**Part A: Gather and Filter information from the three** [**Dimensions of NGSS**](http://standards.nsta.org/AccessStandardsByTopic.aspx) **and** [**PhET**](http://phet.colorado.edu/) **Interactive Simulations**

Step 1: Select PEs and PhET Sim(s) that work together.

***a. Select PEs, identify the Clarification Statements and Assessment Boundaries associated with chosen PE.***

* MS-PS3-1 Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object.
* MS-PS3-2 Develop a model to describe that when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system.

**MS-PS3-1**- Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known

* Clarification Statement: Emphasis is on descriptive relationships between kinetic energy and mass separately from kinetic energy and speed. Examples could include riding a bicycle at different speeds, rolling different sizes of rocks downhill, and getting hit by a wiffle ball versus a tennis ball.
* Assessment boundary: None

**MS-PS3-2** Develop a model to describe that when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system.

* Clarification Statement:Emphasis is on relative amounts of potential energy, not on calculations of potential energy. Examples of objects within systems interacting at varying distances could include: the Earth and either a roller coaster cart at varying positions on a hill or objects at varying heights on shelves, changing the direction/orientation of a magnet, and a balloon with static electrical charge being brought closer to a classmate’s hair. Examples of models could include representations, diagrams, pictures, and written descriptions of systems.
* Assessment Boundary: Assessment is limited to two objects and electric, magnetic, and gravitational interactions

***b. Evaluate PhET sims for alignment with PEs, Clarifications, Boundaries***

**PhET Sim Table 1:**

|  |  |  |  |
| --- | --- | --- | --- |
| Sim Name | Main Topics | Sample Learning Goals PhET | Reflection and reasoning |
| Energy Skate Park Basics | Energy  Conservation of Energy  Kinetic Energy  Potential Energy  Friction | Explain the Conservation of Mechanical Energy concept using kinetic energy (KE) and gravitational potential energy (PE).  Describe how the Energy Bar and Pie Charts relate to position and speed.  Explain how changing the Skater Mass affects energy. (Tab 1)  Explain how changing the Track Friction affects energy. (Tab 2)  Predict position or estimate speed from Energy Bar and Pie Charts.  Calculate speed or height at one position from information about a different position.  Calculate KE and PE at one position from information about a different position.  Design a skate park using the concepts of mechanical energy and energy conservation. |  |

Step 2: Collect and Filter NGSS specifics for lesson

***a. Identify the DCIs, CCs, and Science and Engineering Practices that are coded to the PEs for grade band endpoints.***

**Grade Band Table 2:**

|  |  |  |
| --- | --- | --- |
| **Science and Engineering Practices** | **DCI** | **Crosscutting Concept (CC)** |
| **Developing and Using Models**  [Develop a model to describe unobservable mechanisms. (MS-PS3-2)](http://standards.nsta.org/Practices.aspx?id=2&exampleid=474) | **PS3.A: Definitions of Energy** A system of objects may also contain stored (potential) energy, depending on their relative positions.[(MS-PS3-](http://standards.nsta.org/DisciplinaryCoreIdeas.aspx?id=7&detailid=233)2) | **Systems and System Models**  M[odels can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy and matter flows within systems. (MS-PS3-2)](http://standards.nsta.org/CrosscuttingConcepts.aspx?id=4&detailid=86) |
| **Analyzing and Interpreting Data**  [Construct and interpret graphical displays of data to identify linear and nonlinear relationships. (MS-PS3-1)](http://standards.nsta.org/Practices.aspx?id=4&exampleid=285) | **PS3.A: Definitions of Energy** M[otion energy is properly called kinetic energy; it is proportional to the mass of the moving object and grows with the square of its speed. (MS-PS3-1)](http://standards.nsta.org/DisciplinaryCoreIdeas.aspx?id=7&detailid=233) | **Systems and System Models**  [Proportional relationships (e.g. speed as the ratio of distance traveled to time taken) among different types of quantities provide information about the magnitude of properties and processes. (MS-PS3-1),](http://standards.nsta.org/CrosscuttingConcepts.aspx?id=3&detailid=89) |
| **Developing and Using Models**  [Develop a model to describe unobservable mechanisms. (MS-PS3-2)](http://standards.nsta.org/Practices.aspx?id=2&exampleid=474) | **PS3.C: Relationship Between Energy and Forces** W[hen two objects interact, each one exerts a force on the other that can cause energy to be transferred to or from the object. (MS-PS3-2)](http://standards.nsta.org/DisciplinaryCoreIdeas.aspx?id=9&detailid=117) | **Systems and Systems Models**  M[odels can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy and matter flows within systems. (MS-PS3-2)](http://standards.nsta.org/CrosscuttingConcepts.aspx?id=4&detailid=86) |
| **Engaging in Argument from evidence**  Constructing a claim | **PS3.A: Definitions of Energy** Motion energy is properly called kinetic energy; it is proportional to the mass of the moving object and grows with the square of its speed | **Scale, Proportion, and Quantity** |

***b. Use DCI grade band progressions and Appendix E to find what the standards list for former and future grade bands.***

