Possible Pre Lab Questions

Read Lab 3.

1. A right triangle has a height of and a hypotenuse of . How do you calculate the angle opposite the height?

1. A right triangle has a height, , that is between and a length, , that is between
   1. What is the maximum possible angle opposite the height, ?
   2. What is the minimum possible angle opposite the height, ?
2. From Lab 2 we know that the car slows down with acceleration, , when it rolls on a level track. If the track is tilted we will calculate that a car should roll down the track **without friction** with an acceleration of . However, when we actually roll the car down the tilted track, we measure a third acceleration, . Write an equation that combines these three accelerations into a meaningful relationship.

Lab 3

Acceleration on an Incline Track

In this lab we will experimentally explore the relationship between position, velocity, and acceleration. Each group should gather all the equipment that you needed for Lab 2.

For Lab 3 we will also need:

1 wooden block to tilt the track.

1 protractor with a plum bob.

1 bubble level

1 heavy metal bar that fits into the aluminum box

If you need any other equipment please let the instructor know. Reasonable requests will be honored.

**A 10% penalty will be assessed to any group who does not return all supplies neatly at the end of the lab period.**

**Calculate the acceleration on an incline track.**

We know from experience that a car that is on a hill or incline has a tendency to accelerate down the hill. We would like to theoretically determine how large this acceleration is and verify our theory with experimentation.

**Set Up**

Level the track using the bubble level. If the track is warped, you will need to do the best that you can and then mention the warp to the instructor and in your procedure.

Place the wooden block under the track’s leg so that it is no longer level. This should provide a sufficient angle to the track that the car noticeably speeds up as it travels down the track.

Follow the steps of Lab 2 to set up the photogates and picket fence on the car.

Make sure you obey the two rules of lab work:

**1) Measure Everything! (Don’t forget the thickness of wooden block and the distance between the where the track is touching the table and where the track is touching the block.)**

**2) Every measurement and result has an uncertainty. Make sure you take advantage and report it!**

Make sure that you run enough trials, and take enough data to answer all the questions.

You will need to take data with the track tilted at an angle large enough for the car to accelerate from rest.

**Part 1 - Angles**

1. Measure the tilt of your track using the protractor with the plum bob. Make sure you estimate the uncertainty in your measurement. Let’s call this measurement . Note, we are measuring how much the track has tilted, so you might need to take a **difference** between a flat track and a tilted track. Your answer must be less than .
2. **Find the triangle and use a trig function.**

A horizontal track like the one shown below in figure 1 has a block of height “H” placed under the legs, which are a distance L apart, on one side so it is tilted at an angle, , like figure 2. We can use the relationship

To solve for :

L

Sloping table

Level track

H

Block

Sloping table

Figure 2

Figure 1

1. Let’s find the uncertainty of . It is pretty clear that if H is large and L is small, than is large. So if we use our equation from 2) to calculate using (H+H) for the height AND (L-L) for the length. Similarly, we can calculate using (H-H) and (L+L). Now we can estimate and
2. It should be pretty clear that and should be the same because they both measure the same thing. However, they are probably not equal, and they probably have very different uncertainties. **How are you going to deal with this?** Simplify these two values for the angle into one value and report it in your procedure & conclusion.

**Part 2- Accelerations**

1. Hit Collect in Logger Pro, **release the car from rest**, take four time measurements at two different locations on the track with photogates.
2. On Blackborad/Canvas you should have an Excel file titled “Lab 3 Template”. Copy the data from Logger Pro into the appropriate boxes in the Excel file. You will need to record all your measurements in this file. Use Excel formulas to conduct all your calculations. Your Lab 2 materials should help significantly with this.
3. Using the Excel file determine both the acceleration and the absolute uncertainty in the acceleration. Call this value . You may use either the Distance or the Time method for calculating acceleration (you do not need to do both).
4. Repeat 5) keeping everything the same, however do not release the car from rest. Give the car a gentle push**, but make sure you are not touching the car when it enters the photogate.** You can copy all the cells in Excel that you have already used, move down the page and paste where it says Trial 2. Then copy over the new times from the Logger Pro and you should immediately get your acceleration. Call this .
5. Is there a significant difference between and ? Justify your answer in the conclusion portion of your Lab report. What does this say about the importance of the initial velocity for our later experiments?
6. Repeat 5) with an extra bars of mass in the car. Call this .
7. Is there a significant difference between and ? Justify your answer in the conclusion portion of your Lab report. What does this say about the importance of the mass in these experiments?
8. To wrap up our experimental section of this lab, let’s average together all the values for **which are not significantly different** and call this new averaged value . This should be reported in your Intro and Conclusion sections.
9. **Find the hidden triangle and use a trig function. (Cells J12 through N15)**

We know gravity pulls down all objects straight down with a magnitude of as in Figure 3. Because the track prevents the car from going straight down we will **decompose** the acceleration into a component that are perpendicular to the track, , and a component that is parallel to the track, as shown in Figure 4.

Figure 3

Figure 4

1. The angle between and is that same as from Figure 2. In the Procedure section, draw a picture showing the track, , , and to argue that the angle between the track and horizontal is the same as the angle between and .
2. Now that we have the magnitude of and the angles in the triangle, we can calculate the magnitude of .
3. We need to know how the uncertainty of , becomes an uncertainty in , . However, isn’t multiplied or raised to a power, it is in a trigonometry function. So we are going to repeat the procedure we used in step 3. Recalculate but this time plug in instead of , and call the result . Again recalculate but this time plug in instead of , and call the result . Now .
4. In your Conclusion section, compare with . **Make sure you comment on whether there is an overlap in the absolute uncertainties.**
5. Even if we had overlap in our uncertainties, we know that our calculation of did not include the fact that a car on a level track will slow down. **Is there any way to add the results from Lab 2 to improve our comparison between and ? If so make sure you also include this in your conclusion.**