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Rolling Along — Lab 1.2

Purpose

The purpose investigate and compare accelerated and non-accelerated motion.

Required Equipment

- Meter stick or meter tape
- Masking tape
- Timer

Discussion

Galileo recognized that an object dropped from rest accelerated at such a high rate that it becomes difficult to time and study. Galileo also understood that if he used an incline plane (a ramp) he could decrease the rate of the acceleration and make it easier to time and study the motion of an object; the less step an incline, the smaller the acceleration. In this activity you duplicate Galileo's famous motion experiment by timing an object released from various positions along an incline plane. You will record, graph, and compare the motion of an object that has changing velocity and one that is traveling at constant velocity in order to understand the difference between accelerated and non-accelerated motion. This experiment will require students to make many timing measurements using a stopwatch or, if available, a computer. If you use a stop- watch, develop good timing techniques so as to minimize errors due to reaction times.

The Setup (part A: accelerated motion)

1. Setup a ramp as instructed so that it sits with a 10 degree angle.
2. If not already done, mark the following starting positions on your track using tape or pencil: 0.3-m, 0.6-m, 0.9-m, 1.2-m, 1.5-m, and 1.8-m.
3. Use either a stopwatch or a photogate to measure the time it takes the object to travel down the ramp from each of the six points. If you are using a stopwatch, select someone in your group to be the timer. This person must also be the same person releasing your object from the directed starting point in order to eliminate error. Do several practice runs in order to minimize error.

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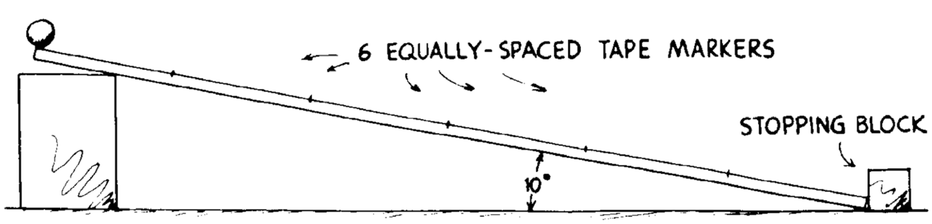

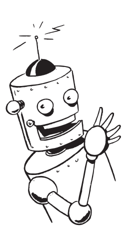

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4. Place your object on the track at the first release point. Release the object and make at least three timings from each position, and record each time and calculate the average of the three times in **Data Table A**.
5. Repeat until you have timed your object three times at each starting position on the track

Data Table A

Distance (m)	Time (s)				Start-Velocity (m/s)	Final Velocity (m/s)	Acceleration (m/s/s)
	trial #1	trial #2	trial #3	Ave Time			
0.3 m					0 m/s		
0.6 m					0 m/s		
0.9 m					0 m/s		
1.2 m					0 m/s		
1.5 m					0 m/s		
1.8 m					0 m/s		
						Ave Acceleration	

Calculating Final Velocity (part A)

6. Calculate the final velocity (v_f) of your object for each distance and record in **Data Table A**. The starting velocity for all distances will be 0 m/s.

$$\Delta d = \frac{(v_o + v_f)}{2}\Delta t \longrightarrow v_f = \left(\frac{2d}{t}\right) - v_o \longrightarrow \boxed{v_f = \frac{2d}{t_{ave}}}$$

Calculating Acceleration (part A)

7. Calculate the average acceleration $(\bar{a})$ for each trial distance and record in **Data Table A**. The starting velocity (v_o) for all distances will be 0 m/s.

$$\bar{a} = \frac{\Delta v}{\Delta t} \longrightarrow \bar{a} = \frac{v_f - v_o}{t} \longrightarrow \boxed{\bar{a} = \frac{v_f}{t_{ave}}}$$

8. Find the average acceleration $(\bar{a})$ for all trials and record in **Data Table A**.

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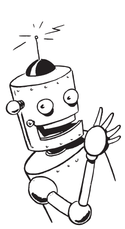

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The Setup (part B: non-accelerated motion)

In this part of the experiment you will be timing the motion of your object as it travels along a level track. Setup a your ramp as demonstrated by your instructor so that it sits level.

9. Instead of releasing your object from rest, your object will be given a push and therefor your object will start it's travel with some initial velocity (v_o).

10. Obtain a launch setup from your instructor and attach as instructed.

11. If not already done, mark the following starting positions on your track using tape or pencil: 0.3-m, 0.6-m, 0.9-m, 1.2-m, 1.5-m, and 1.8-m.

Finding the Starting Velocity (part B)

12. Since your object will be starting with some initial velocity (v_o), you will need to calculate what that starting velocity (v_o) is for your object.

