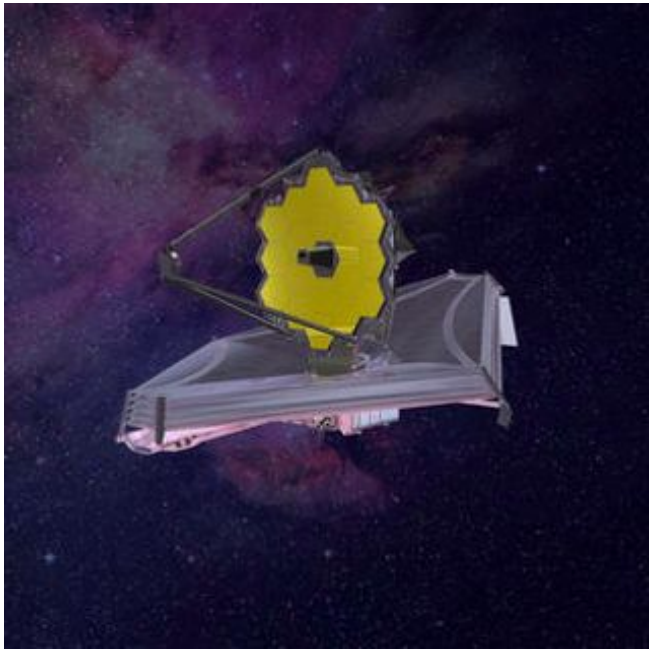
Task 4

What questions do you still have?

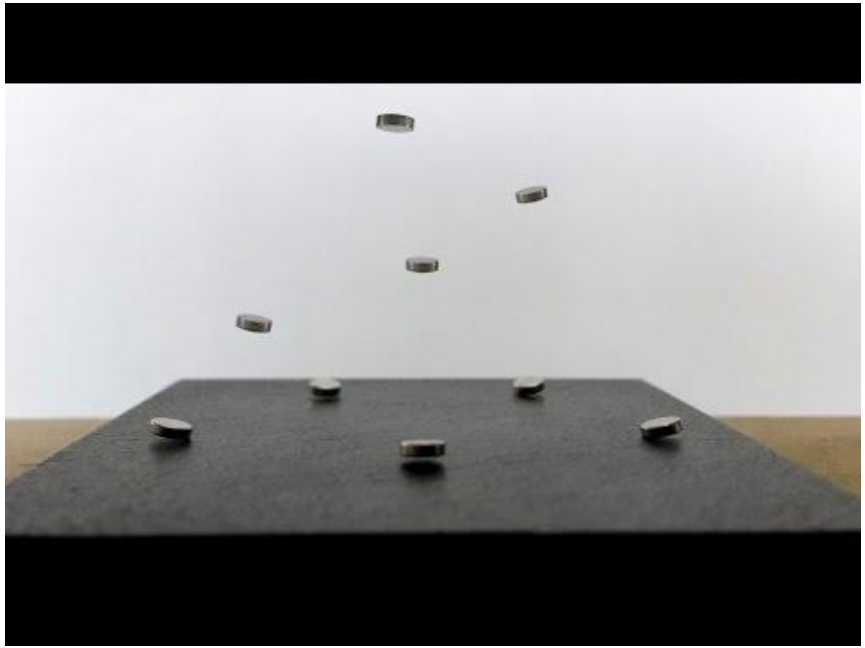


Engage

How can we protect the telescope as it moves through space?



