**Overview**: The following rubrics can be used to assess the individual project: a Pitch Presentation for a proposed telescope route. Each rubric is aligned to one section of the *Individual Project Criteria for Success*, located on the Culminating Project Student Instructions. \*If student provides no assessable evidence (e.g., “I don’t know” or leaves answer blank), then that student response cannot be evaluated using the rubric and should be scored as a zero.

Below we provide an alignment table that details the dimensions assessed for each criterion.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Student Criteria for Success** | **Disciplinary Core Idea** | **Science and Engineering Practice** | **Crosscutting Concept** |
| 1 | * 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. | ESS1.B: Earth and the Solar System  * The solar system consists of the sun and a collection of objects, including planets, their moons, and asteroids that are held in orbit around the sun by its gravitational pull on them. | N/A | 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. |
| 2 | * 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. | ESS1.B: Earth and the Solar System  * The solar system consists of the sun and a collection of objects, including planets, their moons, and asteroids that are held in orbit around the sun by its gravitational pull on them. * The solar system appears to have formed from a disk of dust and gas, drawn together by gravity. | Developing and Using Models  * Develop and use a model to describe phenomena. | Systems and System Models  * Models can be used to represent systems and their interactions. |
| 3 | * 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: 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. | ESS1.A: The Universe and Its Stars  * Patterns of the apparent motion of the sun, the moon, and stars in the sky can be observed, described, predicted, and explained with models.  ESS1.B: Earth and the Solar System  * This model of the solar system can explain eclipses of the sun and the moon. Earth’s spin axis is fixed in direction over the short-term but tilted relative to its orbit around the sun. The seasons are a result of that tilt and are caused by the differential intensity of sunlight on different areas of Earth across the year. | Developing and Using Models  * Develop and use a model to describe phenomena. | Patterns  * Patterns can be used to identify cause-and-effect relationships. |
| 4 | * 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. | PS2.B: Types of Interactions   * Gravitational forces are always attractive. There is a gravitational force between any two masses, but it is very small except when one or both of the objects have large mass—e.g., Earth and the sun. | Engaging in Argument from Evidence   * Construct and present oral and written arguments supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem. | N/A |
| 5 | * + Cite data from Task 4 to convince non-scientific audiences that any magnetic field you create is real even though they cannot see them. | PS2.B: Types of Interactions   * Forces that act at a distance (electric, magnetic, and gravitational) can be explained by fields that extend through space and can be mapped by their effect on a test object (a charged object, or a ball, respectively). | N/A | Cause and Effect   * Cause and effect relationships may be used to predict phenomena in natural or designed systems. |
| 6 | * + 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. | PS2.B: Types of Interactions  * Electric and magnetic (electromagnetic) forces can be attractive or repulsive, and their sizes depend on the magnitudes of the charges, currents, or magnetic strengths involved and on the distances between the interacting objects. | Asking Questions and Defining Problems  * Ask questions that can be investigated within the scope of the classroom, outdoor environment, and museums and other public facilities with available resources and, when appropriate, frame a hypothesis based on observations and scientific principles. | N/A |
| 7 | * + Passing by planets with different magnetic fields will affect the telescope. Select one planet with a large magnetic field and draw a model to show and explain how passing by this planet would affect the telescope. | PS3.C: Relationships Between Energy and Forces  * When two objects interact, each one exerts a force on the other that can cause energy to be transferred to or from the object. | Developing and Using Models  * Develop a model to describe unobservable mechanisms. | N/A |
| 8 | * + - 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. | PS3.A: Definitions of Energy  * A system of objects may also contain stored (potential) energy, depending on their relative positions.  PS3.C: Relationships Between Energy and Forces  * When two objects interact, each one exerts a force on the other that can cause energy to be transferred to or from the object. | N/A | Systems and System Models   * Models can be used to represent systems and their interactions – such as inputs, processes, and outputs – and energy and matter flows within systems. |

**Rubric 1**: Student describes a background on the solar system, including an explanation of the scale for their class solar system model.

