Energy Skate Park Basics

Time of Lesson: 50 minutes

Content Standards Addressed in Lesson:

TEKS6.8A compare and contrast potential and kinetic energy

TEKS6.8B identify and describe the changes in position, direction, and speed of an object when acted upon by unbalanced forces

NSES (1996) **Grades 5-8 – Content Standard B**

- The motion of an object can be described by its position, direction of motion, and speed.
- Energy is a property of many substances and is associated with heat, light, electricity, mechanical motion, sound, nuclei, and the nature of a chemical. Energy is transferred in many ways.

Scientific Investigation and Reasoning Skills Addressed in Lesson:

TEKS6.3A in all fields of science, analyze, evaluate, and critique scientific explanations by using empirical evidence, logical reasoning, and experimental and observational testing

TEKS6.3B use models to represent aspects of the natural world such as an atom, a molecule, space, or a geologic feature

TEKS6.3C identify advantages and limitations of models such as size, scale, properties, and materials

TEKS6.4A use appropriate tools to collect, record and analyze information, including computers

NSES (1996) **Grades 5-8 – Content Standard A**

- Use appropriate tools and techniques to gather, analyze, and interpret data.
- Develop descriptions, explanations, predictions, and models using evidence.

I. Student Prerequisite Skills/Understandings

Students should have a basic understanding of kinetic and potential energy. This understanding should include that kinetic energy is the energy of motion and potential energy is dependent on position.

II. Objectives: Students will be able to

1. Examine how an object's potential and kinetic energy change as it moves and how an object's total energy remains constant.
2. Determine the variables that affect an object's potential and kinetic energy.
3. Propose modifications to the *Energy Skate Park Basics* PhET simulation.

III. Supplies Needed

Engage: per class

- 1 – Doll
- 1 – Car that doll will fit in
- 1 – Ramp

Explore: per pair

- 1 – Computer

Elaborate: per class

- 1 – Flat wooden stick with object attached
- 1 – Ramp
- Supply of water

IV. Advanced Preparation

- Bookmark the link for the *Energy Skate Park Basics* PhET on each computer.
- Test experiment for Elaborate to determine how much water to have.
- Attach objects to flat wooden stick.

5E Organization

Engage (3 minutes)

Content Focus: An object can have potential and kinetic energy.

Teacher places doll inside toy car and rolls the car down a ramp tilted at low and high angles. Students discuss what happened to the doll in each case relating their observations to the doll's potential and kinetic energy. The Question of the Day, "What does the kinetic and potential energy of an object depend on?" is introduced to the students.

Questions to guide students' learning and thinking	Questions to gather information about students' understanding and learning
• [After teacher releases car] What happened to the doll? • What would happen if we increased the height of the ramp?	• When did the doll have potential energy? Kinetic energy?

✓ **Checkpoint:** Students can describe what they just observed.

Explore – *Energy Skate Park Basics* PhET Simulation (35 minutes)

Content Focus: identify and describe the changes in position, direction, and speed of a skater when acted upon by unbalanced forces, compare and contrast potential and kinetic energy of a skater in a PhET simulation.
Investigation Skills: analyze, evaluate, and critique scientific explanations by using empirical evidence, and experimental testing, use a PhET simulation to mimic a real world event, identify advantages and limitations of using a PhET simulation, use computers to collect, record and analyze information

If needed, teacher reviews the basic definitions for potential and kinetic energy. Students are divided into pairs and assigned the job of either Driver or Navigator. Students are given five minutes to explore the *Energy Skate Park Basics* simulation (see: http://phet.colorado.edu/en/simulation/energy-skate-park-basics). After five minutes, teacher collects students' attention and students share what they have observed. Activity sheets are passed out and students are given 30 minutes to complete their investigations. Students switch roles halfway through their investigations.

