Name 1: _____

Name 2: _____

Date: _____

Challenge #3: A Rocky Landing

Overview

Up to **two** students can work on this challenge. Remember each team member must contribute to at least one the completion of one of the physics components for one challenge and the completion of one of the engineering components for another challenge. This challenge is about **energy and the law of conservation of energy**. You will be asked to do the following:

1. Calculate gravitational potential energy and kinetic energy

2. Determine how much energy your system would need to absorb

3. Answer questions about energy

Calculating Gravitational Potential Energy

One of the first things you will need to do is quantitatively determine what percentage of mechanical energy is lost to air resistance as a result of the shape of your rover. After doing this, you will be able to determine how much energy remains, which would be the amount of energy your system would need to absorb.

Since we do not wish to destroy your rover, we will use something with the shape of your rover in its place. Lasercut a piece of cardboard in the shape of your rover and calculate its potential energy as if it were dropped from **.75m**. Write down values to your variables below.

Mass (m): _____

Acceleration due to Gravity (g): _____

Height (Δy): _____

Gravitational Potential Energy (U_g): _____

Determining Kinetic Energy and Energy Loss

Take a video of your piece of cardboard as it falls from .75m face down onto the floor. Make sure to have a meter stick in the background for this. Then, use Vernier Video Analysis to analyze your video and determine the speed of the piece of cardboard right before it hits the ground. Write this value below and subsequently determine your calculated kinetic energy.

Mass (m): _____

Speed (v): _____

Kinetic Energy (K): _____

Your kinetic energy should be slightly less than your gravitational potential energy. Determine how much energy is lost by subtracting your kinetic energy from your gravitational potential energy and write it below.

Energy Loss (E_{loss}): _____

You should now determine what percentage of energy loss can be attributed to the shape of your rover by using the following equation:

$$E_{loss \, \%} = \frac{E_{loss}}{U_g} * 100$$

Energy Loss Percentage (E_{loss %}): _____

Energy-Damping System

Now that you know your energy loss percentage, due to the shape of your rover, to air resistance, we can approximate how much energy you need your system to absorb.

First, calculate how much gravitational potential system your rover actually would have for a fall of .75m by using the mass of your rover.

Mass (m): _____

Acceleration due to Gravity (g): _____

Height (Δy): _____

Gravitational Potential Energy (U$_g$): _____

Now determine the amount of energy your system needs to absorb by using the following equation:

$$E_{absorb} = U_g * \frac{E_{loss\,\%}}{100}$$

Energy Absorb (E$_{absorb}$): _____

Exceeding Proficiency*: If you determine the spring constant for the following part on your own, and it is correct or reasonable, you will receive exceeding proficiency.*

A common way people design a vehicle to "absorb" energy is by using a suspension system; essentially, adding a spring or a set of springs to each wheel. Assume that you have four springs of identical spring constants, each one attached to one of the wheels. If you wish for the springs to compress only 3cm, what would the spring constant need to be to absorb the remainder of the gravitational potential energy and turn it into elastic potential energy?

Please remember that the equation for elastic potential energy is as follows and use the box below for your calculations:

$$U_e = \frac{1}{2}k\Delta x^2$$

Spring Constant (k): _____

Questions About Energy

What are sources of mechanical energy loss for this challenge?

_____

_____

What might be a way to maximize sources of mechanical energy loss to eliminate the

need for springs for this challenge?

_____

_____

_____

_____

What are some limitations of the experimental approximations made in this challenge component?

_____

_____

_____

_____

Point System (TEACHER ONLY - CIRCLE ONE)

Not Yet (0pts) (50%)	Approaching Proficiency (10pts) (60%)	Somewhat Proficient (20pts) (70%)	Proficient (30pts) (85%)	Exceeding Proficiency (40pts) (100%)
You have not correctly completed any of the elements of this challenge component.	You have correctly completed at least one element of this challenge component.	You have correctly completed half of the elements of this challenge component.	You have correctly completed all of the elements of this challenge component.	You have additionally and correctly completed the independent element of this challenge component.
Comments:				