An Invisible Force at Work

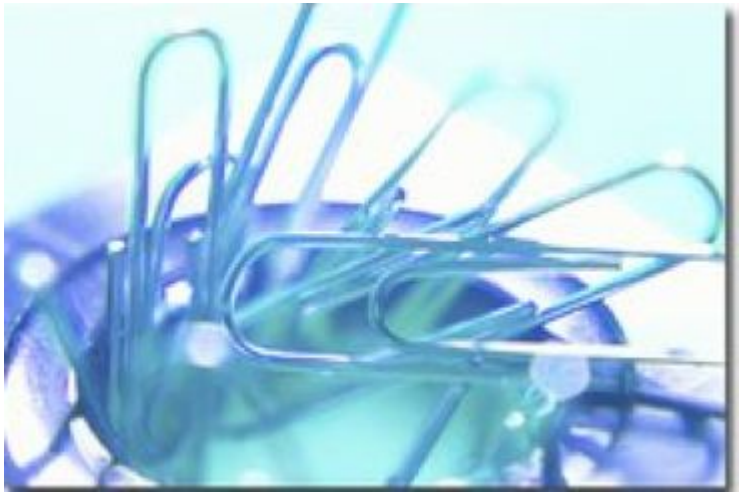


https://www.youtube.com/watch?v=LLIIYtnDups

Discuss the video in pairs and make predictions in your student guide

Explore

Conduct investigations to learn more about these invisible forces



With your group,

1. Visit the lab stations to try to figure out how objects that aren't touching each other can behave this way.
2. Use the questions to discuss each investigation.
3. Record your observations, drawings, and data analysis in your student guide.

Explain

Draw Conclusions About The Invisible Forces

In partners,

1. Use the lab data to come to a conclusion: What causes the interactions we see between objects not in contact with each other?
    a. Explain how you know: What are multiple examples of specific evidence in the lab stations that support this conclusion?

Critique, Correct, and Clarify

1. Critique: Analyze the response for how well it incorporates **evidence**:

   1. Invisible fields exist between some objects not in contact with each other, creating forces that cause objects to look like they are moving on their own.

      a. I know this because in the stations, objects would be attracted to each other or repelled away from each other even though they weren't touching. Sometimes, you could even use materials to visualize the field. This proves that there are fields between objects and explains why objects appear to float or move on their own.

2. Correct: Write an improved explanation in your student guide.
3. Clarify: Describe how and why you corrected the response.

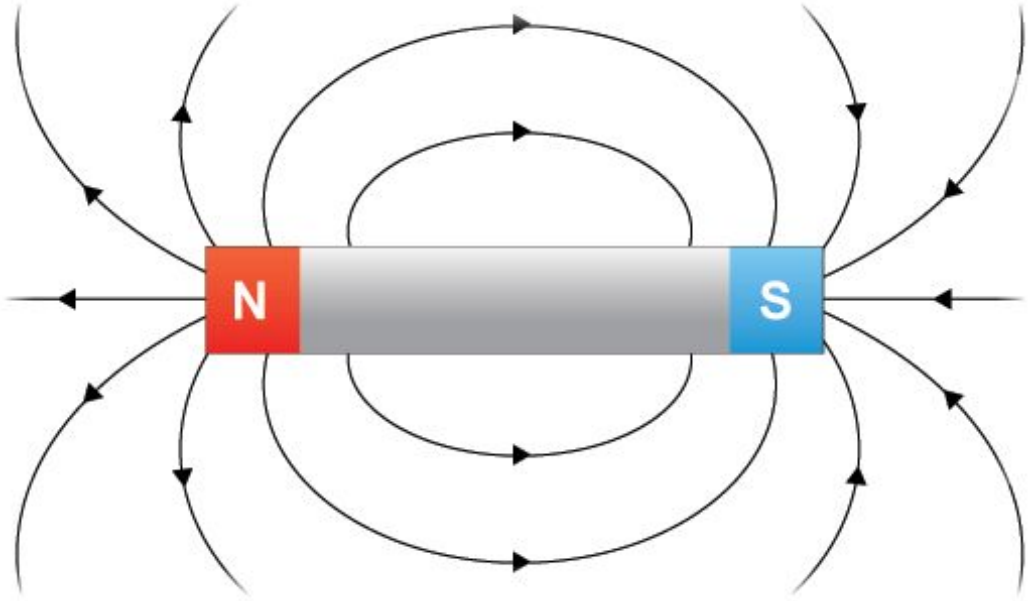
Draw Conclusions About The Invisible Forces

In partners,

2. Based on what you saw in the investigations, write 2-3 general rules that will describe to others how different objects can interact when they are not touching.

