EF 151 – Physics for Engineers

Lab 3.3 Conservation of Energy; Elastic Potential Energy

Objectives
- Work problems involving conservation of energy and F=ma
- Learn about elastic potential energy

Task 1. Answer the concept questions on elastic potential energy.
1. A truck, initially at rest, rolls down a frictionless hill and attains a speed of 20 m/s at the bottom. To achieve a speed of 40 m/s at the bottom, how many times higher must the hill be?
   A) half the height
   B) the same height
   C) \( \sqrt{2} \) times the height
   D) twice the height
   E) four times the height

2. Paul and Kathleen start from rest at the same height and time on frictionless water slides with different shapes. At the bottom, whose velocity is greater?
   A) Paul
   B) Kathleen
   C) both the same

3. Paul and Kathleen start from rest at the same height and time on frictionless water slides with different shapes. Who makes it to the bottom first?
   A) Paul
   B) Kathleen
   C) both the same

4. A cart starting from rest rolls down a hill and at the bottom has a speed of 4 m/s. If the cart were given an initial push, so its initial speed at the top of the hill was 3 m/s, what would be its speed at the bottom?
   A) 4 m/s
   B) 5 m/s
   C) 6 m/s
   D) 7 m/s
   E) 25 m/s

5. When you pay the electric company by the kilowatt-hour, what are you actually paying for?
   A) energy
   B) power
   C) current
   D) voltage
   E) none of the above

Task 2. Power generated by human beings
(a) Trained athletes can exert power for their movements ranging from around 5 hp for 1 s to 0.4 hp or less for periods extending over several hours.
   (i) Estimate the time it takes a weightlifter to lift 100 kg a distance of 2 m.

   (ii) A bicyclist is limited by wind resistance, which is roughly of the form \( F = Av^2 \) where \( A = 0.20 \, \text{kg/m} \). Estimate the speed a cyclist can maintain for 1 hour in terms of miles per hour. Do you believe your answer?

(b) Time how long it takes a group member to climb a flight of stairs.
   (i) What power was your group member exerting in terms of horsepower?

   (ii) Is this person on par with a trained athlete?

   (iii) How long would a 60 Watt light bulb have to burn to expend the same amount of energy?
**Task 3. Tennis Ball on Bungee Cord**
(a) A tennis ball is connected to a bungee cord that has a length of $X_1$ in its undeformed position. Under the weight of the tennis ball, the bungee cord has a length of $X_2$. Draw the FBD of this system and develop an equation that can be used to calculate the spring constant of the bungee cord.

(b) The same tennis ball is held at the underformed position of length $X_1$. Using conservation of energy, develop an equation to predict how far the ball will drop.

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**Task 4. Inclined to Conserve**
1. On the graph below, sketch the kinetic energy, the gravitational potential energy, and the elastic potential energy as a function of time for a car running down an inclined track and bouncing back off the end a couple of times.
2. Extend the plunger and run the car down the inclined track collecting data in DataStudio.
3. Observe plots of the kinetic energy, the gravitational potential energy, the elastic potential energy, and the total mechanical energy.