* Dimensions Assessed: DCI – ESS1.B: Earth and the Solar System, CCC – Scale, Proportion, and Quantity

|  |  |  |  |
| --- | --- | --- | --- |
| **Emerging (1)** | **Developing (2)** | **Proficient (3)** | **Advanced (4)** |
| Student describes an **inaccurate** background on the solar system **AND/OR** includes an **inaccurate** explanation of the scale for their class solar system model. | Student describes a **partial** background on the solar system, including an **accurate but general** explanation of the scale for their class solar system model. | Student describes a **complete** background on the solar system, including an **accurate but general** explanation of the scale for their class solar system model. | Student describes a **complete** background on the solar system, including an **accurate and specific** explanation of the scale for their class solar system model. |
| **Look Fors:**   * Student inaccurately describes what is in the solar system. For example, “The solar system consists of stars.” * And/or student does not give an accurate scale or explanation is too general. For example, “we created a smaller model.” | **Look Fors:**   * Student describes a partial background on the solar system, including the sun, planets, moons, or asteroids, but not all components (which may or may not be specifically identified). * Student accurately describes the scale of the class model: “1000 km = 1 cm for planet size and 1 AU = 10 cm for distance from the sun. The sun is not to scale.” * Student generally explains the scale for their planet but does not give specific data. For example, “We created a scale for planet size and a scale for distance between the planets to create a model that would fit in the classroom.” | **Look Fors:**   * Student describes a complete background on the solar system, including the sun, planets, moons, and asteroids (which may or may not be specifically identified). * Student accurately describes the scale of the class model: “1000 km = 1 cm for planet size and 1 AU = 10 cm for distance from the sun. The sun is not to scale.” * Student generally explains the scale for their planet but does not give specific data. For example, “We used this scale for our planet because using the same scale for both measures and the sun would make the model too large for the classroom.” | **Look Fors:**   * Student describes a complete background on the solar system, including the sun, planets, moons, and asteroids (which may or may not be specifically identified). * Student accurately describes the scale of the class model: “1000 km = 1 cm for planet size and 1 AU = 10 cm for distance from the sun. The sun is not to scale.” * Student accurately explains that they used the size and orbital radii of each planet to generate two scales and cites specific data. For example, “Mercury at 4879 km in diameter and 0.39 AU from the sun is 4.8 cm wide and 3.9 cm from the sun in the model.” |

**Rubric 2**: Student draws a model to show the layout and motions of the solar system and explains the forces that hold the parts of the system together.

* Dimensions Assessed: DCI – ESS1.B: Earth and the Solar System, CCC – System and System Models, SEP – Developing and Using Models

|  |  |  |  |
| --- | --- | --- | --- |
| **Emerging (1)** | **Developing (2)** | **Proficient (3)** | **Advanced (4)** |
| Student draws an **inaccurate** model to show the layout and motions of the solar system **and/or** **inaccurately** explains the forces that hold the parts of the system together. | Student draws an **accurate** model to show the layout and motions of the solar system and **generally** explains **at least one of the** forces that hold the parts of the system together. | Student draws an **accurate** model to show the layout and motions of the solar system and **accurately** explains **one of the** forces that hold the parts of the system together. | Student draws an **accurate** model to show the layout and motions of the solar system and **accurately** explains the forces that hold the parts of the system together. |
| **Look Fors:**   * Student may create an inaccurate model that shows a different planet in the middle or shows all the planets lined up in a perfect line. * Student’s explanation of the forces involved in the solar system is inaccurate. For example, “The solar system has planets orbiting the sun because there are no forces in space since it is a vacuum.” | **Look Fors:**   * Model shows the different parts of the solar system (at least planets, but may also show moons and asteroids). Model shows objects in orbit around the sun. * Student accurately explains the role of either gravity or speed. but does so generally and without detail. For example, “The reason the solar system began and looks this way is because of gravity.” | **Look Fors:**   * Model shows the different parts of the solar system (at least planets, but may also show moons and asteroids). Model shows objects in orbit around the sun. * Student accurately explains the role of either gravity or speed. For example, “The solar system was first formed by dust and gas drawn together by gravity. This is the force that continues to keep planets orbiting around the sun.” | **Look Fors:**   * Model shows the different parts of the solar system (at least planets, but may also show moons and asteroids). Model shows objects in orbit around the sun. * Student accurately explains the roles of speed and gravity. For example, “The solar system was first formed by dust and gas drawn together by gravity. The reason this layout persists is that the sun with its large mass keeps the planets in orbit with its large gravitational pull. The speed at which the planets move allows them to orbit instead of getting pulled right into the sun.” |

**Rubric 3**: Student draws a model of the Sun-Earth-Moon system and uses patterns from the model to explain why we experience a phenomenon on Earth.