Elaborate

These invisible fields are called magnetic fields!



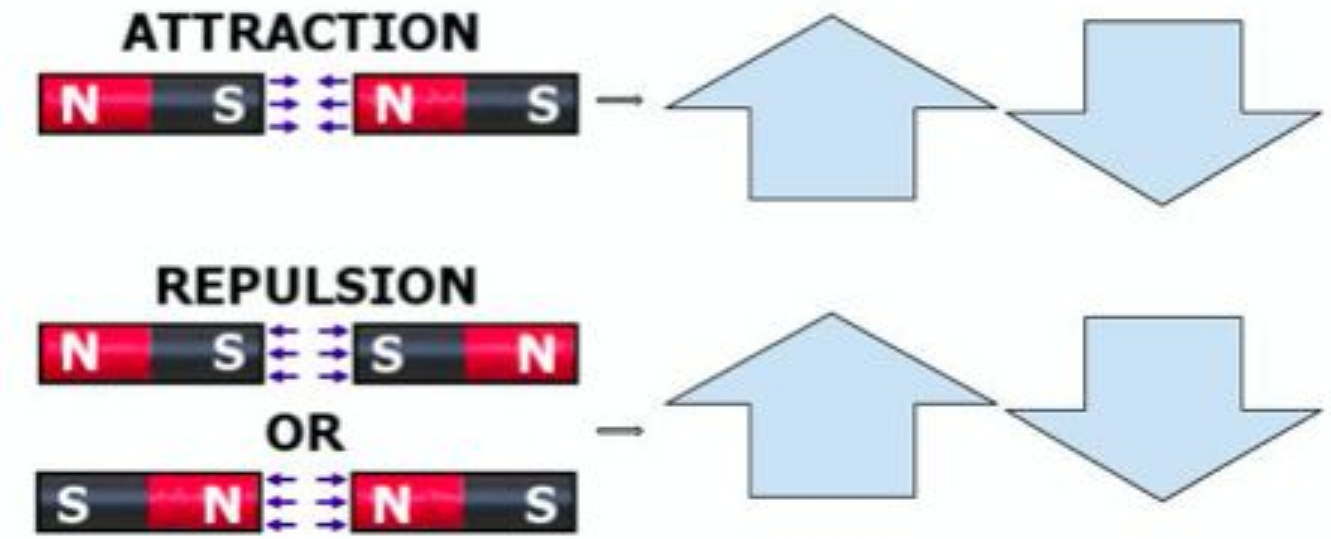
We will use magnetic fields to protect the new telescope as it travels through space.

What factors affect the strength of magnetic fields?

With your group, answer the questions in your student guide to help you better protect the new telescope:

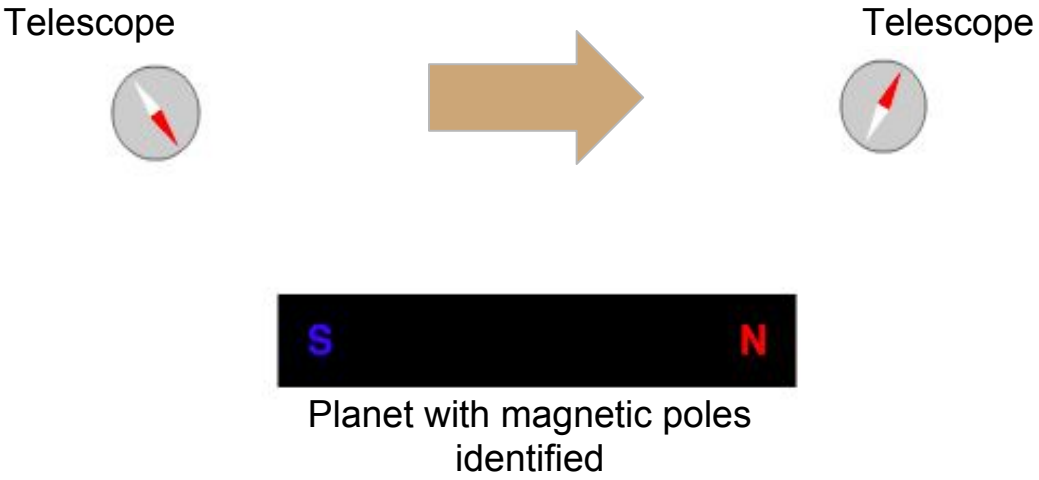
1. Ask testable questions to determine factors that affect the strength of magnetic fields.
2. Conduct investigations based on your experimental questions.
3. Apply data to create a strong magnetic field around your telescope.

