

Barbie Bungee Jump

High School Physics

Concept: The change in energy storage systems during a bungee jump activity demonstrates how energy can be transferred from one system to another. Primarily, potential gravitational energy is transferred into kinetic energy then to elastic energy as the bungee cord is stretched to the maximum it will stretch. The energy transfers are then reversed in order as the bungee cord retracts the jumper back towards the jump platform. For the bungee jump to be successful, the jumper needs to stay alive! This could be used as a final project or alternate assessment. Students should have an understanding of the different kinds of energy and how they work.

WI Science Standards:

A.12.3 Give examples that show how partial systems, models, and explanations are used to give quick and reasonable solutions that are accurate enough for basic needs

A.12.5 Show how the ideas and themes of science can be used to make real-life decisions about careers, work places, life-styles, and use of resources

C.12.1 When studying science content, ask questions suggested by current social issues, scientific literature, and observations* of phenomena, build hypotheses that might answer some of these questions, design possible investigations*, and describe results that might emerge from such investigations

C.12.2 Identify* issues from an area of science study, write questions that could be investigated*, review previous research on these questions, and design and conduct responsible and safe investigations to help answer the questions

C.12.3 Evaluate* the data collected during an investigation*, critique the data-collection procedures and results, and suggest ways to make any needed improvements

C.12.4 During investigations*, choose the best data-collection procedures and materials available, use them competently, and calculate the degree of precision of the resulting data

D.12.7 Qualitatively and quantitatively analyze* changes in the motion of objects and the forces that act on them and represent analytical data both algebraically and graphically

D.12.8 Understand* the forces of gravitation, the electromagnetic force, intermolecular force, and explain* their impact on the universal system

G.12.2 Design, build, evaluate, and revise models and explanations related to the earth and space, life and environmental, and physical sciences

Classroom Management Goals/Skills

- Use attention getting strategy
- Assign groups for cooperation
- Use the scientific method for reporting

Objectives: The student will be able to:	Evaluation Question for each Objective
Define gravitation potential energy	What are the variables that affect gravitational potential energy? How are the variables related (mathematical relationship)?
Define elastic energy	What are the variables that affect elastic energy? How are the variables related (mathematical relationship)?
Identify conservation of energy	How are gravitational potential energy and elastic energy related in this experiment?

Vocabulary:

Gravity – the force of the attraction of masses causing an acceleration of 9.8 meters/second².

Mass – the amount of matter in an object, measured in kilograms.

Height – a distance, in this instance, from the canyon floor to the jumping platform in meters.

Stretch – the change in length of the bungee cord, in meters.

Spring Constant – the amount of force required to stretch a bungee cord in Newton/meters.

Material List and Advanced Preparations:

- Rubber bands (various sizes and types)
- A Barbie or Ken doll
- Metersticks
- Force sensors or masses

Safety:

Stretched rubber bands make great projectile launchers or snapping devices. Stress that these are not to be used to hurt anyone!

Engagement		
What the teacher will do	Eliciting Questions/ Student Responses	What the students will do
Play a YouTube video (or a few) of people bungee jumping, bungee type amusement rides.	What things are happening that prevent these people from dying, yet allows them to have an experience that they feel is exciting?	Students will answer questions posed by the teacher.
Discuss how energy is used in these situations.	What types of energy are involved? <i>Potential gravitational energy, kinetic energy, chemical energy, elastic energy.</i>	Students will answer questions posed by the teacher.
Discuss the types of energy that are crucial for a successful bungee jump, and the terms needed for the activity.	How do you determine potential gravitational energy? $E_g = (\text{mass})(\text{height})(\text{gravity})$ <i>gravity = 9.8 m/s²</i> How do you determine elastic energy? $E_{el} = 1/2(\text{spring constant})(\text{stretch}^2)$ <i>Spring constant is determined by graphing the stretch of the rubber band bungee vs. the force used</i>	Students will take down brief notes to prepare them for the exploration.

Discuss how the conservation of energy will be used in this activity.	How will you use the formulas for energy to make a bungee jump successful? $E_g = E_{el}$	Students will take down brief notes to prepare them for the exploration.
Ask students to sketch a bungee jump with the steps involved that include energy transfers.	Draw your prediction of the initial stage in a bungee jump. Include items needed to find the energy stored. Draw your prediction of what it would look like at the end of the jump when the bungee is at full stretch. Include items needed to find the energy stored.	Students will diagram in their lab books.

