Student Learning Plan - Conservation of Energy

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Physics
Grades 11 & 12

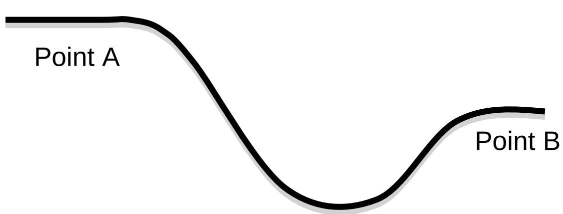
I. Objective:	**II. Assessment:**
The students will be able to:	
1. design an equation that will predict the ideal velocity of a roller coaster at different points on its track.	1. Students will be asked to design an energy balance for the Jackrabbit Rollercoaster (Kennywood) in their notebooks. Teacher will assess by walking around the room and checking each for accuracy.
2. predict the energy loss of a real roller coaster.	2. The students will construct a diagram for the Jackrabbit and predict its energy loss by using actual measurements obtained from Pictometry On-Line.

III. PA State Academic Standard(s):

A. Standard 3.4.10.B – *Analyze energy sources and transfers of heat*.
B. Standard 3.4.12.B – *Apply and analyze energy sources and conservations and there relationship to heat and temperature*.
C. Standard 7.1.12.A – *Analyze data and issues from a special perspective using the appropriate geographic tools*.

IV. Materials:

A. Video clip (or dvd clip) taken from the front of a roller coaster as it goes up and down at least one large hill.
B. Computer with internet access to Pictometry On-line https://pol.pictometry.com/
(preferably with a projector output)
C. Slide or overhead of a rollercoaster track that goes from a big hill (point A) to a smaller hill (point B).



V. Lesson Development (42 minute module):

A. **Anticipatory Set** (1- 2 minutes)

1. Without saying anything show video (or dvd) clip.
2. Have the students watch the clip again, but this time ask them to write in their notebooks the different types of energy the riders on the rollercoaster are experiencing.
3. Ask the students to name the different types – answers will vary, but should include: potential & kinetic… and hopefully <u>heat</u>.

B. **Procedures** (40 minute class)

1. Show slide or overhead of rollercoaster track.

2. Ask the students to use the Law of Conservation of Energy to design an equation that will allow them to predict the velocity of a rollercoaster at any point along the track as long as the rollercoaster is under ideal conditions and its relative height and starting height are known. Students are to design the equation in their notebooks.

3. Walk around and check their progress as they work.

4. The base equation should be as follows:

$$E_{input} = E_{output}$$
$$PE_{g,A} + KE_A = PE_{g,B} + KE_B$$

Where E is energy, PEg is gravitational potential energy, & KE is kinetic energy.

5. Substituting in the equations for each energy, the students should have designed the following equation that will allow them to calculate velocity at any point B as long as the velocity at point A can be assumed to be zero:

$$mgh_A + ½\ mv_A^2 = mgh_B + ½\ mv_B^2$$

Where m is mass, g is Earth's gravitational acceleration, h is relative height, & v is velocity.

6. Next ask the students to show how the above equation would change if the rollercoaster starts from rest at point A and is under real-life (un-ideal) conditions.

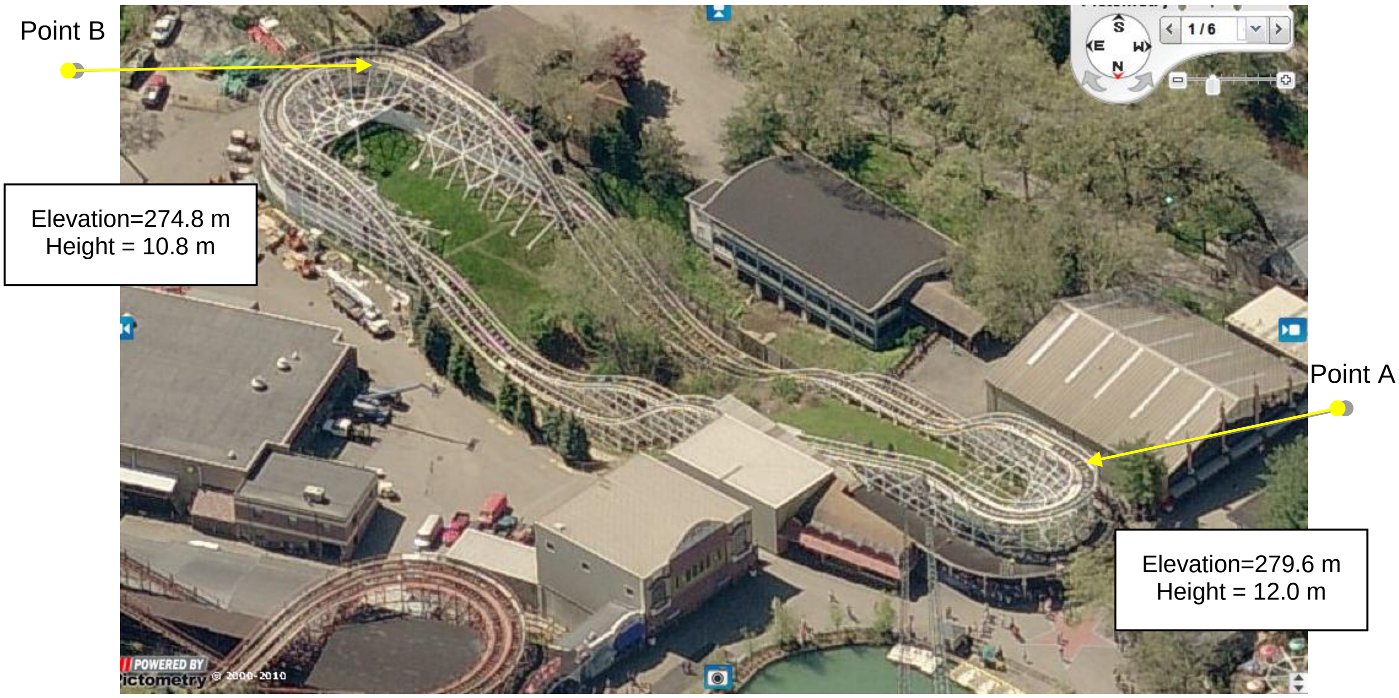
7. The students should design the following equation:

