

Measuring Velocity and Acceleration of an Object Rolling Down an Inclined Plane

Part 1: Acceleration

1. Elevate your ramp so that you have an inclined plane—you will either elevate your ramp with two physics books or four physics books. Use tape to mark even increments of distance on your ramp. Place a piece of tape at the following locations: 0cm, 20cm, 40cm, 60cm, and 100cm.
2. Set your photogate to *pulse*.
3. Place the first photogate at 0cm, and the second photogate at 20cm.
4. Release the ball and measure the time it takes the ball to travel from 0cm to 20cm—record in your data table.
5. Repeat step 5 two more times; you will take the average of these readings.
6. Repeat steps 4-5 with the photogates at the following locations:
 - a. 0cm and 40cm
 - b. 0cm and 60cm
 - c. 0cm and 80cm
 - d. 0cm and 100cm
7. Find another group who used a different angle and share your data.

Data Table 1 – Reproduce in your journal!!

		Time (seconds)			
Angle		Trial 1	Trial 2	Trial 3	Average
2 books	0-20cm				
	0-40cm				
	0-60cm				
	0-80cm				
	0-100cm				

4 books	0-20cm				
	0-40cm				
	0-60cm				
	0-80cm				
	0-100cm				

Graph 1

Plot a graph of position vs. time for the ball at the angle you used. At zero seconds, the position is 0 meters—be sure to plot (0,0) on your graph. For each row, use the position at the end of the increment as the x-coordinate and the average time as the y-coordinate.

Type your names on the graph and send it to the printer.

Questions (Answer in your journal)

1. What is acceleration?
2. Does the ball accelerate down the ramp? Cite evidence to defend your answer
3. What happens to the velocity if the angle of the ramp is increased? Cite evidence to defend your answer.
4. What is velocity?
5. Calculate the average velocity of the ball rolling down the ramp with 2 books. Show your work. [average velocity = total displacement/total time]
6. Calculate the average velocity of the ball rolling down the ramp with 4 books. Show your work.
7. Why can the average velocities calculated in steps 5 and 6 be misleading if you are interested in finding the velocity of the ball at a certain point (instantaneous velocity) along the ramp?
8. Calculate the slope of the tangent line to the position-time graph at the following points: 0cm, 20cm, 40cm, 60cm, 80cm, 100cm. Be sure to follow the slope with the correct units.

Part 2: Instantaneous Velocity

1. Remove the accessory photogate, and set your base photogate to *gate*.
2. Place the gate at 20cm.
3. Release the ball from 0cm and let it pass through the photogate.
4. The time on the photogate reflects the time the ball took to roll through the photogate.
5. Repeat steps 2-4 two times; record all data in Data Table 2.
6. Repeat steps 2-5 for the following points: 40cm, 60cm, 80cm, and 100cm.
7. Use a ruler to measure the diameter of your ball; record this measurement in *meters*—how might this piece of information be used to help you calculate instantaneous velocity?
8. Use only your data for the analysis; you will not need to share data for this portion of the lab.

Data Table 2 – Reproduce in your journal!!

Position (m)	Time (s)				Instantaneous Velocity (m/s)
	Trial 1	Trial 2	Trial 3	Average	
0					0
20					
40					
60					
80					
100					

Graph 2

Plot a graph of velocity vs. time for the ball at the angle you used.

Questions

1. How does the instantaneous velocity at each position compare to the slopes of the tangent lines for these positions on the position-time graph?
2. Based on this data, is the ball accelerating? Cite evidence to defend your answer.
3. Calculate the average acceleration of the ball as it rolled down the ramp.
4. Calculate the slope of the velocity vs. time graph

Part 3: Calculating Acceleration

Using the formula $a = \Delta v / \Delta t$ [$a = (v_f - v_i) / (t_f - t_i)$], calculate the acceleration of the ball at each interval. Fill in the table below **in your journal** to help you accomplish this.

Interval	Final Velocity (m/s)	Initial Velocity (m/s)	Final Time (s)	Initial Time (s)	Acceleration (m/s²)
0cm - 20cm					
20cm - 40cm					
40cm - 60cm					
60cm - 80cm					
80cm - 100cm					

Questions

1. Is the acceleration of the ball constant?
2. How does the acceleration of the ball compare to the average acceleration calculated in the previous section?
3. How does the acceleration of the ball compare to the slope of your velocity-time graph?
4. Is it possible to have a constant acceleration and a changing velocity?
5. What is the only situation in which both acceleration and velocity remain constant?