# PHYS 111 s01 F23 Exam 2 Activity (25 points)

Inclined plane study

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**Goal and Equipment:** The goal of this activity is to measure the angle and accelerations of a cart on an inclined plane and to compare it with theory. A track is tilted by a piece of a 2x4 wooden board, and the angle is measured by three different methods, two using Phyphox and another with length measurements and trigonometry. After determining the angle of the track, accelerations down the track are calculated and measured with a Vernier Rotary Sensor and calculated and measured values are compared. As such this activity is divided into two parts: Angle measurement, and Acceleration calculation and measurement. A keyboard on a wooden surface

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## Angle measurement:

Method 1 – Length measurement (3 points)

Inclined plane with angle, height, and length along inclined labeled.

Description automatically generatedPlace the section of the 2”x4” board so that the 4” dimension is under the track somewhere between 70 cm mark and 100 cm mark forming an inclined plane. The angle will depend on the placement of the board so note your choice of distance here:

Board touching track at 90 cm

The 4” dimension of the 2”x4” is actually 3.5 inches or 8.7 cm.

Use trigonometry to calculate the angle. Show your method.

A smartphone with arrows pointing to a graph

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We practiced this in class. Place your phone (or device) is on the track with the top facing up. This should be the “portrait” orientation. Start Phyphox and under the category “Raw Sensors” go to the “**Acceleration with g**” experiment. Go to “**Multi**” and start data collection by pressing the triangle at the top right in the orange band. Your X acceleration should be very small and only Y and Z components of acceleration should be significant. Once the graphs have stabilized stop the data collection and record the following data.

Accelerometer X = -0.05 m/s2

Accelerometer Y = 1 m/s2

Accelerometer Z = 9.84m/s2

Absolute acceleration = 9.89 m/s2

Calculate: = 9.8

Calculate: Tilt angle:

Method 3 – Inclination from Phyphox (2 points)

With your phone still on the tilted ramp, go to the “**Tools**” category near the bottom of the list and start **“Inclination”** in the **“Flat”** mode. Give this a few seconds to stabilize and then **stop** the data collection. From this screen you should be able to find the two tilt angles to report below.

Tilt up/down = 5.83

Tilt left/right = -0.15°

Comparison and average: (4 points)

At this point you should have three measurements of the tilt angle. Copy them just below and find the average. We will use the average for the calculation of the acceleration.

|  |  |
| --- | --- |
|  | 5.5 |
|  | 5.25 |
|  | 5.83 |
|  | 5.52 |

## Calculation of Accelerations

Simple Formula

As was discussed in class on Monday, Oct. 2, 2023, the acceleration should be approximated by:

Calculation 1 – empty cart (3 points)

Weigh your cart to find ;

254 g

Use this value to calculate the expected acceleration if . Be sure to show your work.

(254sin(5.52)-10) / (254-10)\*9.8 = 0.57 m/s^2

Calculation 2 – cart with 250 g (2 points)

Use the previous value of value of but add 250 g to it and again calculate the expected acceleration if . Be sure to show your work.