Questions to guide students' learning and thinking	Questions to gather information about students' understanding and learning
• How could you determine what kinetic and potential energy depend on using the simulation? • In the first tab, what does the simulation not consider? • How would friction affect the motion of the skater? • What observations can you make about the	• How is your simulation similar/different from the real world? • What advantages does using the pie chart have? • What conclusions can you make about how speed influences kinetic energy? • If you were to design a skate park, what would you use? How would it look? Why?

energy of the skater as he rolls up and down the ramp? • What happens to the total energy bar? • What can you change in the simulation? • What evidence are you using to support your conclusions?	• If the total energy bar remains the same, what does that tell you about the total energy of an object? • How does mass affect the total energy of the skater?

✓ **Checkpoint:** Students have completed their activity sheets. Computers are collected.

Explain (20 minutes)

Content Focus: compare and contrast potential and kinetic energy, identify and describe the changes in position, direction, and speed of an object when acted upon by unbalanced forces
Investigation and Reasoning Skills: analyze, evaluate, and critique scientific explanations by using empirical evidence, logical reasoning, and experimental and observational testing, identify advantages and limitations of models such as size, scale, properties, and materials

Teacher leads a class discussion on the results and observations of the students' investigations using the PhET simulation. Students discuss how the potential and kinetic energy of the skater changed but the skater's total energy remains constant as he moved up and down the ramp. The Law of Conservation of Energy is introduced and related to the students' experiences with the simulation. The teacher introduces the term gravitational potential energy. The relationship between the skater's speed and energy is discussed. Students share ways they were able to change the total energy of the skater. Teacher revisits the Question of the Day and asks students to answer the question in groups using their simulation sheets as evidence. Students decide why potential and kinetic energy are important to learn about. Limitations and advantages of using a model are described. Students explain how they would change the simulation to make it a better representation of the real world.

Questions to guide students' learning and thinking	Questions to gather information about students' understanding and learning
• What happened to the energy of the skater as he rolled up and down the ramps? • As the skater traveled down the ramp, what happened to the skater's potential energy? • What evidence did we have that the potential energy decreased? • As the skater traveled down the ramp, what happened to the kinetic energy? • As the skater traveled up the ramp, what happened to the skater's potential energy? Kinetic energy? • What happened to the total energy as the skater moved? • When the skater was high above the ground, did the skater have a high or low potential energy?	• What energy transformation did you observe as the skater moved up the ramp? Down the ramp? • How does the skater's position affect his potential and kinetic energy? • How does the skater's speed affect his potential and kinetic energy? • What force(s) acted on the skater as he moved? • If you were designing a skate park and wanted to have a skateboarder go really fast, where would you want your skateboarder to start? • Why do you think changing the track affected the total energy of the skater? • If the potential energy increased or decreased what happened to the kinetic energy later in

	the skater's motion? • How does friction influence the skater's motion? • What are the advantages/disadvantages of using a simulation? • What changes would you make to the simulation? • What other experiments could you use to study an object's potential or kinetic energy? • Why do you think learning about potential and kinetic energy is important? • What careers are concerned with potential and kinetic energy?

✓ **Checkpoint:** Students are able to communicate their conclusions and observations using the simulation as evidence.

Elaborate (5-10 minutes)

Content Focus: Friction opposes the motion of an object.

Teacher shows images of different water park rides and asks students what makes the rides appear so fast. The teacher models a waterslide using a ramp and an object attached to a wooden stick. The teacher varies the amount of water on the slide (ramp) to demonstrate that with more water the toy slides faster. Students relate this experience to the simulation explaining what would happen with higher water slides to the kinetic and potential energy.

Questions to guide students' learning and thinking	Questions to gather information about students' understanding and learning
• [Referring to the photos of the waterslides] Which rides would be the fastest? Why? • What do you think makes the rides feel fast? • What observations can you make about how the amount of water affects the motion of the object?	• What conclusions can you make about the potential and kinetic energy of the object as it slides down the water slide? • How does the water help eliminate friction?

✓ **Checkpoint**: Students can describe the object's potential and kinetic energy at various points in the object's motion. Students can explain how the water helps eliminate friction.

Evaluate

Use evaluations in attached documents.
A possible journal prompt: You have been assigned the task of creating the world's greatest rollercoaster ever! What would you take into consideration with your design? Draw out your design and label the points of highest and lowest potential energy and highest and lowest kinetic energy.

Question of the Day:

What does the potential and kinetic energy of an object depend on?