* Dimensions Assessed: DCIs – ESS1.B: Earth and the Solar System and ESS1.A: The Universe and Its Stars, SEP – Developing and Using Models, CCC – Patterns
* \*\*Note: Because of the breadth of ESS1.A and ESS1.B, not all examples from each DCI are assessed. Instead, students are given a choice of phenomena corresponding to each DCI. Thus, you will need to apply this rubric two times, once for each of the phenomena students choose. For more evidence of these DCIs, see student information charts from the Task 1 Explore.

|  |  |  |  |
| --- | --- | --- | --- |
| **Emerging (1)** | **Developing (2)** | **Proficient (3)** | **Advanced (4)** |
| Student draws an **inaccurate** model of the Sun-Earth-Moon system **and/or** uses patterns from the model to **inaccurately** explain why we experience a phenomenon on Earth. | Student draws an **accurate** model of the Sun-Earth-Moon system and uses patterns from the model to **incompletely** explain why we experience a phenomenon on Earth. | Student draws an **accurate** model of the Sun-Earth-Moon system and uses patterns from the model to **accurately but generally** explain why we experience a phenomenon on Earth. | Student draws an **accurate** model of the Sun-Earth-Moon system and uses patterns from the model to **accurately and completely** explain why we experience a phenomenon on Earth. |
| **Look Fors:**   * Student model is inaccurate. For example, the Sun, Earth, and moon are shown in dramatically inaccurate relative sizes (e.g. Earth is smaller than moon) or the positions of bodies are not relevant to the phenomenon they are trying to describe. * Student describes a phenomenon inaccurately. For example, “ When the moon comes between Sun and Earth, it will be a full moon.” | **Look Fors:**   * Student model shows the Sun, Earth, and moon at relative sizes and accurate positions relevant to the phenomenon they are describing. * Student explanation is incomplete. For example, “This causes seasons.” | **Look Fors:**   * Student model shows the Sun, Earth, and moon at relative sizes and accurate positions relevant to the phenomenon they are describing. * Student uses the model to accurately but generally explain why we experience a phenomenon on Earth. For example, if describing eclipses, a student might show a diagram of the moon between the Earth and sun and say, “When the moon comes directly between the Earth and sun, it causes an eclipse.” | **Look Fors:**   * Student model shows the Sun, Earth, and moon at relative sizes and accurate positions relevant to the phenomenon they are describing. * Student uses the model to accurately explain why we experience a phenomenon on Earth. For example, if describing apparent motion of the sun, a student might show a diagram of the Earth spinning on its axis around the sun and say, “Earth rotates on its axis each day. This makes the sun appear to move through the sky, even though it is really the Earth that is moving.” |

**Rubric 4**: Student argues why the telescope needs to stay farther away from some planets but not others, supporting with evidence from Task 3.

* Dimensions Assessed: DCI – PS2.B: Types of Interactions, SEP – Engaging in Argument From Evidence

|  |  |  |  |
| --- | --- | --- | --- |
| **Emerging (1)** | **Developing (2)** | **Proficient (3)** | **Advanced (4)** |
| Student **inaccurately** argues why the telescope needs to stay farther away from some planets but not others. | Student **accurately** argues why the telescope needs to stay farther away from some planets but not others, supporting with **no** evidence from Task 3. | Student **accurately** argues why the telescope needs to stay farther away from some planets but not others, supporting with **one piece** of evidence from Task 3. | Student **accurately** argues why the telescope needs to stay farther away from some planets but not others, supporting with **multiple sources** of evidence from Task 3. |
| **Look Fors:**   * Student explanation is accurate. For example, “Some planets have a stronger magnetic field, which creates a higher gravitational pull, so the telescope needs to stay away from those.” | **Look Fors:**   * Student explanation is accurate. For example, “ Some planets have larger masses and more mass means more gravitational attraction. Thus, the telescope should stay farther away from planets with greater mass to avoid getting pulled into their gravitational field.” * However, student cites no evidence to support this argument. | **Look Fors:**   * Student explanation is accurate. For example, “ Some planets have larger masses and more mass means more gravitational attraction. Thus, the telescope should stay farther away from planets with greater mass, such as Jupiter and Saturn, to avoid getting pulled into their gravitational field.” * Student supports the argument with only one piece of evidence from Task 3. For example, “The pHet simulation showed us that increasing the mass of the Sun or Earth increased gravitational attraction and caused collisions.” | **Look Fors:**   * Student explanation is accurate. For example, “ Some planets have larger masses and more mass means more gravitational attraction. Thus, the telescope should stay farther away from planets with greater mass, such as Jupiter and Saturn, to avoid getting pulled into their gravitational field.” * Student supports the argument with multiple sources of evidence from Task 3. For example, “The pHet simulation showed us that increasing the mass of the Sun or Earth increased gravitational attraction and caused collisions. Similarly, the data table from task 3 showed us that as planet mass increases, the rate of falling rock increases, which means gravity increases.” |

**Rubric 5**: Student predicts that any magnetic field they create will be present even though we cannot see them, citing data to back up this claim.

