Science Unit | Grades 9-12 | Lesson 4: Potential & Kinetic Energy

Lesson Description

Energy…for the body it comes in all forms: drinks, chocolate, and sunlight just to name a few. When it comes to Physics in motion, energy comes in two main forms: Potential and Kinetic. Each plays a very significant role in the enjoyment and safety of a roller coaster ride. Both Potential and Kinetic energy affect a rider's emotions, adrenaline levels, and nervous system. So grab a friend or family member and go see for yourself what happens as you come across high levels of Potential and Kinetic energy. Then complete the fun activity which identifies a few of those areas.

Concepts

Potential Energy
Kinetic Energy
Solving equations

Objectives

Students will:

- Identify where Potential and Kinetic energy occurs in certain roller coasters around Silver Dollar City.
- Evaluate expressions by substituting values for variables. (bonus)
- Simplify expressions using correct order of operations. (bonus)

Content Standards

National Standards in Science (Physics)

- **Standard 10**: Understands forces and motion.
  - Benchmark 8, Grades 9-12: Knows that laws of motion can be used to determine the effects of forces on the motion of objects (e.g., objects change their motion only when a net force is applied; whenever one object exerts force on another, a force equal in magnitude and opposite in direction is exerted on the first object; the magnitude of the change in motion can be calculated using the relationship F=ma, which is independent of the nature of the force).

CLE's: 1.B.2.c.: Mechanical energy comes from the motion (Kinetic energy) and/or relative position (Potential energy) of an object.

Time Required

Varies by student – Use teacher discretion to determine appropriate grade level

Materials

- Student Activity Sheet from the Kids-U-Cation website
- Writing utensil

Procedures

1. Print off the student activity sheet from the Silver Dollar City website (teachers).
2. Ride each of the roller coasters listed.
3. Determine where Potential and Kinetic energy occur.
4. For the bonus questions, use facts given in the packet to solve the equations.

Closure

Review the key points of this lesson by discussing the following:

- As you rode the roller coasters, did you think about where Potential and Kinetic energy occurs as you were going over certain parts of the track?
- What emotions were you experiencing during points of high Potential energy?
  - Fun Fact: Scientists have monitored guests' emotional response to Potential and Kinetic energy on roller coasters with body sensors. When either or both of these are high, the body's stress level and adrenaline levels increase. Plus, the body's nervous system triggers your sweat glands to start reacting.
- Go over the order of operations to make sure students did the equations correctly.
- Discuss why accurate math figures are imperative for the safety and enjoyment of the ride.

Assessment/Independent Practice

Give an assignment or test of your choosing.

Name/Date: _____

Potential and Kinetic Energy

Using the information provided, label where potential and kinetic energy occur as well as the amount of energy (i.e. High, Low, No, Increasing, Decreasing) for each of Silver Dollar City's roller coasters. Then ride them yourself to feel energy in action!

1. Powderkeg

A)

B)

C)

2. Wildfire

A)

B)

C)

3. Giant Swing

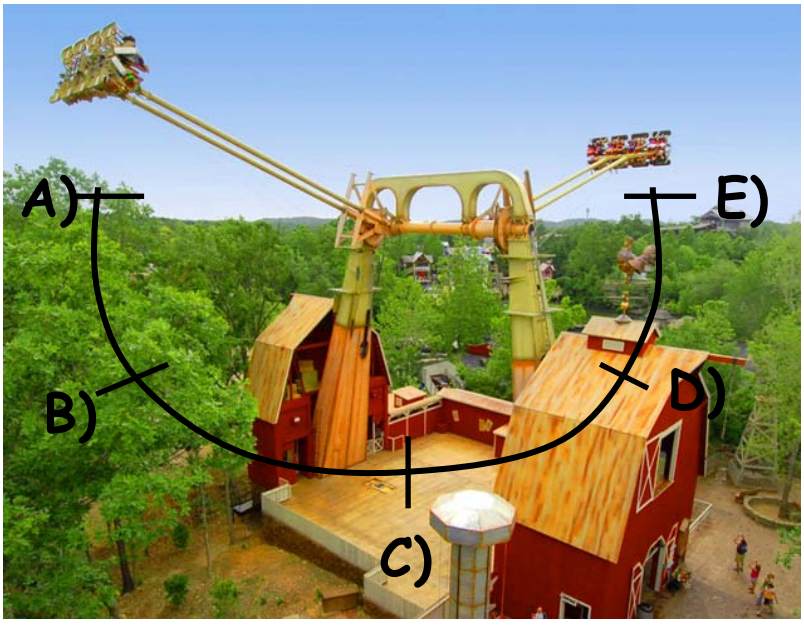
A)

B)

C)

D)

E)



Potential and Kinetic Energy

How A Ride Works

At the starting station the train attaches itself to a moving chain that pulls it up the First steep incline – the lift hill – and on to the first drop. Devices called chain dogs are located on two or more of the trains. These engage with the moving chain like a sprocket does to a roll of film, and the train is pulled up the steep incline giving that distinctive clanking sound. The higher the train is lifted by the chains, the more potential energy is built up, forming a larger amount of kinetic energy when the train is dropped.

At the crest of the lift hill, a release mechanism on the track uncouples the chain dogs as the car passes over, allowing the train to spend down the slope by the force of its own weight. It is at the top of this hill where the train has a large quantity of potential energy, but it has very little kinetic energy. Kinetic energy is the energy of motion. As the train accelerates down the hill, the potential energy is converted into kinetic energy. There is very little potential energy at the bottom of the hill but there is a large amount of kinetic energy. The kinetic energy at the bottom of the hill gives the roller coaster enough speed to safely make it around a loop. If the acceleration at the bottom is too low, the train will fall out of the loop, if it is too high the physical limits of the body are pushed posing a threat to the overall safety of the passengers as well as causing damage to the ride itself.

Formulas:

$KE = \frac{1}{2} (m) (v^2)$

1 Joule = 1 kg (m^2/s^2)

*Where m = mass of object; v = speed of object

BONUS 1: Using the formulas above, determine the kinetic energy of a 625-kg roller coaster car that is moving with a speed of 18.3 m/s. Try to convert your final answer to Joules. Show your work.

BONUS 2: If the roller coaster in the problem above were moving with twice the speed, then what would be its new kinetic energy? Try to convert your final answer to Joules. Show your work.