13. Release your object form the launch setup as demonstrated by your instructor and record the time between photogates in the **Data Table B**.

Data Table B

Distance (m)	Time (s)				start-velocity (m/s)
	trial #1	trial #2	trial #3	Ave Time	
0.1 m					

14. Calculate the average time for the three trials and record in **Data Table B.**

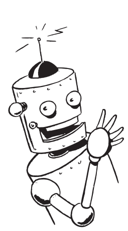
15. Using the formula for average velocity, calculate the starting velocity (v_o) of your cart and record in **Data Table B**.

$$v = \frac{d}{t_{ave}}$$

Show your work:

Starting Velocity (v_o): ______________

16. The starting velocity (v_o)from **Data Table B** will be the same for every trial in **Data Table C** of this lab. Take the starting velocity (v_o)from **Data Table B** and record this value in the column under Starting-Velocity (v_o) in **Data Table C** .



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Timing the Object (part B)

17. Place your object on the track at the launch point. Release the object and make at least three timings over each distance, and record each time and calculate the average of the three times in **Data Table C**.

18. Repeat until you have timed your object three times over each distance on the track.

Data Table C

Distance (m)	Time (s)				Start-Velocity (m/s)	Final Velocity (m/s)	Acceleration (m/s/s)
	trial #1	trial #2	trial #3	Ave Time			
0.3 m							
0.6 m							
0.9 m							
1.2 m							
1.5 m							
1.8 m							
						Ave Acceleration	

Complete the Data Table (part B)

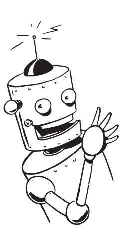
19. The starting velocity (v_o)from **Data Table B** will be the same for every trial in **Data Table C** of this lab. Take the starting velocity (v_o) from **Data Table B** and record this value in the column under Starting-Velocity (v_o) in **Data Table C** .

20. Calculate the final velocity (v_f) for each distance and record in **Data Table C.**

$$\Delta d = \frac{(v_o + v_f)}{2}\Delta t \longrightarrow \boxed{v_f = \left(\frac{2d}{t_{ave}}\right) - v_o}$$

21. Calculate the average acceleration for each trial distance and record in **Data Table C**.

$$\overline{a} = \frac{\Delta v}{\Delta t} \longrightarrow \boxed{\overline{a} = \frac{v_f - v_o}{t_{ave}}}$$



22. Find the average acceleration (a) for all trials and record in **Data Table C**.

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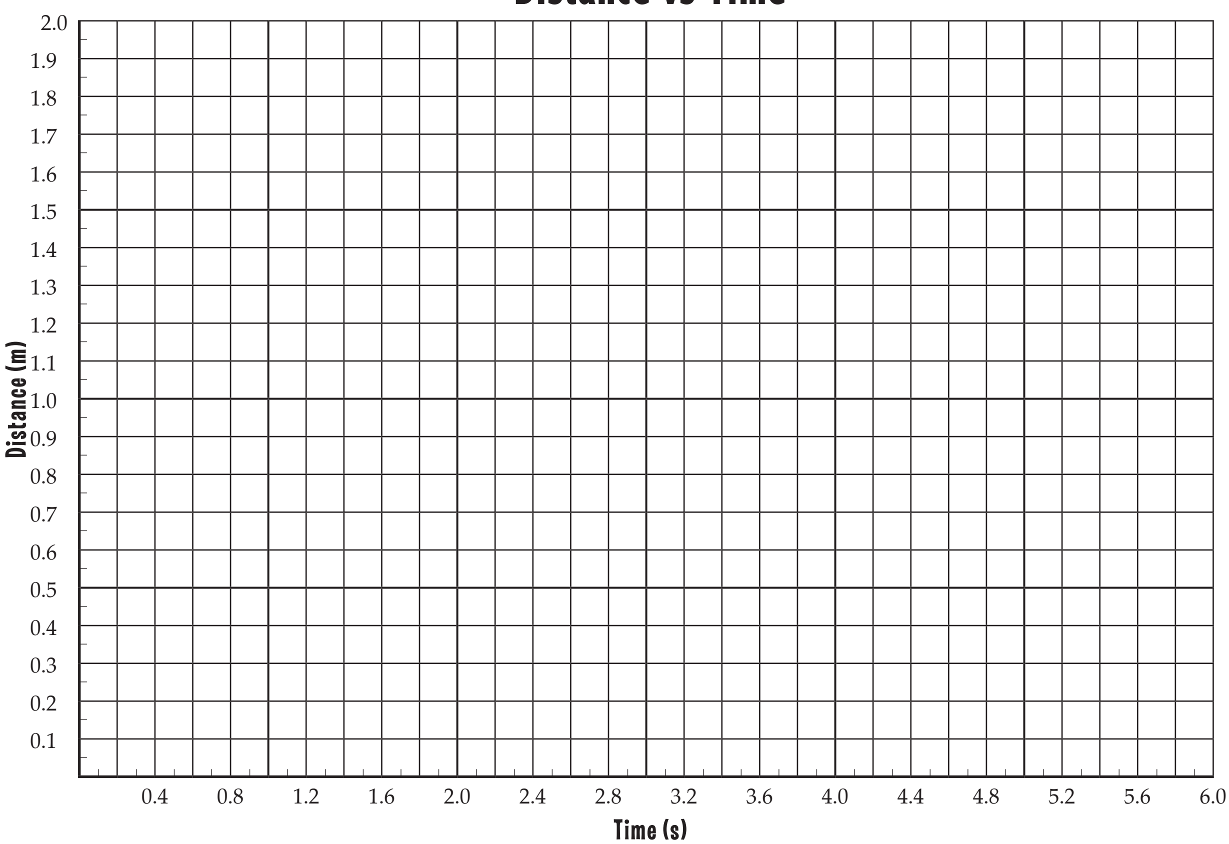
Graph The Results