* Dimensions Assessed: DCI – PS2.B: Types of Interactions, CCC – Cause and Effect

|  |  |  |  |
| --- | --- | --- | --- |
| **Emerging (1)** | **Developing (2)** | **Proficient (3)** | **Advanced (4)** |
| Student predicts that any magnetic fields they create will be present even though we cannot see them, but uses **no** data to back up this claim. | Student predicts that any magnetic field they create will be present even though we cannot see them, using **general trends in** data to back up this claim. | Student predicts that any magnetic field they create will be present even though we cannot see them, using **general trends and one specific source of** data to back up this claim. | Student predicts that any magnetic field they create will be present even though we cannot see them, using **accurate and specific** data **from multiple sources** to back up this claim. |
| **Look Fors:**   * Student makes the claim from the criteria, but does not use any data to back it up. For example, “Even though we can’t see magnetic fields, there is lots of evidence that they are real.” | **Look Fors:**   * Student uses general trends from multiple sources to back up their claim, but no specific data. For example, “Even though we can’t see magnetic fields, there is lots of evidence that they are real. We did many experiments that support this claim. In all the experiments, there appeared to be some invisible force either keeping objects apart or pulling them together, even when not touching.” | **Look Fors:**   * Student uses general trends from multiple sources to back up their claim, but only specifically cites one source. For example, “Even though we can’t see magnetic fields, there is lots of evidence that they are real. We did many experiments that support this claim. In all the experiments, there appeared to be some invisible force either keeping objects apart or pulling them together, even when not touching. In Experiment 1, for example, when we put two magnets with the same poles oriented towards each other, there was an invisible force that kept them apart.” | **Look Fors:**   * Student uses multiple sources to back up their claim, citing specific observations. For example, “Even though we can’t see magnetic fields, there is lots of evidence that they are real. We did many experiments that support this claim. In Experiment 1, when we put two magnets with the same poles oriented towards each other, there was an invisible force that kept them apart. In Experiment 2, we could move a paper clip with a magnet without them actually touching. Similarly, In Experiment 3, we could pick up paperclips with a wire-wrapped nail connected to a battery without them touching at first.” |

**Rubric 6**: Student describes the best ways to strengthen the magnetic field around the telescope and identifies relevant questions that were investigated to gather this information.

* Dimensions Assessed: DCI – PS2.B: Types of Interactions, SEP – Asking Questions

|  |  |  |  |
| --- | --- | --- | --- |
| **Emerging (1)** | **Developing (2)** | **Proficient (3)** | **Advanced (4)** |
| Student **inaccurately** describes way**(s)** to strengthen the magnetic field around the telescope and does not identify relevant questions that were investigated to gather this information. | Student **accurate**ly describes way**(s)** to strengthen the magnetic field around the telescope **but does not** identify relevant questions that were investigated to gather this information. | Student **accurate**ly describes **a** way to strengthen the magnetic field around the telescope and identifies **a** relevant question that was investigated to gather this information. | Student **accurate**ly describes **multiple** ways to strengthen the magnetic field around the telescope and identifies relevant question**s** that were investigated to gather this information. |
| **Look Fors:**   * Student inaccurately identifies factors that strengthen magnetic fields. For example, “changing the direction of the pole.” * Thus, any questions identified are irrelevant. | **Look Fors:**   * Student accurately identifies factors (one or multiple) that strengthen magnetic fields. For examples, see right-hand column. * Student does not identify the questions they investigated relevant to the factors they identified. For example, they may say “What is a magnetic field?” | **Look Fors:**   * Student accurately describes one factor that strengthens magnetic fields. For examples, see right-hand column. * Student identifies a question they investigated relevant to the factor they identified. For example, if a student identifies increasing the battery voltage as the factor to strengthen the magnetic field, the question could be: “How did battery size affect the strength of the magnetic fields?” | **Look Fors:**   * Student accurately describes multiple factors that strengthen magnetic fields. For example: creating more loops in the coil, changing the core metal to metals like iron or neodymium, increasing the battery voltage, changing the metal of the wire, etc. * Student identifies the questions they investigated relevant to the factors they identified. For example, if a student identifies creating more loops in the coil and changing the core metal as the factors to strengthen the magnetic field, the questions could be: “What magnet materials seemed to be more attractive? How did the number of coils affect the magnetic field? How do we know when the magnetic field is strong?” |

**Rubric 7**: Student draws a model to show and explain how passing by planets with different magnetic fields will affect the telescope.

