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Energy Skate Park Lesson Design using NGSS and PhET

created Summer 2014 by PhET Interactive Simulations Teacher Workgroup

Part A: Gather and Filter information from the three Dimensions of NGSS and PhET 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.

HS-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 explaining the meaning of mathematical expressions used in the model.

Assessment Boundary: Assessment is limited to basic algebraic expressions or computations; to systems of two or three components; and to thermal energy, kinetic energy, and/or the energies in gravitational, magnetic, or electric fields.

HS-PS3-2 Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative positions of particles (objects)

Clarification Statement: Examples of phenomena at the macroscopic scale could include the conversion of kinetic energy to thermal energy, the energy stored due to position of an object above the earth, and the energy stored between two electrically-charged plates. Examples of models could include diagrams, drawings, descriptions, and computer simulations.

Assessment Boundary: none

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

Table 1b: PhET Sim Selection

Sim Name	Main Topics	PhET Sample Learning Goals	Reflection and Reasoning
1. Energy Skate Park Basics (MS & HS) http://phet.colorado.edu/en/simulation/energy-skate-park-basics HTML 5 version http://phet.colorado.edu/sims/html/energy-skate-park-basics/latest/energy-skate-park-basics_en.html.	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.	(We did reflect, but at the time this column was not in the table, so we didn't record our reflections. Some of our ideas are later in this document, for example, the idea of dropping the skater to increase thermal energy. We also tested the sim to see if speed could be scaled to obtain quantitative values for kinetic energy - it can.)

		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.	
2. Energy Skate Park (Optional MS and HS) http://phet.colorado.edu/en/simulation/energy-skate-park	Energy Conservation of Energy Energy Kinetic Energy Potential Energy Friction	Explain the Conservation of Mechanical Energy concept using kinetic and gravitational potential energy.	(See comments above. We ended up not using this sim because students are able to scale the speed on the basic sim))

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.

HS: DCIs

PS3.A DCI - Definition of Energy

- Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system. That there is a single quantity called energy is due to the fact that a system's total energy is conserved, even as, within the system, energy is continually transferred from one object to another and between its various possible forms. ((HS-PS3-1), (HS-PS3-2)
- At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, ~~sound, light~~, and thermal energy. (HS-PS3-2), (HS-PS3-3)
- These relationships are better understood at the microscopic scale, at which all of the different manifestations of energy can be modeled as a combination of energy associated with the motion of particles and energy associated with the configuration (relative position of the particles). In some cases the relative position energy can be thought of as stored in fields (which mediate interactions between particles). This last concept includes radiation, a phenomenon in which energy stored in fields moves across space. (HS-PS3-2)

PS3.B DCI - Conservation of Energy

- Conservation of energy means that the total change of energy in any system is always equal to the total energy transferred into or out of the system. (HS-PS3-1)
- Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems. (HS-PS3-1)

- ➔ Mathematical expressions, which quantify how the stored energy in a system depends on its configuration (e.g. relative positions of charged particles, compression of a spring) and how kinetic energy depends on mass and speed, allow the concept of conservation of energy to be used to predict and describe system behavior. (HS-PS3-1)
- ➔ The availability of energy limits what can occur in any system. (HS-PS3-1)

HS: Practices - Models and Math

- ➔ Create a computational model or simulation of a phenomenon, designed device, process, or system (HS-PS3-1)
- ➔ Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-PS3-2)

HS - CCs

Systems and System Models

- ➔ Models can be used to predict the behavior of a system, but these predictions have limited precision and reliability due to the assumptions and approximations inherent in models. (HS-PS3-1)

Connections to Nature of Science:

Science Knowledge Assumes and Order and Consistency in Natural Systems

- ➔ Science assumes the universe is a vast single system in which basic laws are consistent. (HS-PS3-1)

Energy and Matter

- ➔ Energy cannot be created or destroyed—it only moves between one place and another place, between objects and/or fields, or between systems.(HS-PS3-2)

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

Compilation:

(Grades 6-8 **DCI's**) Kinetic energy can be distinguished from the various forms of potential energy. Energy changes to and from each type can be tracked through physical or chemical interactions. The relationship between the temperature and the total energy of a system depends on the types, states, and amounts of matter.

