Name 1: _____

Name 2: _____

Date: _____

Challenge #8: Giving a Gift

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 **momentum and the law of conservation of momentum**. You will be asked to do the following:

1. Determine initial momentum of the system
2. Determine final momentum of the system
3. Determine how much momentum is lost and why

Initial Momentum

Remember that, to determine the momentum of the system, you need to determine the momentum of each individual component. In this case, the system consists of two components – the flag and your rover. Please determine their individual masses first.

Flag Mass (m_{flag}): _____

Rover Mass (m_{rover}): _____

After determining their masses, you must know their initial velocities. For the rover, please make sure your rover is traveling at a constant velocity and use Vernier Video Analysis (with the meter stick in the foreground) to determine its initial velocity, which should be constant. Write their respective velocities below.

Initial Flag Velocity (v_{flag1}): _____

Initial Rover Velocity (v_{rover1}): _____

Now you are able to calculate the momentum for each and the system as a whole, remember:

$$p = mv$$

&

$$p_{before} = p_{flag1} + p_{rover1}$$

Initial Flag Momentum (p_{flag1}): _____

Initial Rover Momentum (p_{rover1}): _____

Total Initial Momentum (p_{before}): _____

Final Momentum

The type of collision that occurs when both are moving is called a hit-and-stick collision. For this type of collision, the momentum is given by:

$$p_{after} = (m_{flag} + m_{rover})v_{flag+rover}$$

The Law of Conservation of Momentum

The law of conservation of momentum states that there should be no difference between the momentum before and after a collision; that is:

$$p_{before} = p_{after}$$

Predicting Velocity

If we assume this to be true, what do you expect the final velocity to be after the hit-and-stick collision? Use the space below to answer this question.

Theoretical Final Velocity ($v_{flag+rover}$): _____

We can also determine our velocity experimentally. Take another video of your rover moving the flag across the field at a constant velocity with the meter stick in the foreground. Using Vernier Video Analysis, determine what the final velocity should be and write it below.

Experimental Final Velocity ($v_{flag+rover}$): _____

Is the velocity you measured from Vernier Video Analysis less than, equal to, or greater, than the velocity predicted by using the law of conservation of momentum?

Why do you think you received the result you did to the previous question?

What might be some sources of momentum loss for this system?

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

Impulse results in a change of momentum and it can be measured using the following equation:

$$J = \Delta p = F\Delta t$$

Use the space below to determine the force on the flag between when it is first impacted by your rover until it reaches the destination base.

Impact Force (F): _____

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:				