* Dimensions Assessed: DCI – PS3.C: Relationships Between Energy and Forces, SEP – Developing and Using Models

|  |  |  |  |
| --- | --- | --- | --- |
| **Emerging (1)** | **Developing (2)** | **Proficient (3)** | **Advanced (4)** |
| Student draws an **inaccurate** model to show and explain how passing by planets with different magnetic fields will affect the telescope. | Student draws an **accurate** model to **generally** show how passing by planets with different magnetic fields will affect the telescope.  OR  Student **accurately explains** how passing by planets with different magnetic fields will affect the telescope. | Student draws an **accurate** model to **generally** show **and explain** how passing by planets with different magnetic fields will affect the telescope. | Student draws an **accurate** model to **accurately** show and explain how passing by planets with different magnetic fields will affect the telescope. |
| **Look Fors:**   * Student model and explanation are inaccurate. For example, a student may show the telescope accelerating toward Jupiter. | **Look Fors:**   * Student draws a model of the telescope’s interaction with a planet that has a large magnetic field (Ex: Jupiter and Neptune). Model shows the general interaction but does not use specific written explanation to describe the effect and why it is happening.   OR   * Accurate explanation is present but model is missing. See Advanced Look-Fors for an accurate student response. | **Look Fors:**   * Student draws a model of the telescope’s interaction with a planet that has a large magnetic field (Ex: Jupiter and Neptune). * Model generally shows and explains how passing by a planet with a large magnetic field will cause the telescope to spin and align, but the specifics of this alignment are not explained in detail, as shown in the Advanced Look Fors. | **Look Fors:**   * Student draws a model of the telescope’s interaction with a planet that has a large magnetic field (Ex: Jupiter and Neptune). * Model accurately shows and explains how passing by a planet with a large magnetic field will affect the telescope. For example, “Passing by a planet with a large magnetic field will cause the telescope to spin so that one pole of the telescope’s field aligns with the opposite pole of the planet’s field. This will not happen if there is not a strong magnetic field.” As a comparison, this is similar to how the north side of a bar magnet would be attracted to the North Pole (which is actually a south magnet). |

**Rubric 8**: Student labels a telescope model to show moments of most potential magnetic energy and most kinetic energy and explains the interaction of these forms of energy within the magnetic system.

* Dimensions Assessed: DCI – PS3.A: Definitions of Energy and PS3.C: Relationships Between Energy and Forces, CCC – Systems and System Models

|  |  |  |  |
| --- | --- | --- | --- |
| **Emerging (1)** | **Developing (2)** | **Proficient (3)** | **Advanced (4)** |
| Student **inaccurately** labels a telescope model to show moments of most potential magnetic energy and most kinetic energy. | Student **accurately** labels a telescope model to show moments of most potential magnetic energy and most kinetic energy **but** **does not** explain the interaction of these forms of energy within the magnetic system. | Student **accurately** labels a telescope model to show moments of most potential magnetic energy and most kinetic energy and **generally** explains the interaction of these forms of energy within the magnetic system. | Student **accurately** labels a telescope model to show moments of most potential magnetic energy and most kinetic energy and **specifically** explains the interaction of these forms of energy within the magnetic system. |
| **Look Fors:**   * On their model, student does not accurately label “potential magnetic energy” and “kinetic energy” (See Look Fors in other columns for correct locations). | **Look Fors:**   * On their model, student accurately labels “potential magnetic energy” at a point when the telescope is beginning to spin and “kinetic energy” at a point towards the end of the telescope’s spin. * Student does not offer a specific explanation for their labels or explanation is inaccurate or irrelevant to their labels. | **Look Fors:**   * On their model, student accurately labels “potential magnetic energy” at a point when the telescope is beginning to spin and “kinetic energy” at a point towards the end of the telescope’s spin. * Student explains this relationship accurately, but without complete detail. For example, “As the telescope spins, the potential energy is transformed into the kinetic energy.” | **Look Fors:**   * On their model, student accurately labels “potential magnetic energy” at a point when the telescope is beginning to spin and “kinetic energy” at a point towards the end of the telescope’s spin. * Student explains this relationship specifically. For example, “Changing the orientation of the telescope’s magnet in relation to the poles in the corresponding planet affects the amount of potential energy. As the telescope begins to spin, potential energy is transformed into the kinetic energy.” |