Background knowledge:

- basic definition of energy, kinetic energy and gravitational potential energy
- different forms of energy exist
    - There are various forms of PE

    - PE is different from KE
    - Difference between motion (KE, speed) and interactions (PE, distance)
- energy can be *transferred* from one object to another
    - Energy changes can be tracked
- energy can be *transformed* (in one object) from one form to another
- relationship exists between speed & mass and kinetic energy (energy of motion) including proportionality (KE = 1/2mv^2)
- Stored energy depending on position (grav PE depends on height)
- When one form of energy changes another must also change
- When the energy of one object changes the energy of another must have changed
- A system can be described in terms of its components and their interactions

Learn through lesson:

- Conservation of Energy (Total Energy remains constant)
    - (Total E at time a = Total E at time b)
    - Must explain this equation
- Energy is measurable/calculable
- Friction causes kinetic energy to be converted to thermal energy
- Kinetic energy is related to velocity and mass
    - Be able to explain the mathematical relation
    - $KE = \frac{1}{2} mv^2$
    - Derive using a graph
- Potential energy is related to position and mass
    - Be able to explain the mathematical relation
    - $KE = \frac{1}{2} mv^2$
    - reference level for PE_{grav}
    - Derive using a graph
- Total Energy is calculated by adding all types of energy together
    - Total E = KE + ThE + PE
    - Be able to use this with conservation of E to calculate the change in energy of KE when PE or ThE is changed (or vice versa).
    - KE + ThE + PE at time A = KE + ThE + PE at time B
- Define Mechanical energy
- E can’t be created (total is a limit to what can be done), or destroyed

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

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Practices included in our PEs:

2-**Develop and use models**

- Use a model to provide mechanistic accounts of phenomena
- Develop and/or use a model (including mathematical and computational) to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems
- Evaluate merits and limitations of two different models of the same proposed tool, process, mechanism, or system in order to select or revise a model that best fits the evidence or design criteria.

5-**Use math and computational thinking** (create a mathematical model)

- Create and/or revise a computational model
- Apply techniques of algebra and functions to represent and solve scientific and engineering problems.
- Decide if qualitative or quantitative data are best to determine whether a proposed object or tool meets criteria for success

Practices that also fit:

1-**Asking questions and defining problems**

- Ask questions that arise from examining models or a theory, to clarify and/or seek additional information and relationships.
- Evaluate a question to determine if it is testable and relevant.

3-**Planning and carrying out investigations**

4-**Analyze and interpret data**

7-**Engaging in argument from evidence**

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

HS Literacy

- SL.11-12.5 - Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest. (HS-PS3-1), (HS-PS3-2), (HS-PS3-5)

HS Math

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- HSN-Q.A.1 - Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. (HS-PS3-1), (HS-PS3-3)
- HSN-Q.A.2 - Define appropriate quantities for the purpose of descriptive modeling. (HS-PS3-1), (HS-PS3-3)
- HSN-Q.A.3 - Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-PS3-1), (HS-PS3-3)
- MP.2 - Reason abstractly and quantitatively. (HS-PS3-1), (HS-PS3-2), (HS-PS3-3), (HS-PS3-4), (HS-PS3-5)
- MP.4 - Model with mathematics. (HS-PS3-1), (HS-PS3-2), (HS-PS3-3), (HS-PS3-4), (HS-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.

Prior Knowledge:

- Definitions of and equations for KE and PE
- Friction causes objects to heat up

Table 3a: Filter DCI for Grade Level

DCI Identification Code	DCI Segments Previously Covered in this Course	DCI Segments Targeted in this Lesson	DCI Segments Still to be Addressed in Course
HS-PS3.A **Definition of Energy**	Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system. ~~That there is a single quantity called energy is due to the fact that a system's total energy is conserved, even as, within the system, energy is continually transferred from one object to another and between its various possible forms. ((HS-PS3-1), (HS-PS3-2)~~	~~Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system.~~ That there is a single quantity called energy i due to the fact that a system's total energy is conserved, even as, within the system, energ is continually transferred from one object to another and between its various possible forms. ((HS-PS3-1), (HS-PS3-2)	~~Energy is a quantitative property of a syster that depends on the motion and interactions of matter and radiation within that system. That there is a single quantity called energy is due to the fact that a system's total energ is conserved, even as, within the system, energy is continually transferred from one object to another and between its various possible forms. ((HS-PS3-1), (HS-PS3-2)~~

