Lab: Acceleration on an Inclined Plane

Analysis

The objective of this analysis was to determine the experimental acceleration of a cart on an inclined plane and compare it to the theoretical value.

<u>Data and Graphing</u>

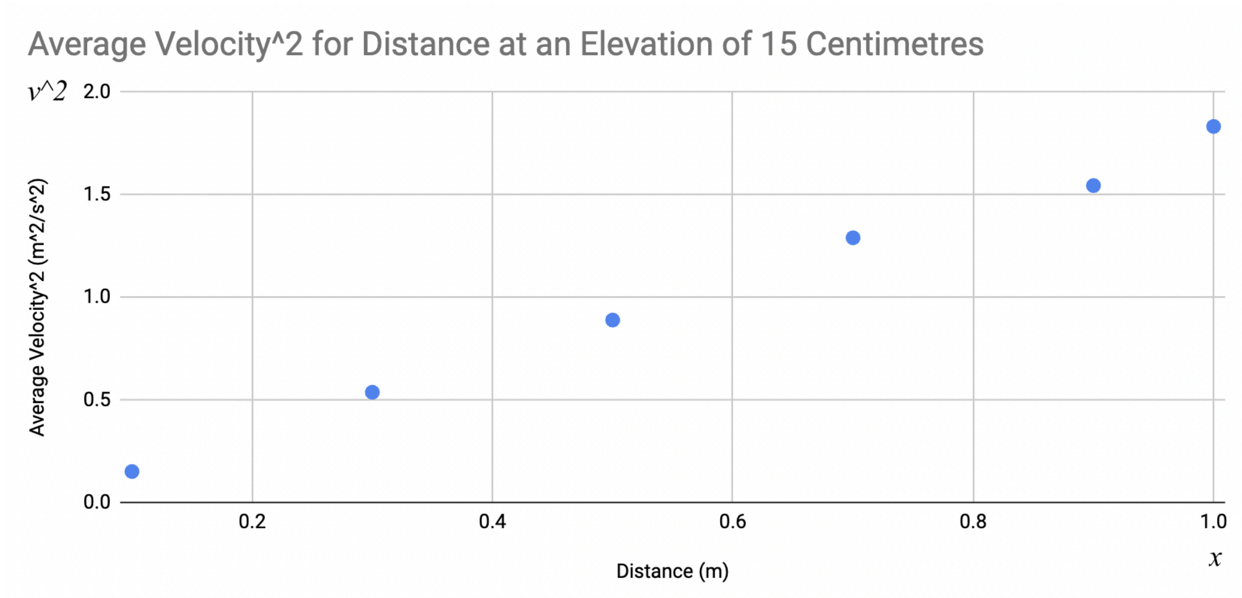
1) After collecting data on average velocities of the cart at various distances for incline heights of 3 books (15 cm) and 4 books (20 cm), two separate graphs were created (utilising Google Sheets) comparing velocity^2 (*v*^2) in m^2/s^2 to distance travelled by the cart (x) in metres.

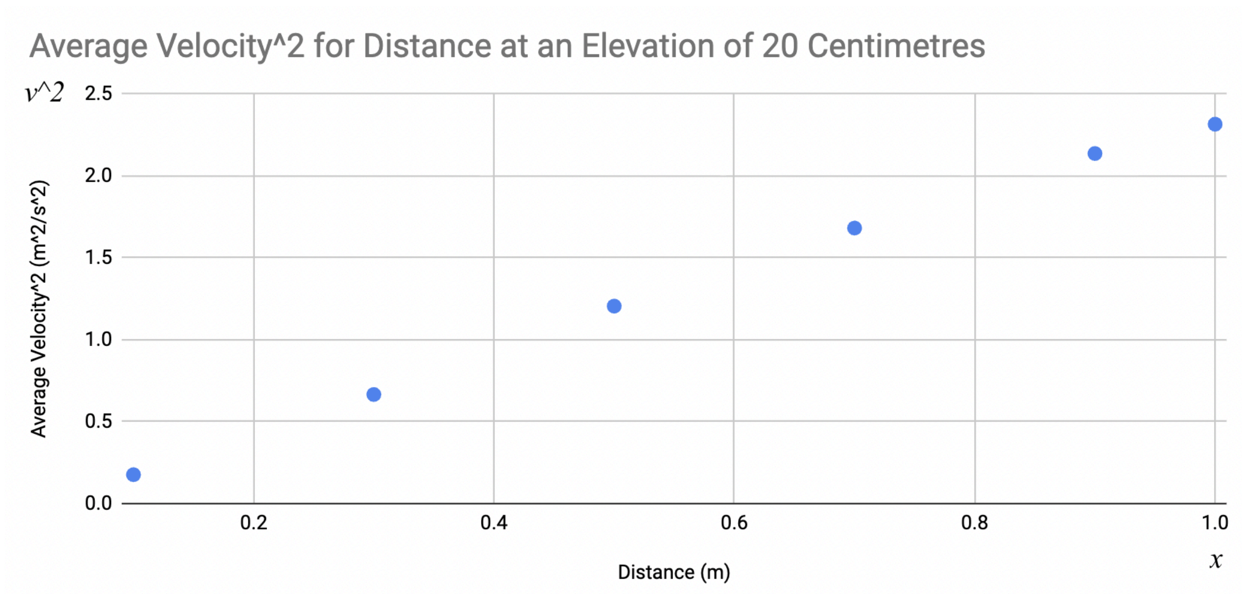
    a. As the objective of this lab was to find the acceleration of the cart, the relationship between the average velocity and distance variables could be expressed using the following constant acceleration equation:
    v^2 = (*v0*)^2 + 2*a*(delta*x*)

