**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?*

**Introduction**

Until 400 years ago, all that we knew about our solar system came from observations with the naked eye. This made it really difficult to know what was in our solar system, how these objects were arranged, and how they moved throughout the system. Then, telescopes were invented and we could suddenly see planets and stars in more detail than we ever thought possible. In the last few decades, scientists took this a step further and developed a telescope that could actually be launched into space. The first was known as the Hubble Space Telescope and has been orbiting Earth for more than 25 years with an unobstructed view of the universe. For this unit’s project, students will be operating under the context that NASA has developed a more advanced space telescope that will go even farther out into our solar system; they need to learn everything they can about the solar system to help the new telescope reach its destination. This Lift-Off Task asks students to draw off their own prior knowledge to generate questions around the phenomenon of our solar system—questions that they will continue to explore throughout this unit.

**Alignment Table**

Because the Lift-Off tasks focus on student-generated questions, we do not identify specific Disciplinary Core Ideas or Science and Engineering Practices in this table.

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| **Crosscutting Concepts (\*depending upon student-generated questions)**   * Patterns   + Patterns can be used to identify cause-and-effect relationships. * Cause and Effect   + Cause and effect relationships may be used to predict phenomena in natural or designed systems. * Scale, Proportion, and Quantity   + Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small. * Systems and System Models   + Models can be used to represent systems and their interactions.   + Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy and matter flows within systems. |
| **Equity and Groupwork**   * Share and listen to broad and diverse student contributions. * Make connections between each other’s ideas. * Work together to co-construct a concept map. |
| **Language**   * Use connector words to link ideas. * Generate and write questions about the phenomenon. * Organize key questions in a concept map. |

**Learning Goals**

This learning task introduces students to the phenomenon of our solar system and asks them to begin generating questions that will guide them through the unit. More specifically, the purpose is to:

* Individually generate a list of questions about our solar system.
* Make connections between related questions.
* Generate possible answers to questions, using prior knowledge.
* Apply prior knowledge of our solar system to make a list of solar system parts that a telescope would have to navigate through in order to be launched into space.

**Content Background for Teachers**

Students have likely studied the solar system in prior grades and know that a solar system consists of a star and all the objects that travel around it – planets, moons, asteroids, comets, and meteoroids. In the case of our solar system, the central star is the sun and is much larger than all the other bodies that travel around it. There are likely tens of billions other solar systems in the Milky Way Galaxy alone, but for the sake of this unit, we will be focused on our own solar system.

At this point in the unit, we are building off of students’ prior knowledge of our solar system, asking students to generate questions they would need to ask to make sense of this phenomenon. These might be questions related to what they would find in the solar system, the arrangement of these objects, the movement of these objects, how this system came to be, and much more.

Our solar system consists of eight planets and their moons, as well as dwarf planets and their moons. The eight planets in order from the sun are: Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, and Neptune (Pluto is no longer considered a planet by most scientists). All of these planets orbit the sun and have a different orbital radii and speed that results in the particular arrangement of our solar system.

How did this configuration come to be? About 4.5 billion years ago, a dense cloud of interstellar gas and dust collapsed, forming a solar nebula, or a swirling disk of material. At the center, gravity pulled more and more material in until the pressure was so great that hydrogen atoms began to combine into helium, releasing tons of energy. The sun was born from this interaction, using up 99% of the matter. However, matter farther out was also clumping together, forming larger objects. Some became planets, dwarf planets, and large moons. Others never quite came together and are part of the asteroid belt. As one can see, gravity is essential, not only in the making but also in the maintaining of our solar system as we know it today. Students will explore these and other concepts in more depth as they go through the unit.

In this task, students create a concept map, which is a graphical tool that helps to organize and represent knowledge and questions, and is a successful academic language instruction tool. As students learn more about the solar system, they will add more questions and ideas to this concept map. If your students have not had previous experience making concept maps, please see the instructions in Part B below for strategies on teaching this skill.