Describe the new telescope's magnetic system



Complete the model by filling in the arrows with the phrases "kinetic energy" and "potential energy"

Predict: How will the magnetic field affect the behavior of the telescope as it moves past different planets?



Hint: Look at the orientation of the telescope.

How will the magnetic field affect the behavior of the telescope as it moves past different planets?

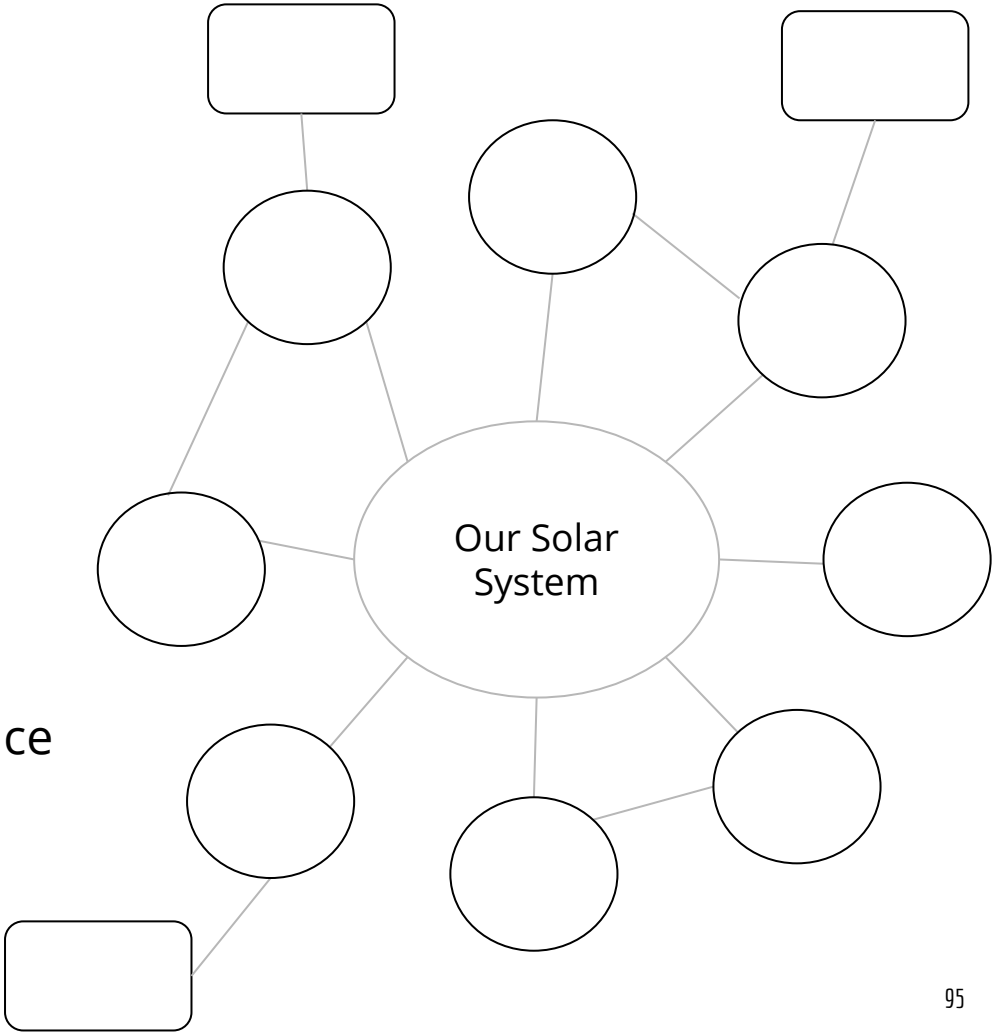
https://www.youtube.com/watch?v=G_uKt2i2jvc