Name: _____

Energy Skate Park Basics PhET Activity

Review: (fill in the blanks)
Potential Energy is the energy _____ in an object because of its _____.

Kinetic Energy is the energy of _____.

1. **Explore** the simulation.
Question: What can you change about the simulation?

2. **Investigate** how the potential and kinetic energy of the skater change as the skater moves from the top of the ramp to the bottom.
Fill in the blanks based on your observations:

As the skateboard rolls down the ramp it loses _____ energy and gains

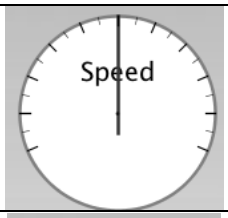
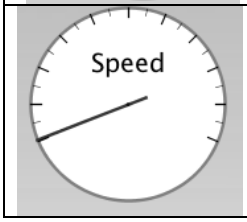
_____ energy. The total energy of the skateboarder remains _____.

3. **Explore** how the potential and kinetic energy change as the height of the skateboarder changes. Fill in the table based on your observations.

Height of Skater (m)	**What is greater? (circle your answer)**	
	Kinetic Energy	Potential Energy
	Kinetic Energy	Potential Energy
	Kinetic Energy	Potential Energy
0	Kinetic Energy	Potential Energy

Question: What conclusions can you make about how the height of the skater influences the *potential* and *kinetic energy* of the skater?

4. **Explore** how the skater's change in speed relates to the *potential* and *kinetic energy* of the skater. Fill in the table based on your observations.

Speed	**What is greatest? (Potential or Kinetic Energy)**	**What is lowest? (Potential or Kinetic Energy)**
		
		
		

Question: How does the speed relate to the *potential* and *kinetic energy* of the skater?

5. Find ways to change the **total energy bar**. If you change the track, explain what makes the track different from the others (Hint: where does the skate boarder start?).
Use the table below to record your observations.

What did you do?	**The total energy…. (circle your answer)**
Increase the mass of the skater	Increases Decreases
	Increases Decreases
	Increases Decreases

Conclusion: In a few sentences describe what you think the total energy of the skater depends on. Use the tables you filled in during this activity as your evidence.

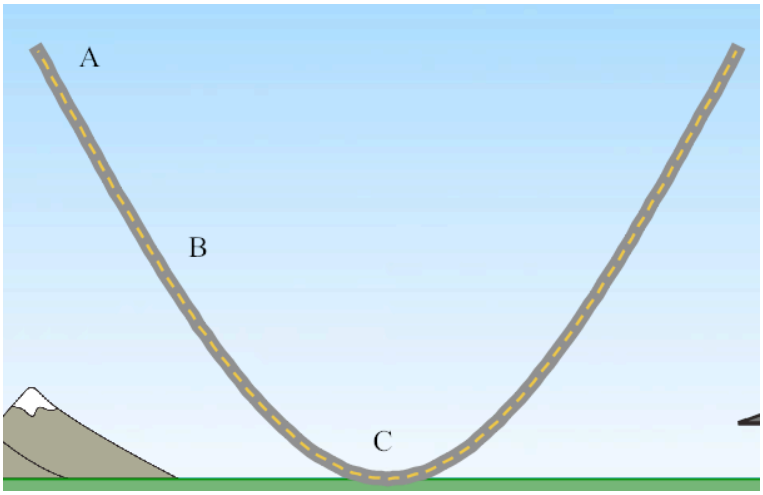
Photo of Aquatica Water Park Ride
(http://o.tqn.com/d/travelwithkids/1/0/e/h/1/aquatica_slide.jpg)

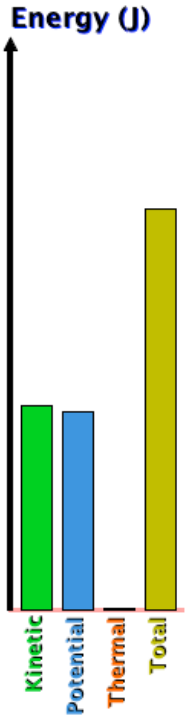
Photo of ride at White Water Park (http://www.ultimatewaterpark.com/waterparks/white-water.html)

Name: _____

Show off what you know!