**Academic Vocabulary**

* Solar System
* Telescope
* Space

\*Additional academic vocabulary will vary by class

**Time Needed (Based on 45-Minute Periods)**

2 Days

* Introduction, Part A and Part B: 1 period
* Class Concept Map, Project Overview, and Project Organizer: 1 period

**Materials**

* Unit 2, Lift-Off Task Student Version

Part A

* Computer and Projector (for images)

Part B

* Poster paper and markers
* Post-Its (Optional)

Part C

* Class Poster Paper and markers
* \*See Instructions below for other optional materials to use for the class concept map

Connecting to the Culminating Project

* Culminating Project Handout
* Project Organizer Handout

**Instructions**

1. Introduce students to the unit by reading or projecting the Unit Essential Question aloud.
2. Read the short paragraph on page 1 of the student guide aloud, which introduces the phenomenon for the unit: our solar system. Then show a variety of images taken from the Hubble Space telescope to spark any prior knowledge students have about our solar system: <https://www.spacetelescope.org/images/archive/category/solarsystem/>. Do not show students any captions from the images as we want students to generate their own questions from their own prior knowledge.

**Part A**

1. In this Lift-Off task, students will be generating questions to help them make sense of the phenomenon.
2. Have students complete this section individually in their student guide.

* For students who need more support, encourage them to think of the telescope images they observed, visualize a picture of our solar system in their heads, and consider any questions they have.
* Here is a list of some potential questions students might generate: “What is in our solar system? Where does our solar system end? How did the solar system form? How do objects move in the solar system? Why can’t I see all the objects in the solar system from Earth? Why is it called a solar system?”

**Part B:**

1. In this part of the task, students create a concept map as a group.

* Remind students to refer to the directions on their student guide to help them make their concept map. First, students should compare each member’s list of questions and record/connect key questions on a piece of poster paper. They will then draft possible answers to the questions, using prior knowledge.
* Remind students that there are no right or wrong questions or predictions, so students feel encouraged to contribute any and all questions and ideas they think of.
* Because this is a collaborative task, it is recommended that you remind students of group work norms and assign group roles, such as Resource Manager, Facilitator, Recorder, and Harmonizer (See “How to Use this Curriculum” for more details).

1. Students will post their posters on a wall and then walk around and look at each group’s ideas. One suggestion for gallery walks is for students to interact with the posters in some way. For example, students are required to initial or leave post-its on three questions that they are also excited about on other posters.

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| **How to Concept Map**  For students who have not had a lot of experience making concept maps, we have detailed a strategy below for introducing concept mapping using more familiar content. An example is also provided, but this will vary depending on what your students come up with as you make your own model.   1. Write the phenomenon in the middle of the poster, in this case “Humans breathe harder when they exercise.” 2. Macintosh HD:Users:laurenstoll:Downloads:Sample Concept Map (1).jpgAsk students to share questions they might ask to make sense of this phenomenon and make a list of these questions on the board. 3. Model the process of reviewing the list and finding similarities amongst the questions.    * Place these key questions on the concept map poster, modeling how to put similar questions near each other on the poster. Circle these to signify that these are questions, not content knowledge. 4. Ask students to look at the key questions and see if any of the questions are connected: Would answering one question lead to one of the other questions? Model making these connections by drawing arrows between the circles. 5. In this Lift-Off task, students will only be drafting possible answers to the questions, not actually gathering and recording learned concepts. However, throughout the unit, they will be adding content they have learned. Model this by recording a student’s prior knowledge to one of the questions, using boxes to signify that these are pieces of content knowledge rather than questions.    * Use connector words to identify the relationships between the content boxes (See image above for an example). 6. Optional: To emphasize crosscutting concepts using a concept map, make a key of different colors for the crosscutting concepts emphasized in this unit. Identify questions that clearly show evidence of the different crosscutting concepts and circle them with the corresponding colors. Explain to students how you made that choice by pointing out the language that hints at that crosscutting concept. \*Note: not all boxes and circles will necessarily have a crosscutting concept. |