Use information from the video to revise the prediction you made in Question #5.

Class Concept Map

Add to your class concept map:

- New questions (circles)
- New ideas learned (squares)
- New connections (lines and connector words)
- Crosscutting concepts used (trace in color)
    - Cause and Effect
    - Systems and System Models



Evaluate

Connecting to the Culminating Project

You are developing a model of the solar system and proposing the best route a new telescope should take through space. We need to protect the new telescope from solar wind as it travels through space. Scientists say that the new and best protection is to create a magnetic field around the telescope. But how do we do this? Use what you have learned to make some recommendations for a protective magnetic field.

- How will we know a magnetic field has been created? We can't see them, so what evidence is there that magnetic fields exist?
- What kinds of factors affect the strength of magnetic fields?
  - What questions did you have to investigate to find out this information?
- Research magnetic fields on different planets. Based on what you learned about the arrangement of objects and potential energy, how might the telescope be affected as it passes these different planets?

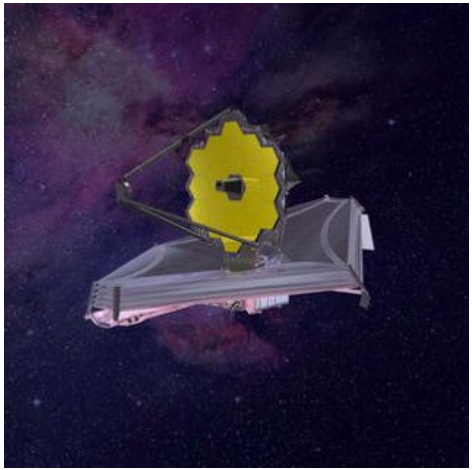
Complete this **individually** in your Project Organizer.

Reflection

Complete the questions at the end of your student guide to reflect on what you have learned in Task 4.

Culminating Project

Plot a new telescope's route through space!



Group Project - A planet contribution to a class-wide solar system model and a presentation of your telescope route within the solar system model

Individual Project - A presentation in your choice of format that pitches your telescope route and describes the forces and energy involved

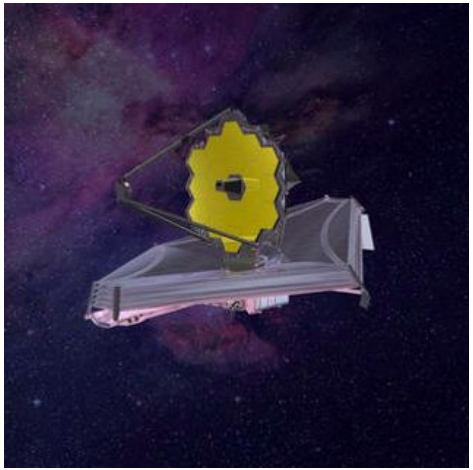
Don’t forget to use your checklist of criteria!

Group Project Criteria for Success

Your group’s route presentation within the class model should:

- ❑ Show and describe your contribution to the class-wide model of the solar system. Include information about the following:
  - The name of your planet
  - The actual size and the scaled size of your planet
  - The actual distance and the scaled distance from the sun
  - The mass of your planet
- ❑ Show and describe a potential route for the telescope within the class-wide model.
  - Explain what information in the tasks led your group to choose this route.
- ❑ Recommend the best way to create a protective magnetic field around the telescope.
  - Show and explain how passing by different planets in your route might affect the telescope.

