**Name 1**: _____

**Name 2**: _____

**Date**: _____

**Challenge #10: Resupply Mission**

**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 **kinematics**. You will be asked to do the following:

1. Create constant acceleration program

2. Create a force diagram for the supply box

3. Determine the coefficient of friction of the supply box on the given surface

4. Determine how long it should take to move the box to the desired location, based on net force

**Programming**

To create a program that has a constant acceleration, you must increase its speed at the same rate. To do this, please use the program template below; feel free to modify the "step" size of **100** and the time between steps of **0.5**.

*for i in range(100,900, +**100**):*

*MD1.forwardMOT12(i)*

*MD2.forwardMOT34(i)*

*sleep(**0.5**)*

*MD1.stopMOT12()*

**Determining Push and Net Accelerations**

Prior to creating a force diagram for the supply box, it is important that you determine your push and net accelerations. The best way to determine the accelerations of your rover is by using Vernier Video Analysis. Make sure to get steady videos with a meter stick in front and that this is on the actual test surface. First, obtain a video **without** the supply box and then a video **with** the supply box. Fill out the corresponding sections.

**Determining Push Acceleration (No Supply Box)**

When you are analyzing the video on Vernier Video Analysis, look at your X Velocity (m/s) vs. Time (s) graph. If you need help to access this graph, please ask your teacher. Select two points that lie on a straight line and determine push acceleration. Make sure to write down:

**Initial Velocity ($v_0$)**: _____

**Final Velocity (v)**: _____

**Time (t)**: _____

**Acceleration ($a_{push}$)**: _____

**Determining Net Acceleration (With Supply Box)**

When you are analyzing the video on Vernier Video Analysis, look at your X Velocity (m/s) vs. Time (s) graph. If you need help to access this graph, please ask your teacher. Select two points that lie on a straight line and determine net acceleration. Make sure to write down:

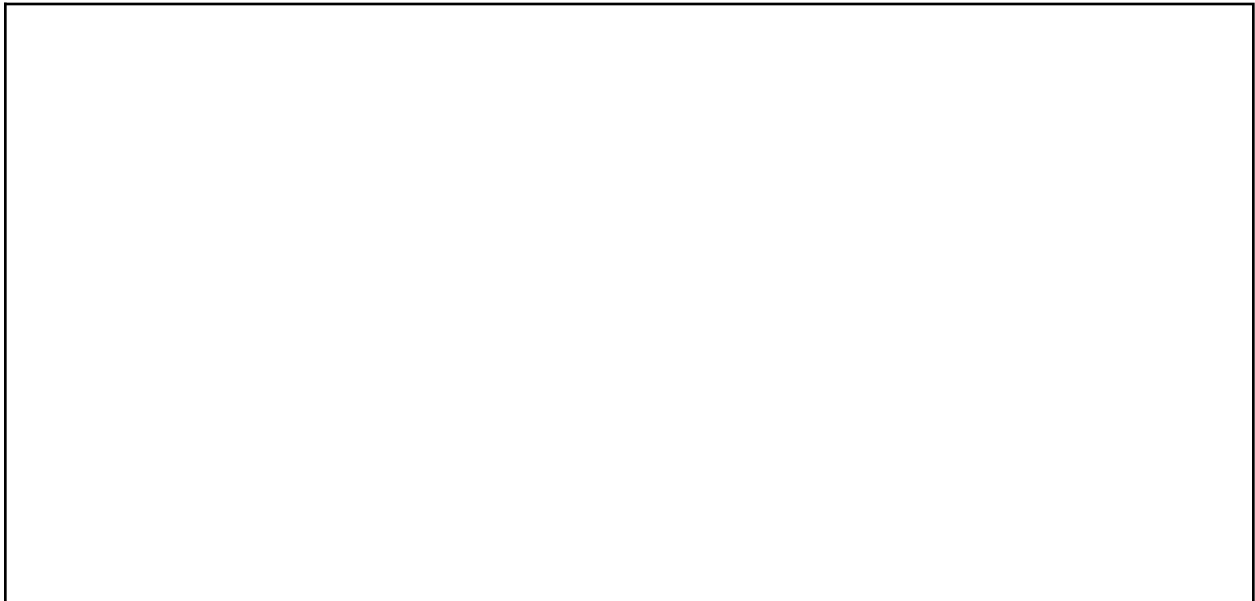**Initial Velocity ($v_0$)**: _____

**Final Velocity (v)**: _____

**Time (t)**: _____

**Acceleration ($a_{net}$)**: _____

**Force Diagram (or Free Body Diagram)**

To create a force diagram, first write down all of the forces present below.

_____

_____

_____

_____

In the space provided draw your force diagram and make sure the magnitude of the forces are relative to each other. Please also include the net force in your force diagram.

**Determining Drag or Friction Force**

You can determine the force of the push using Newton's second law (with the mass of the rover). Remember that you know the net force on the supply box as well, which means you can calculate the friction force or drag force on the supply box (**hint**: $F_{net}=F_{applied}-F_f$). Use the space below to write down your calculations and write the final value for the friction force.

**Friction Force (F$_f$)**: _____

**Coefficient of Friction (μ)**: _____

*Exceeding Proficiency: If you, additionally, determine the theoretical time to the desired*

*location on your own, and it is correct or reasonable, you will receive exceeding proficiency.*

### Theoretical Time to the Desired Location

Rewrite your calculated net acceleration from Vernier Video Analysis below . Remember

that you will be starting from rest and measure the distance from the side of the supply box

closest to the rover to the desired location and write it below.

**Acceleration (a$_{net}$)**: _____

**Initial Velocity (v$_0$)**: _____

**Distance to Desired Location (Δx)**: _____

Using a kinematic equation, determine the time you would expect for the supply box to reach the desired location. Include your work in the space below.

**Time to Desired Location (t)**: _____

**Experimental Time to Desired Location**

Now, starting from the same place, experimentally measure – four times – the time to the desired location and complete the table below.

| Trial | Time(s) |
|---|---|
|  |  |
|  |  |
|  |  |
|  |  |
| **Average Time**: |  |

How does the experimental time compare to the theoretical time from the previous section?

_____

_____

What might be some sources of error that would lead to a difference between the two times?

_____

_____

_____

_____

## 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**: | | | | |