**Part C**

1. Construct a whole-class concept map that begins to help students make sense of the phenomenon of our solar system.

* Start with the phenomenon in the middle.
* Then ask students to share out the questions that were most common across all the posters in the classroom. As you record questions on the poster, organize them based on connections you see. Draw circles around each question (as you add to the concept map throughout the unit, you’ll also be adding concepts learned, which can be written in boxes to distinguish them from the questions).
* Ask students to identify any connections they see between the questions and record these as lines between the questions.
  + Recommended: Give pairs of students think time to come up with 1-2 connections to add to the class concept map and call on pairs using equity sticks. This encourages more equitable participation in this class-wide activity.
* The purpose of this concept map is to facilitate generation of student questions, promote language development, and support understanding of the science content throughout the unit. Allowing students to ask their own questions and use their own words to make meaning of the concepts will not only help them make deep connections about science content, but will also help their oral and written language development.
* This whole class concept map will be revisited at the end of each subunit, asking students questions like: Are there any new questions you have about the phenomenon? Are there any connections you want to add or change? What is your reason for that addition/revision? Are there more connections we can make between the questions/ideas already on the map? Do you want to add any new ideas/concepts to the map?

1. Because this concept map will be added to and revised throughout the unit, here are some practical options for implementation.

* If you have access to white board paper, we encourage you to use these for class posters since it will allow you and your students to make revisions throughout the unit.
* Another option is to use smaller pieces of paper for each class and project using a document camera; this will save space as opposed to doing large class posters.
* We highly recommend students keep their own version of this concept map in their notebooks, adding questions and concepts as they go through the unit.

1. Once the draft concept map is complete, introduce students to the crosscutting concepts for this unit. We recommend posting posters of each crosscutting concept in your classroom (See beginning of teacher guide for templates).

* The crosscutting concepts for this unit are: Patterns; Cause and Effect; Scale, Proportion, and Quantity; and Systems and System Models. Assign a color for each crosscutting concept that can be used throughout the unit.
* Have students analyze the class concept map for as many examples of the crosscutting concepts as they can find. Depending on the questions they have, they may be able to find an example of each of the crosscutting concepts or perhaps just some.
* We recommend modeling this process by picking a question, identifying the crosscutting concept, and tracing the circle in the corresponding color. Explain the key words that helped you identify the crosscutting concept in this question. Some identifying words that students might look for are:
  + **Patterns**: These could be phrases such as, “is the same as”, “has in common with”, “is similar to”, “shares” etc.
  + **Cause and Effect:** These could be phrases such as, “that results in,” “that causes,” “that explains why,” “is due to,” etc.
  + **Systems and Systems Models**: These could be phrases such as, “is a part of” “connects to,” “interacts with,” “is made up of,” “works together with,” etc.
  + **Scale, Proportion, and Quantity**: These could be phrases such as, “is proportional to,” “compared to,” “has a ratio of,” “is bigger/smaller than,” “is longer/shorter than,” etc.

**Connecting to the Culminating Project**

1. Hand out the Culminating Project Task Card and read the Challenge and Group Project Criteria for Success aloud as a class.
   * Take questions for clarification.
2. Give a brief overview of the Background on the new telescope. This will give students detail on where the new telescope will need to be launched.
3. Pass out their Project Organizer and explain that they will complete a section of this after each task in class. Students should independently complete the Lift-Off Task section of the Project Organizer in class. Revisions can be done for homework, depending upon student’s needs and/or class scheduling.
   * Students have been tasked with developing a model of the solar system and proposing the best route a new telescope should take through space. The student prompt is as follows: 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?

**Reflection**

1. At the end of the task, ask students to reflect on what they have learned over the course of this task by answering the following three questions in their student guide:
   * At the beginning of this task, you made a list of all the questions you have about the solar system. Look back at your list: think about the questions your peers asked that you did not initially write down. How are their questions different from the ones you originally asked?

* In this unit, we will be focusing on four crosscutting concepts: **Patterns**: patterns can be used to identify cause and effect relationships; **Cause and Effect**: cause and effect relationships may be used to predict events; **Scale, Proportion, and Quantity**: scaled models can be used to study time, space, or energy systems that are too large or too small; **Systems and System Models**:models can be used to represent systems and their interactions. Looking at your class concept map, give one example of how a crosscutting concept came up in today’s task.
  + Now that you understand what project you’ll be working on over the course of this unit, what else do you need to know? What additional questions do you have?

1. There are no right answers, but encourage students to look back at their initial lists and their class concept map. They should not change their initial responses, but rather use this reflection space to add to their questions and ideas based on what they have learned through this task. By generating more of their own questions, students continue to engage in sense-making of the phenomenon and the gathering of knowledge and skills for their final project.