a =( 504sin5.52-10) / (504-10)\*9.8 = 0.57 m/s^2

## Measuremet of accelerations (5 points)

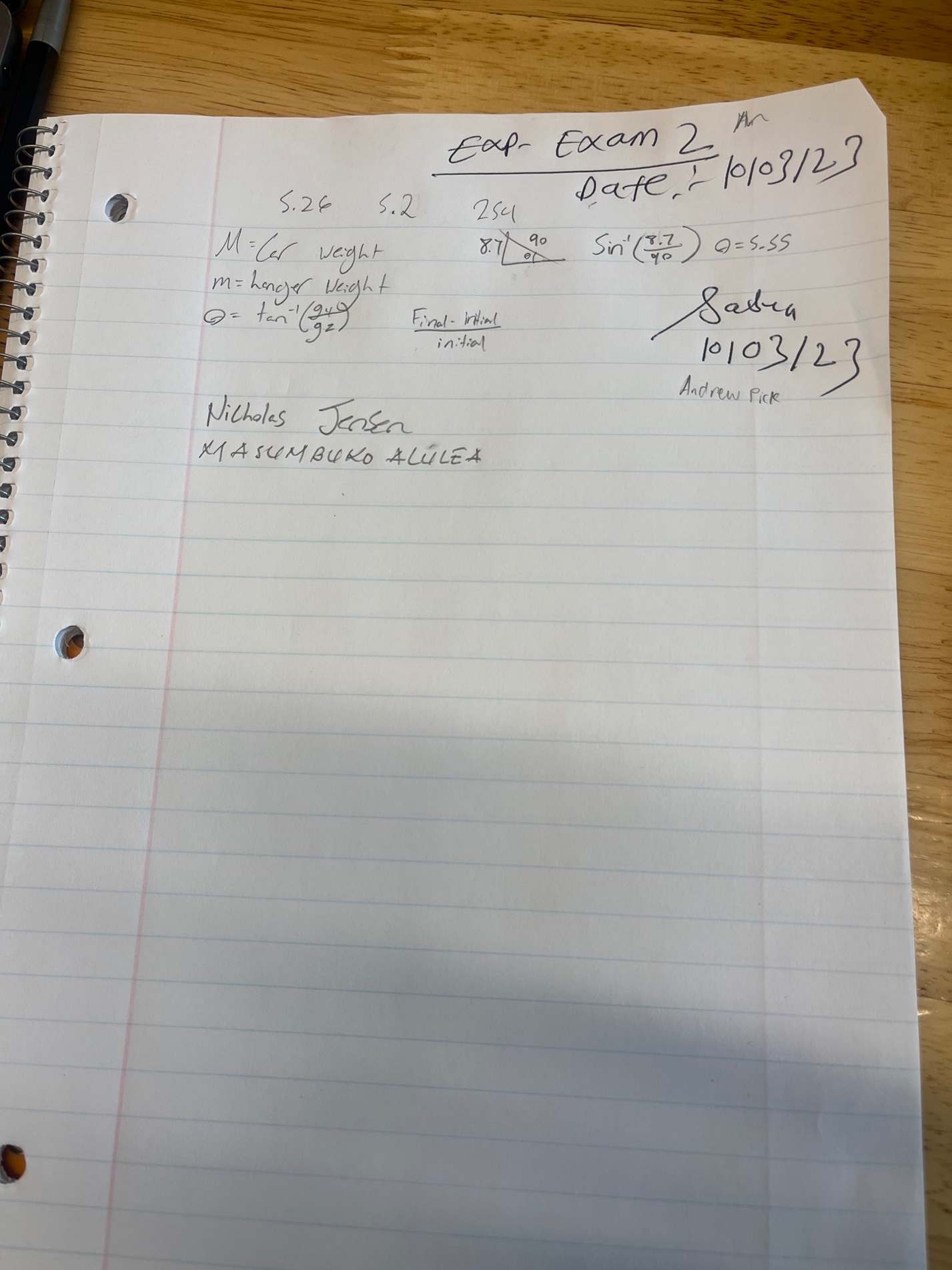
Use the Vernier Rotary Motion Sensors to measure the acceleration of the carts as they roll from the top of the inclined track to the bottom. You may have to connect the LabPro to Logger Pro, select Rotary Motion Sensor, and select “mm” setting.

To measure the acceleration, do a **linear curve fit** to the **Velocity vs. time** graph and report the slope. Be sure to always use the biggest wheel of the pulley. Report your measurements below and compare with your calculations. Report your results in . The percentage difference is the difference divided by the average.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Measured | Calculated | Difference | % Difference |
|  | 683.4 mm/s | 570 | 113.4 | 18.09% |
|  | 911.9 | 760 | `151.9 | 18.16% |

A graph showing a graph

Description automatically generatedCaution: Pick only the data for the time when the cart is rolling down the ramp. The shaded region is appropriate for a curve fit in the plot on the right. The slope there is the acceleration.



A screenshot of a device

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A screenshot of a graph

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