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	At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, ~~sound, light, and thermal energy~~. (HS-PS3-2), (HS-PS3-3) ~~These relationships are better understood at the microscopic scale, at which all of the different manifestations of energy can be modeled as a combination of energy associated with the motion of particles and energy associated with the configuration (relative position of the particles). In some cases the relative position energy can be thought of as stored in fields (which mediate interactions between particles). This last concept includes radiation, a phenomenon in which energy stored in fields moves across space. (HS-PS3-2)~~	~~At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light,~~ and thermal energy. (HS-PS3-2) (HS-PS3-3) These relationships are better understood at the microscopic scale, at which all of the different manifestations of energy can be modeled as a combination of energy associated with the motion of particles ~~and energy associated with the configuration (relative position of the particles). In some cases the relative position energy can be thought of as stored in fields (which mediate interactions between particles). This last concept includes radiation, a phenomenon in which energy stored in fields moves across space. (HS-PS3-2)~~	~~At the macroscopic scale, energy manifests itself in multiple ways, such as in motion,~~ sound, light, ~~and thermal energy. (HS-PS3-2), (HS-PS3-3)~~ ~~These relationships are better understood a the microscopic scale, at which all of the different manifestations of energy can be modeled as a combination of energy associated with the motion of particles~~ and energy associated with the configuration (relative position of the particles). In some cases the relative position energy can be thought of as stored in fields (which mediate interactions between particles). This last concept includes radiation, a phenomenon i which energy stored in fields moves across space. (HS-PS3-2)
HS-PS3-B **Conservation of Energy**	~~Conservation of energy means that the total change of energy in any system is always equal to the total energy transferred into or out of the system. (HS-PS3-1)~~ Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems. (HS-PS3-1) Mathematical expressions, which quantify how the stored energy in a system depends on its configuration (e.g. relative positions of charged particles,	Conservation of energy means that the total change of energy in any system is always equal to the total energy transferred into or out of the system. (HS-PS3-1) Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems. (HS-PS3-1) Mathematical expressions, which quantify how the stored energy in a system depends on its configuration (e.g. relative positions of charged particles, compression of a spring) and how kinetic energy	~~Conservation of energy means that the total change of energy in any system is always equal to the total energy transferred into or out of the system. (HS-PS3-1)~~ ~~Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems. (HS-PS3-1)~~ ~~Mathematical expressions, which quantify how the stored energy in a system depends on its configuration (e.g. relative positions of charged particles,~~

	compression of a spring) and how kinetic energy depends on mass and speed, ~~allow the concept of conservation of energy to be used to predict and describe system behavior.~~ (HS-PS3-1) ~~The availability of energy limits what can occur in any system. (HS-PS3-1)~~	depends on mass and speed, allow the concept of conservation of energy to be used to predict and describe system behavior. (HS-PS3-1) The availability of energy limits what can occur in any system. (HS-PS3-1)	~~compression of a spring) and how kinetic energy depends on mass and speed, allow the concept of conservation of energy to be used to predict and describe system behavior. (HS-PS3-1)~~ ~~The availability of energy limits what can occur in any system. (HS-PS3-1)~~

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

Table 3b: Developing Lesson-Level Performance Expectations

Sci and Eng Practices	DCI	CCs	Lesson Level Performance Expectation	Brainstorming Lesson Ideas
Developing and Using Models Develop and/or use multiple types of models to provide mechanistic accounts and/or predict phenomena, and move flexibly between model types based on merits and limitations.	**Lesson Part A** At the macroscopic scale, energy manifests itself in multiple ways such as thermal energy. These relationships are better understood at the microscopic scale, at which all of the different manifestations of energy can be modeled as a combination of energy associated with the motion of particles	Scale, proportion & quantity Cause and Effect	A. Use a model to provide a mechanistic account of the nature of thermal energy at the microscopic level and connect it to the macroscopic level.	Can thermal energy be used to do work? When you rub your hands together, describe what is happening (in terms of energy)? Where does the energy come from? How is friction involved? What happens to the objects/molecules in a system when energy is converted to Thermal Energy? (gets hot, have more KE, drop skater and see PE to thermal)
Developing and Using Models	**Lesson Part B** c((HS-PS3-1), (HS-PS3-2)	Systems & System Models	B.1 Use the graphical models in the simulation to illustrate the relationship between total energy, KE, PE, and ThE.	Sketch a diagram of another system of objects (eg, skier skiing down a hill, pendulum, parachuting, climbing and rapelling), and sketch graphical representations (pie chart, bar graph, line

Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system. Evaluate merits and limitations of two different models of the same proposed tool, process, mechanism, or system in order to select or revise a model that best fits the evidence or design criteria.	Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems. (HS-PS3-1) The availability of energy limits what can occur in any system	Energy & Matter: Flows, cycles & conservation	B.2 Evaluate merits and limitations of two different models (pie chart, bar graph) of the same system in order to address energy as a limiting factor.	graph) showing the object's energy at different positions/times. Table with one column a moment in time and the other column the type of energy the object has. We give a table with some time periods from the skater and students reproduce table for new situations (rock climber, sky diving…) What objects are included in the systems represented by the pie chart and bar graph? Compare the pie chart and bar graph--how do they each represent "total" energy? What is meant by "total energy"? What gave the guy PE to start with? How can you transfer all PE to Th E? Use the sim as evidence to make and evaluate claims about energy availability as a limiting factor in a system. * Where did the skater get her initial energy? How can you increase her total energy? When you drop the skater on the track, does all of the energy get converted to KE and/or PE?
Using math and computational thinking Create and/or revise a computational model. **Developing and Using Models**	**Lesson Part C** Conservation of energy means that the total change of energy in any system is always equal to the total energy transferred into or out of the system. (HS-PS3-1) The availability of energy limits what can occur in any system	Systems & System Models Energy & Matter: Flows, cycles & conservation	C.1 Use graphical representations in the simulation to create and explain a computational model (equation) demonstrating conservation of energy in a system C.2	Use your mathematical model to solve problems to predict the types and amounts of energy that the skater has at different positions. Maybe a three step process to get to the final equation. The first step is to identify the equation that Total E = KE+PE+ThE. The second step is to identify that Total E at time A = total E at time B. The third step is to put it all together.

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Develop and/or use multiple types of models to provide mechanistic accounts and/or predict phenomena, and move flexibly between model types based on merits and limitations.			Move flexibly between model types by explaining the connection between the computational model and the graphical model.	Assessment - students make a diagram to demonstrate the connections between the graphical representation and the equation that was developed.
Use math and computational thinking Apply techniques of algebra and functions to represent and solve scientific and engineering problems. **Constructing Explanations and designing solutions** Make a quantitative and/or qualitative claim regarding the	**Lesson Part D** Allow the concept of conservation of energy to be used to predict and describe system behavior. (HS-PS3-1)	Systems and system models Models can be used to predict the behavior of a system, Energy and matter: flows, cycles and conservation	D.1 Apply the mathematical model to make and evaluate claims, solve problems and predict changes in forms and amounts of energy at different configurations of system.	Roller coaster with loop. An engineering student designed a loop on a roller coaster, but did not factor in the effect of friction when calculating measurements for the design. What changes could be made to the design to ensure that the riders will go fast enough to make it around the loop? X Joules are transferred to thermal E by friction between points A and B. If you are travelling at speed v on hill A, which is h m high, how high must hill B be to go a certain speed. Student A has a claim. What part of student A's claim is correct and which is incorrect. Use equations to justify your answer. Two different claims by students.

relationship between dependent and independent variables. Apply scientific ideas, principles, and/or evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects.				

Step 4 : Determine evidence from formative and summative assessment.

Table 4: Evidence Table

Lesson Segment	**Lesson Level PE**	**Evidence**	**PhET Learning Objectives**	**Student Cues, Question Prompts, Ideas for Formative & Summative Assessment**
Part A	Use a model to provide a mechanistic account of the nature of thermal energy at the microscopic level and connect it to the macroscopic level.	Students will be able sketch molecular models demonstrating changes in energy at the microscopic level, and be able to explain what these models mean at the macroscopic level for the skater on the ramp. Things to look for: * Molecular (microscopic) model: as thermal energy increases,	Describe how a change in thermal energy of the system affects the motion of molecules at the microscopic level, and the motion of the skater at the macroscopic level.	Formative: Class discussion, exit ticket Summative: Draw and explain microscopic and macroscopic models of thermal energy.