Transition

Now that you've created a diagram of the energy systems, we're going to demonstrate how a bungee jump works.

Exploration

What the teacher will do	Eliciting Questions/ Student Responses	What the students will do
Demonstrate various objects free falling, from a piece of paper with much surface and a small mass to some heavier object such as a book with about the same surface area. Let the students take various objects from the room and practice the same demonstration.	Describe the properties that are affecting the objects while they fall. <i>Height, mass, surface area, and gravity.</i>	Students will take down brief notes to prepare them for the exploration.

<p>Demonstrate various simulated bungee cords made from different types of rubber bands and different lengths.</p> <p>Let the students practice with the different cords.</p>	<p>Describe the properties that are affecting the Barbie as she simulates a bungee jump.</p> <p><i>Stretch, the springiness of the rubber bands, length of the rubber bands.</i></p>	<p>Students will take down brief notes to prepare them for the exploration.</p>
<p>Ask each group to build their own bungee cord. Leave the object jumping, the height, and the type of cord up to them.</p>	<p>How would you take the bungee that you built and use it in a real jump situation?</p> <p><i>Students should be able to build a cord, and use an object to simulate a jump.</i></p>	<p>Students will create a lab report of their bungee they created finding all the variables needed. The items used may be very different for each group.</p> <p>Prior knowledge of spring constants is necessary. Use of masses or force sensors needed.</p>

<h2>Transition</h2>
With your bungee cord, demonstrate a bungee jump.

<h2>Explanation</h2>		
What the teacher will do	Eliciting Questions/ Student Responses	What the students will do
Ask each group to present their jump to the class.	During the jump, describe the energy as it changes systems.	Students will perform a jump that they set up. They will explain how energy is changed or transferred to another system.

<h2>Transition</h2>
The different variables all affect a bungee jump. A real bungee jump, in order to be safe, needs to focus on human bodies for the jumper and a stretchy cord. Develop a cord that will safely perform a bungee jump with a specific height and a specific body.

Elaboration

What the teacher will do	Eliciting Questions/ Student Responses	What the students will do
<p>Choose a set height for the jump. Choose a certain barbie (mass will not change). Provide more rubber bands. Set up a fish tank on the floor with the top being the river canyon. Set up a video recorder on the tank to record the jump and determine the death or success of Barbie. Describe the jumping platform as the ceiling or some height that allows a fair distance for Barbie to fall.</p>	<p>Pretend you are a bungee jump company and Barbie comes along to pay you for an experience she won't forget! Your river canyon went dry, and you need to keep her alive. If she hits the ground she will die and you will go to jail, but she wants to get as close to the ground as possible. Can you keep her alive and give her the thrill of her life?</p>	<p>Students will redo the lab with the new variables. They will not get practice trials; no practice trials when it comes to a live person jumping!</p>

Transition

Now you will get a chance to show your understanding of what you learned.

Evaluation

What the teacher will do	Eliciting Questions/ Student Responses	What the students will do
<p>Administer a summative assessment (found at the end of this lesson plan). Need to set up a white background on the tank with grading lines every 5 cm above the canyon floor.</p>		<p>The students will drop Barbie. They will also turn in their lab books for grading.</p>

Barbie Bungee Jump Rubric

Names:

Due Date	10 points = Ready the day of the jump 8 points = One day late 6 points = Two days late 4 points = Three days late 2 points = Four days late 0 points = Five or more days late
Lab Report	20 points = All steps included 17 points = 1 step missing or incomplete 14 points = 2 steps missing or incomplete 11 points = 3 steps missing or incomplete 8 points = 4 steps missing or incomplete 0 points = 5 steps or more missing or incomplete
Mathematical relationships	10 points = both E_g and E_{el} solved and equal to each other 5 points = either E_g or E_{el} missing or not equal to each other 0 points = neither E_g or E_{el} solved
Bungee Jump (distance Barbie's head is away from the canyon floor)	0 – 5 cm 15 points 5 – 10 cm 12 points 10 – 15 cm 9 points 15 – 20 cm 6 points 20 + cm 3 points Hit her head/ below canyon floor = 0 points