Plot a new telescope's route through space!



Group Project - A planet contribution to a class-wide solar system model and a presentation of your telescope route within the solar system model

Individual Project - A presentation in your choice of format that pitches your telescope route and describes the forces and energy involved

Don’t forget to use your checklist of criteria!

Individual Project Criteria for Success

Your pitch presentation should:

- ❑ Give background on the solar system, including what is in the solar system.
  - Describe the scale you used for the solar system model.
    - As an example, explain the data you used to make your assigned planet to scale.
  - Draw a model that shows the layout of the solar system and how objects move in the solar system.
    - Explain how the solar system began and how these forces continue to hold the parts of the system together to create this layout.

- ❑ Pick at least one phenomenon from each of the following lists:
  1. Pick one: Seasons, lunar phases, **and/or** eclipses of the sun and moon
  2. Pick one: **AND** apparent motion of the sun, moon, **and/or** stars in the sky
  - Draw or create a model of the Sun-Earth-Moon system to show what is happening in each phenomenon.
  - Use patterns from the model to explain why we experience each phenomenon on Earth.

- ❑ Show and describe your group’s proposed route for the telescope.
  - Justify your choice in route: Use gravity to argue why the telescope needs to stay farther away from some planets, but not others. Use evidence from Task 3 to support your reasoning.

- ❑ Describe how your group plans to protect the telescope.
  - Cite data from Task 4 to convince non-scientific audiences that any magnetic field you create is real even though they cannot see them.
  - Describe the best ways to strengthen the magnetic field around the telescope.
    - Identify the questions you needed to investigate in Task 4 to gather this information.
  - Passing by planets with different magnetic fields will affect the telescope. Select a planet with a large magnetic field and draw a model to show and explain how passing by this planet would affect the telescope.
    - On your model, label when the telescope contains the most potential magnetic energy and when it has the most kinetic energy and explain why this is the case.

- ❑ Pitch Presentation Qualities
  - Uses visual aids (posters, diagrams, etc), as necessary
  - Is organized logically
  - Is interesting to the audience
  - Practices good oral presentation skills, if applicable

Peer Review

Pitch Presentation Peer Review Feedback

Complete after you have a full first draft of your pitch presentation.

Pitch Presentation Owner's Name	
Pitch Presentation Reviewer's Name	

Review the following sections of the Pitch Presentation:

- ❑ Give background on the solar system, including what is in the solar system.
  - Describe the scale you used for the solar system model.
    - As an example, explain the data you used to make your assigned planet to scale.
  - Draw a model that shows the layout of the solar system and how objects move in the solar system.
    - Explain how the solar system began and how these forces continue to hold the parts of the system together to create this layout.

  - ➢ Positive Comment:

  - ➢ Constructive Comment:

- ❑ Pick at least one phenomenon from each of the following lists:
  1. Pick one: Seasons, lunar phases, **and/or** eclipses of the sun and moon
  2. Pick one: **AND** apparent motion of the sun, moon, **and/or** stars in the sky
  - Draw or create a model of the Sun-Earth-Moon system to show what is happening in each phenomenon.
    Use patterns from the model to explain why we experience each phenomenon on Earth.

  - ➢ Positive Comment:

  - ➢ Constructive Comment:

- ❑ Show and describe your group's proposed route for the telescope.
  - Justify your choice in route: Use gravity to argue why the telescope needs to stay farther away from some planets, but not others. Use evidence from Task 3 to support your reasoning.

  - ➢ Positive Comment:

  - ➢ Constructive Comment:

- ❑ Describe how your group plans to protect the telescope.
  - Cite data from Task 4 to convince non-scientific audiences that any magnetic field you create is real even though they cannot see them.
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