1. What does *gravitational potential energy* depend on?
    a. Position
    b. Air Resistance
    c. Gravity
    d. Both a and c
2. A tiny pig is dropped from the top of a building and lands safely on a trampoline. The tiny pig will have an **increase** in what type(s) of energy as it falls?
    a. Gravity
    b. Potential energy
    c. Kinetic energy
    d. All of the above
3. The following is a graph of the energy of a skateboarder as he travels down a track. Using the diagram on the left, at which point on the track does the graph correspond to?





a. Point A
b. Point B
c. Point C

4. Katy wants to design a rollercoaster where the passenger is traveling super fast at the bottom. What characteristics should the rollercoaster have?
    a. It should be flat and close to the ground. This way the passenger will have an increase in speed because he/she starts out close to the ground.
    b. It should have no friction and the passenger should start off high above the ground. This way the passenger starts out with a lot of potential energy that can be transformed into kinetic energy.
    c. It should have lots of friction and be very tall. This way the passenger will speed up because of the large amount of friction.
    d. It doesn't matter how you design the rollercoaster the passenger's speed will be the same at all points on the rollercoaster.

Name: KEY

Energy Skate Park Basics PhET Activity

Review: (fill in the blanks)
Potential Energy is the energy stored in an object because of its position.

Kinetic Energy is the energy of motion.

1. **Explore** the simulation.
Question: What can you change about the simulation?

You can make the simulation go in slow motion. You can display different things (speed, bar graph, grid, etc.). You can reset the simulation and pause it.

2. **Investigate** how the potential and kinetic energy of the skater change as the skater moves from the top of the ramp to the bottom.
Fill in the blanks based on your observations:

As the skateboard rolls down the ramp it loses potential energy and gains

kinetic energy. The total energy of the skateboarder remains constant.

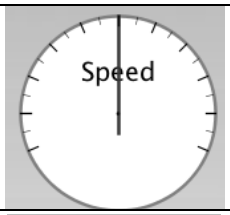
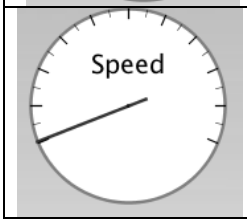
3. **Explore** how the potential and kinetic energy change as the height of the skateboarder changes. Fill in the table based on your observations.

Height of Skater (m)	**What is greater? (circle your answer)**	
6	Kinetic Energy	Potential Energy
4	Kinetic Energy	Potential Energy
2	Kinetic Energy	Potential Energy
0	Kinetic Energy	Potential Energy

Question: What conclusions can you make about how the height of the skater influences the potential energy of the skater?

The higher the skater is the more potential energy he has. As his height decreases, his potential energy decreases and his kinetic energy increases.

4. **Explore** how the skater's change in speed relates to the potential and kinetic energy of the skater. Fill in the table based on your observations.

Speed	What is greatest? (Potential or Kinetic Energy)	What is lowest? (Potential or Kinetic Energy)
	Kinetic Energy	Potential Energy
	Potential Energy	Kinetic Energy
	Potential Energy	Kinetic Energy

Question: How does the speed relate to the potential and kinetic energy of the skater?

As the skater's speed increases, the kinetic energy increases. As the speed decreases, the kinetic energy increases.

5. Find ways to change the **total energy bar**. If you change the track, explain what makes the track different from the others (Hint: where does the skate boarder start?).
Use the table below to record your observations.

What did you do?	The total energy…. (circle your answer)	
Increase the mass of the skater	Increases	Decreases
Decrease the mass of the skater	Increases	Decreases
Change the track where the skater starts at a higher position	Increases	Decreases

Conclusion: In a few sentences describe what you think the total energy of the skater depends on. Use the tables you filled in during this activity as your evidence.

When the skater starts at a higher point, the total energy of the skater increases. When the skater's mass increases, the total energy increases.

Show off what you know!

KEY

1. D – both a and c
2. C – kinetic energy
3. B – point b
4. B – It should have no friction and the passenger should start off high above the ground. This way the passenger starts out with a lot of potential energy that can be transformed into kinetic energy.