Name 1: _____

Name 2: _____

Date: _____

Challenge #7: Down the Canyon

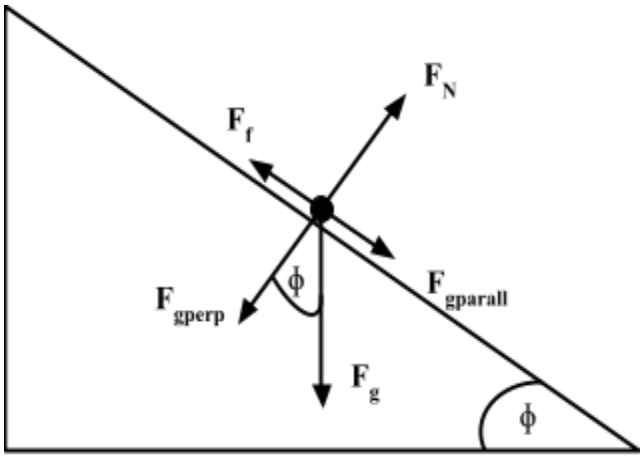
Overview

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 primarily about **forces**. You will be asked to do the following:

1. Determine the value of the friction force on your rover on an incline plane
2. Determine the work done by friction

Determining Gravitational Component Parallel to Incline

To determine the force of friction, you must know the parallel component of the gravitational force. It does help to look at or complete the sixth challenge (Welcome to Seattle), but if you haven't, the diagram below illustrates the different forces acting on an object place atop an incline.



To determine the gravitational component that is parallel to the plane of motion, take one of the available ramps with the same surface material as that for the challenge. Place your rover on the top part of the ramp and increase the angle until it begins to slide. You may increase this angle using our physics textbooks. Note the angle at which it is sliding below (use either a protractor or your smartphone's Measure app).

Active Slipping Angle (ϕ): _____

To determine the gravitational force, remember that:

$$F_g = mg$$

Once you have determined your gravitational force, please write it below.

Gravitational Force (F_g): _____

Using trigonometry (remember SOH CAH TOA), calculate the parallel component to gravitational force and write it below. Feel free to use the space below for your calculations.

Parallel Gravitational Force ($F_{gparall}$): _____

Determining Friction Force

To calculate friction force, take a video of your rover moving down the ramp at the same angle that you used for your calculations above (remember to include a meter stick for distance scaling). Using Vernier Video Analysis (and the origin along the rover path), determine the net acceleration and write it below.

Net Acceleration (a_{net}): _____

Now that you know the net acceleration, use Newton's second law to determine the net force and write it below.

Net Force (F_{net}): _____

Remember that:

$$F_{net} = F_{gparall} - F_f$$

Use the equation above to determine your friction force.

Friction Force (F_f): _____

Exceeding Proficiency*: If you determine the work done by friction for the following part on your own and answer the questions that follow correctly, you will receive exceeding proficiency.*

Doing the Work

Draw a line across the ramp that is on the lowest part of the rover. Then, draw another line where that same part of the rover is much lower on the ramp. What is the displacement of the rover?

Displacement (Δx): _____

To calculate the work done by friction, please use the following equation:

$$W_f = F_f \times \Delta x$$

Please record the work done by friction below.

Work done by Friction (W_f): _____

What type of friction, static or kinetic, are you measuring for this challenge?

Which do you expect to be higher in value, the coefficient of static friction or the coefficient of kinetic friction?

Why did you answer the way you did to the previous question? Please provide an example.

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:				