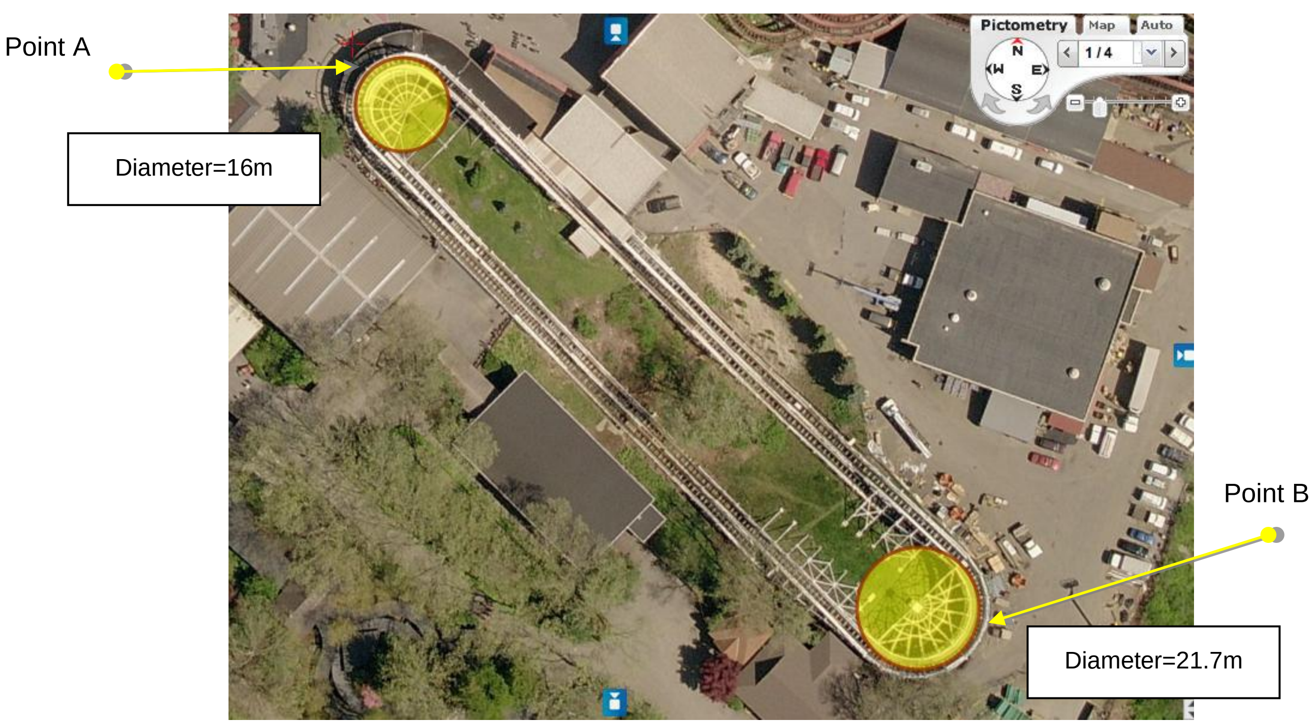
$$mgh_A = mgh_B + ½\ mv_B^2 + Q$$

Where Q is the energy lost to heat.

8. On a computer with internet access, use Pictometry Online to show an aerial view of the Jackrabbit Rollercoaster from Kennywood Park, PA.

9. Use Pictometry's tools to measure the following information (*in meters*):
   a. Elevation @ point A & B
   b. Track height @ point A & B
   c. Turn diameter @ point A & B (OPTIONAL – to be used for *Extensions*)





C. **Question(s)**

1. If the rollercoaster (3,400 kg, including riders) is at rest at point A and its velocity at point B is measured to be 8.9 m/s, calculate the heat loss (Q) as the rollercoaster travels from point A to point B ?m [*Q = 69.4 kJ*]

D. **Closure** (last 2 minutes of class)

1. "In today's lesson you took the concepts that you discovered earlier about energy transformation under ideal conditions and learned to apply it to a real life situation using actual numbers garnered from Pictometry Online. Application is the true essence of physics; in time, I hope that you will see how all the concepts that we uncover in this class can be applied to real-world situations."

VI. Extensions:

1. Using the diameter of the curves at point A & B calculate the centripetal acceleration (a_c) and centripetal force (F_c) a 80 kg rider would feel as they travel through curves at A & B.
   [*Point A* a_c*=0 &* F_c*=0 (b/c v=0); Point B* a_c*=7.3m/s2,* F_c*=581N*]

VII. Adaptations:

1. Review IEP's prior to giving lesson.
2. Lesson should be fine for handicapped and/or impaired students.
3. Students absent during the class will be asked to read the "Conservation of Energy" sections from their text and will be responsible for getting the notes that they missed from the teacher or a classmate.