		molecules get faster; no change in # of particles (different from what they see in the sim); molecules should remain same size. Students may show speed using vector arrows, motion lines, motion map-style diagrams. * Macroscopic (system) model: friction converts PE & KE into ThE; longer the distance traveled, more energy converted to ThE; more ThE means less PE and/or KE available to the skater (slows down, does not speed up as much, does not travel as high)		
Part B.1	Use the graphical models in the simulation to illustrate the relationship between total energy, KE, PE, and ThE.	Students will qualitatively describe energy quantities and energy changes in a system by completing word descriptions and graphical representations in a graphic organizer.	Describe energy changes in a system over time using both words and graphical representations.	Formative: Look at student developed tables Summative: Matching task to match graphs with picture of a situation
Part B.2	Evaluate merits and limitations of two different models (pie chart, bar graph) of the same system in order to address energy as a limiting factor.	Students will be able to compare and contrast how different models depict total energy and specific forms and quantities of energy in a given system. * If y-axis of bar graph represents percent total energy, then an increase in total energy will not alter the graph. If the y-axis represents actual quantities of energy, then increasing total energy will lead to a higher bar for total energy. On a pie chart, total energy can be represented by the whole pie and each individual for will have relative amounts (percent of total).--increasing the total energy will not lead to a change in the graph (overall). However, if the pie	Explain how each model (bar graph and pie chart) shows the total amount of energy available in the system, and draw each model for a situation with a different amount of initial energy.	Formative: Think pair share why does the first hill on a roller coaster have to be the highest? If two hills are the same height, under what circumstances could the coaster get over the second hill and under what circumstances would the coaster not be able to get over the second hill. Summative: Given a bar graph and pie chart of one situation, students will draw new graphs and charts to represent a situation with a different quantity of initial energy. Also explain reasoning.

		represents an actual quantity of energy, then increasing the total (initial) energy will lead to a larger-sized pie.		
Part C.1	Use graphical representations in the simulation to create and explain a computational model (equation) demonstrating conservation of energy in a system.	Students will develop the conservation of energy equation(s), then explain process using evidence from the sim. E_{tot}= KE + PE + ThE $E_{positionA} = E_{positionB}$ $KE_A + PE_A + ThE_A = KE_B + PE_B + ThE_B$	Build , explain, and justify (with the sim) equations for total energy, and conservation of energy.	Formative: Students have 3 correct equations and can explain the different components. Summative: Apply equation to solve problems.
Part C.2	Move flexibly between model types by explaining the connection between the computational model and the graphical model.	Given an equation for an object's energy at a specific position, students will draw a corresponding graphical model (that is correctly scaled), and also do the reverse. Equation-> graphical model Graphical model -> Equation	Draw scaled graphical models of energy for an object at a specific position using your energy equations. AND Write equations for the total energy of an object at a specific position using scaled graphical models.	Formative and Summative: Matching task to match graphs with picture of a situation with specific quantities given to PE KE and ThE
Part D	Apply the mathematical model to make and evaluate claims, solve problems and predict changes in forms and amounts of energy at different configurations of system.	Students will make and evaluate claims using their model and evidence from the sim to support their reasoning. Students will apply their model to solve qualitative and quantitative problems, including making predictions about changes in energy at different positions.	Use your energy model and equation to solve energy related problems. Evaluate claims regarding roller coaster designs using evidence and reasoning from your energy model and the sim to support your conclusion.	

Step 5: Develop a Big Idea and Lesson Plans

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Big Idea Questions

- How does energy influence engineering designs? What physics concepts do engineers need to consider when designing roller coasters, moving rides and roads?
- If energy cannot be created or destroyed, why are we approaching an “energy crisis”? Why can’t we capture and re-use all energy that we use?
- How does the energy of a skier skiing down a hill compare to the energy of a skateboarder moving down a hill?

See attached lesson and teacher guide.

Step 6: Re-examine lesson in light of NGSS and PhET goals

Table 6 Lesson Review and Summary

Lesson Level Expectations	Assessment Evidence
A. **Use a model** to provide a mechanistic account of the nature of thermal energy at the microscopic level and connect it to the macroscopic level.	Students will use models to describe how a change in thermal energy of the system affects the motion of molecules at the microscopic level, and the motion of the skater at the macroscopic level.
B.1 **Use the graphical models** in the simulation to illustrate the relationship between total energy, KE, PE, and ThE. B.2 **Evaluate merits and limitations** of two different models (pie chart, bar graph) of the same system in order to address energy as a limiting factor.	Students will describe energy changes in a system over time using both words and graphical representations. Students will compare and contrast how different models depict total energy and specific forms and quantities of energy in a given system.
C.1 Use graphical representations in the simulation to **create and explain a computational model** (equation) demonstrating conservation of energy in a system	Students will build , explain, and justify (with the sim) equations for total energy, and conservation of energy.

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C.2 **Move flexibly between model types** by explaining the connection between the computational model and the graphical model.	Students will draw scaled graphical models of energy for an object at a specific position using their own energy equations AND write equations for the total energy of an object at a specific position using scaled graphical models.
D.1 Apply the mathematical model to **make and evaluate claims, solve problems and predict changes** in forms and amounts of energy at different configurations of system.	Students will make and evaluate claims using their model and evidence from the sim to support their reasoning. Students will apply their model to solve qualitative and quantitative problems, including making predictions about changes in energy at different positions.