

Investigation 1: Argumentation

Guiding Question: Does a ball rolling on an incline have the same acceleration on the way up as it does on the way down?

Presented by Group 17

Procedure

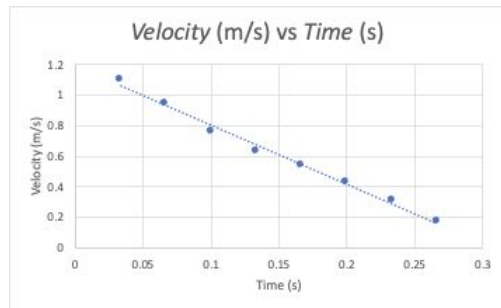
- Our reference object was a canvas, and its length was 0.33 meters measured by a tape measure
- The angle of the incline was measured by a protractor
 - Two angles were tested: 35° and 50°
- We would roll the ball up and then let it roll down the incline on its own at two different angles, and we used a smartphone to record the motion perpendicularly making sure the entire reference object is in the video
 - The ball and reference object were the same distance away from the camera
 - Two trials were performed to reduce error/uncertainties
- The videos were uploaded to the software Tracker. The data collect by Tracker included the positions (m) of the ball rolling up and down the incline over time
- The x (m) vs. t (s) data was transferred to excel
 - The velocities of each position and time were calculated using the formula:

$$v_i = \frac{x_{i+1} - x_{i-1}}{t_{i+1} - t_{i-1}} = \frac{x_{i+1} - x_{i-1}}{2\Delta t_{\text{frame}}}$$

- Both x (m) vs. t (s) points and v (m/s) vs. t (s) points were plotted (Scatterplot)
 - A line of best fit was made for the v (m/s) vs. t (s) graph
 - A linear regression was carried out for the v (m/s) vs. t (s) data
 - Calculated the acceleration of each v (m/s) vs. t (s) data set using the slope of the data
 - Determined the uncertainties and units of the initial velocities and accelerations
 - Determine the R^2 value of each v (m/s) vs. t (s) graph
- Analyze the data by comparing the results between the two angles

Results (V_0 = initial velocity; a = acceleration; R^2 = R-squared value)

Going up an incline with a 35° angle

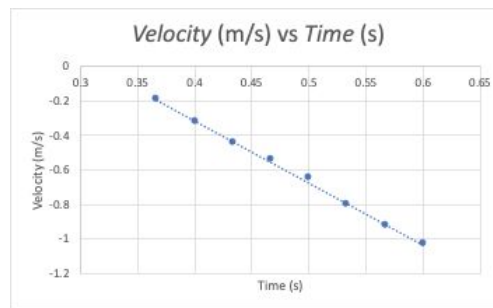


$$V_0 = 1.19 \pm 0.02 \text{ m/s}$$

$$a = -3.9 \pm 0.1 \text{ m/s}^2$$

$$R^2 = 0.992$$

Going down an incline with a 35° angle

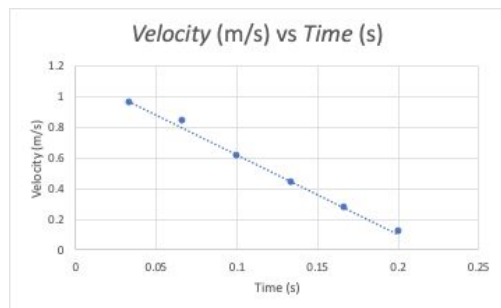


$$V_0 = 1.12 \pm 0.03 \text{ m/s}$$

$$a = -3.59 \pm 0.07 \text{ m/s}^2$$

$$R^2 = 0.998$$

Going up an incline with a 50° angle

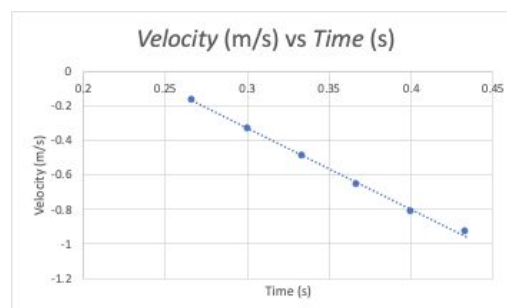


$$V_0 = 1.15 \pm 0.02 \text{ m/s}$$

$$a = -5.2 \pm 0.2 \text{ m/s}^2$$

$$R^2 = 0.996$$

Going down an incline with a 50° angle



$$V_0 = 1.07 \pm 0.04 \text{ m/s}$$

$$a = -4.7 \pm 0.1 \text{ m/s}^2$$

$$R^2 = 0.997$$

Argument

Guiding Question: Does a ball rolling on an incline have the same acceleration on the way up as it does on the way down?

No, a ball rolling on an incline does *not* have the same acceleration on the way up as it does on the way down. The accelerations of the ball going up and down the incline were not statistically the same, given that even with the standard errors, the values of acceleration did not overlap; therefore, the accelerations were considered to be distinguishable. This conclusion was applied for both angles of incline. For example, the acceleration of the ball going up an incline with a 50° angle is $-5.2 \pm 0.2 \text{ m/s}^2$, which means the acceleration can deviate from -5.0 m/s^2 to -5.4 m/s^2 , and the acceleration of the ball going down the same incline and angle is $-4.7 \pm 0.1 \text{ m/s}^2$ which is the same as -4.6 m/s^2 to -4.8 m/s^2 . As shown, even though the values are close to each other, they do not overlap and are not the same.