**Grade Bands DCI Table 3:**

|  |  |  |
| --- | --- | --- |
| Former DCIs | Grade Level DCI | Future DCI (not for HS) |
| **Elementary (3-5)** The faster a given object is moving, the more energy it possesses.  Energy can be moved from place to place by moving objects or through sound, light, or electric currents.  When objects collide, the contact forces transfer energy so as to change the objects’ motions.  . | **Middle (6-8)**  Motion energy is properly called kinetic energy; it is proportional to the mass of the moving object and grows with the square of its speed.  A system of objects may also contain stored (potential) energy, depending on their relative positions.  [When two objects interact, each one exerts a force on the other that can cause energy to be transferred to or from the object.](http://standards.nsta.org/DisciplinaryCoreIdeas.aspx?id=9&detailid=117) |  |

***c. Select additional Science and Engineering Practices that support your chosen DCIs and CCs.***

**Analyzing and Interpreting Data**

* C[onstruct and interpret graphical displays of data to identify linear and nonlinear relationships. (MS-PS3-1)](http://standards.nsta.org/Practices.aspx?id=4&exampleid=285)

**Additional Practices:**

* Distinguish between causal and correlational relationships in data.
* Analyze and interpret data to provide evidence for phenomena.
* Analyze data to define an optimal operational range for a proposed object, tool, process or system that best meets criteria for success.

**Developing and Using Models**

* Develop a model to describe unobservable mechanisms. (MS-PS3-2)

**Additional Practices**

* Evaluate limitations of a model for a proposed object or tool.
* Develop or modify a model—based on evidence – to match what happens if a variable or component of a system is changed.
* Develop and/or use a model to predict and/or describe phenomena.
* Develop and/or revise a model to show the relationships among variables, including those that are not observable but predict observable phenomena.

***d. Select related Common Core Mathematics Standards (CCSS-M) and Common Core Literacy Standards (CCSS-L) related to the PE’s selected.***

**MS Literacy**

* SL.8.5 - Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. (MS-PS3-2)

**MS Math**

* 7.RP.A.2 - Recognize and represent proportional relationships between quantities. (MS-PS3-1), (MS-PS3-5)

**B: Plan your lesson using the above steps and PhET’s tools: sim, Guides for Inquiry, Design, and Facilitation.**

Step 3: Refine lesson focus

***a. Break the DCI into lesson segments.***

**Table 3(a) of grade band DCIs for unit:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Topic** | **DCI Components done** | **DCI specific to this lesson** | **Future DCIs** |
| **Forces and Interactions** **Energy** | **PS2.A: Forces and Motion** The motion of an object is determined by the sum of the forces acting on it; if the total force on the object is not zero, its motion will change. The greater the mass of the object, the greater the force needed to achieve the same change in motion. For any given object, a larger force causes a larger change in motion. | **PS3.C: Relationship 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. |  |

***b. Blend the Practices, DCI Target Segments, and CCs into lesson-specific PEs and sequence the lesson progression.***

**Table 3(b): Example**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Practices** | **DCI Components** | **CC** | **Lesson Level PE** | **Lesson Ideas** |
| Developing and Using Models | PS3:A Definitions of Energy  A system of objects may also contain stored (potential) energy, depending on the relative positions | Systems and Models | Develop a model to describe that when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system. | Predict how potential energy varies - dropping objects from different heights.  different types of potential energy, discussion objects around the room and stored energy  what gpe is |
| Analyzing and Interpreting Data | PS3.A: Definition of Energy  Motion energy is properly called kinetic energy; it is proportional to the mass of the moving object and grows with the square of tits speed | Systems and System Models | Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object using a system model. | How does mass affect KE  How does speed affect KE |
| Developing and Using Models | PS3.C: Relationship 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. | Systems and System Models | Describe friction and identify the factors that determine the friction force between two surfaces | What is friction? rub hands together, discuss |

Step 4 : Determine evidence from formative and summative assessment.

**Table 4: Evidence Table example**

|  |  |  |  |
| --- | --- | --- | --- |
| Lesson Segment | Lesson Level PE | Evidence | PhET Learning Objectives |

Step 5: Develop a Big Idea and Lesson Plans

*See attached lesson*

Step 6: Re-examine lesson

**Table 6**

|  |  |
| --- | --- |
| Lesson Level Expectations | Assessment Evidence |
| Manipulate the model to demonstrate energy at varying positions. | Correctly label amounts of KE and PE at varying positions. |
| Develop a model to describe that when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system. | Construct a skate park, correctly label where PE is the greatest. |
| Describe how friction affects the motion of  objects | Identify that adding different amounts of friction will slow the skater’s motion. |
| I[dentify independent and dependent variables and controls](http://standards.nsta.org/Practices.aspx?id=3&exampleid=539) | Correctly identify variables found in the simulation. |
| Describe how e[nergy may take different forms (e.g. thermal energy, energy of motion)](http://standards.nsta.org/CrosscuttingConcepts.aspx?id=5&detailid=90) | Correctly label points on the track where KE and PE are greatest.  Construct a response that identifies that PE can be transferred into KE and thermal energy. |