    b. However, the initial velocity in this scenario would be 0 m/s, so (*v0*)^2 can be omitted. Thus, the equation to be used which represents the relationship between average velocity and distance is as following:
    v^2 = 2*a*(delta*x*)

    c. In the context of the graphs, the above equation represents a linear relationship between the average velocity and distance travelled. This means that v^2 represents the values on the vertical axis, while change in x – essentially being x – represents the values on the horizontal axis, and 2*a* would be the slope of each graph.

2) To determine the data points on the graph, the average velocity values corresponding to each distance value for the horizontal axis were squared, the resulting values being placed on the vertical axis. Likewise, the distance values were placed on the horizontal axis.





<u>Acceleration Values</u>

3) Using the Google Sheets tools, line of best fit equations were obtained for the first and second graphs respectively:

   Incline 1:
   $v = 1.82(\text{delta}x) - 0.0182$

   Incline 2:
   $v = 2.41(\text{delta}x) - 0.0398$

4) The slope of the best fit lines whose equations were found above can be set to $2a$ (as described in step 2c), allowing for acceleration to be solved for in both cases:

   Incline 1:
   $2a = 1.82$
   $a = 0.91$

   Incline 2:
   $2a = 2.41$
   $a = 1.205$

Therefore, the experimental accelerations for the cart at the two incline heights are 0.91 m/s^2 and 1.205 m/s^2 respectively.

Conclusion

<u>The accelerations of a cart travelling on an inclined plane with height of 15 centimetres and 20 centimetres are 0.91 m/s^2 and 1.205 m/s^2 respectively.</u>

<u>Theoretical Accelerations</u>

5) Additionally, the theoretical or expected acceleration value could also be found based on the formula given in the background information section of the problem: g*sin(theta) .

   a. As g essentially represents the magnitude of the acceleration due to gravity, it can be replaced by the value 9.8 (m/s^2):

      a = 9.8sin(theta)

   b. As theta is the angle that the incline plane makes with the horizontal, sin(theta) could be found for both incline heights based on their respective height measures:

      Incline 1:
      sin(theta) = 15cm/100cm = 0.15

      Incline 2:
      sin(theta) = 20cm/100cm = 0.20

6) The values for sin(theta) in the previous step can now be substituted into their respective equations to solve for the theoretical accelerations:

   Incline 1:
   a = 9.8 * 0.15 = 1.47

   Incline 2:
   a = 9.8 * 0.20 = 1.96

Therefore, the theoretical accelerations for the cart at the two incline heights are 1.47 m/s^2 and 1.96 m/s^2 respectively.

The experimental accelerations seem to be somewhat far from their corresponding theoretical acceleration values.

Percent Error

Percent Error of Acceleration for Incline 1: 38%
Percent Error of Acceleration for Incline 2: 39%

Sources of Error

The primary source of error is friction between the cart's wheels and the track. This force opposes the motion and reduces the cart's acceleration, causing the experimental value to be lower than the expected value.
Old, uneven, or a dirty track could also contribute to inconsistencies in the data.

Measurement accuracies during experimentation is another possible source of error. The provided distances are measured to the tenths place, and any slight deviation in the photogate sensor's placement could introduce error.

Such sources of error that have been mentioned may have been significant, as the percent error values that were calculated were considerably large.