23. Using the data from **Data Table A** and **Data Table C** plot the following on the correct graphs: distance vs. time, final velocity vs. time, and acceleration vs. time.

24. Look at each graph to see if the data forms a straight line or curved line then draw a best fit line on each. Do not make a connect-the-dot line. Your best fit line should be smooth and may not actually touch any of the points but the line will show the general shape of the data.

25. Use colored pencils or some other way to keep track of data point from **Data Table A** and **Data Table C**. Label all best fit lines as **Table A** and **Table C**.

Distance vs Time



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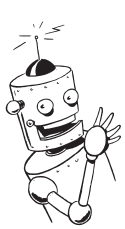

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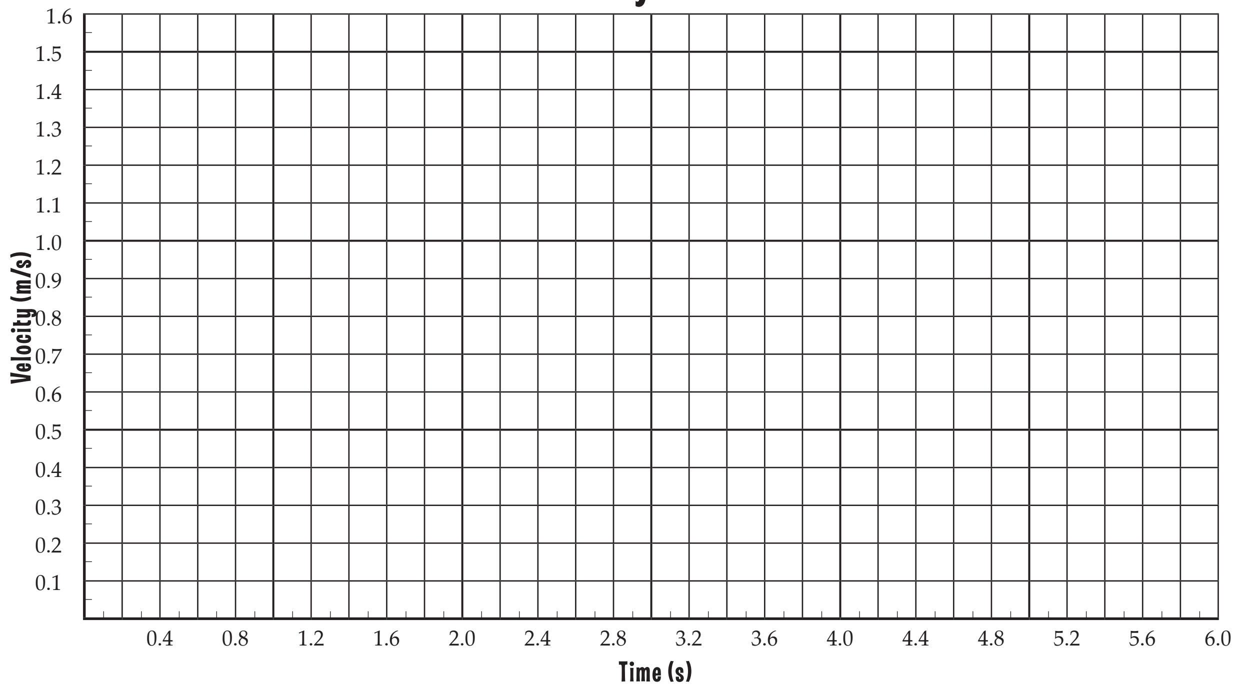
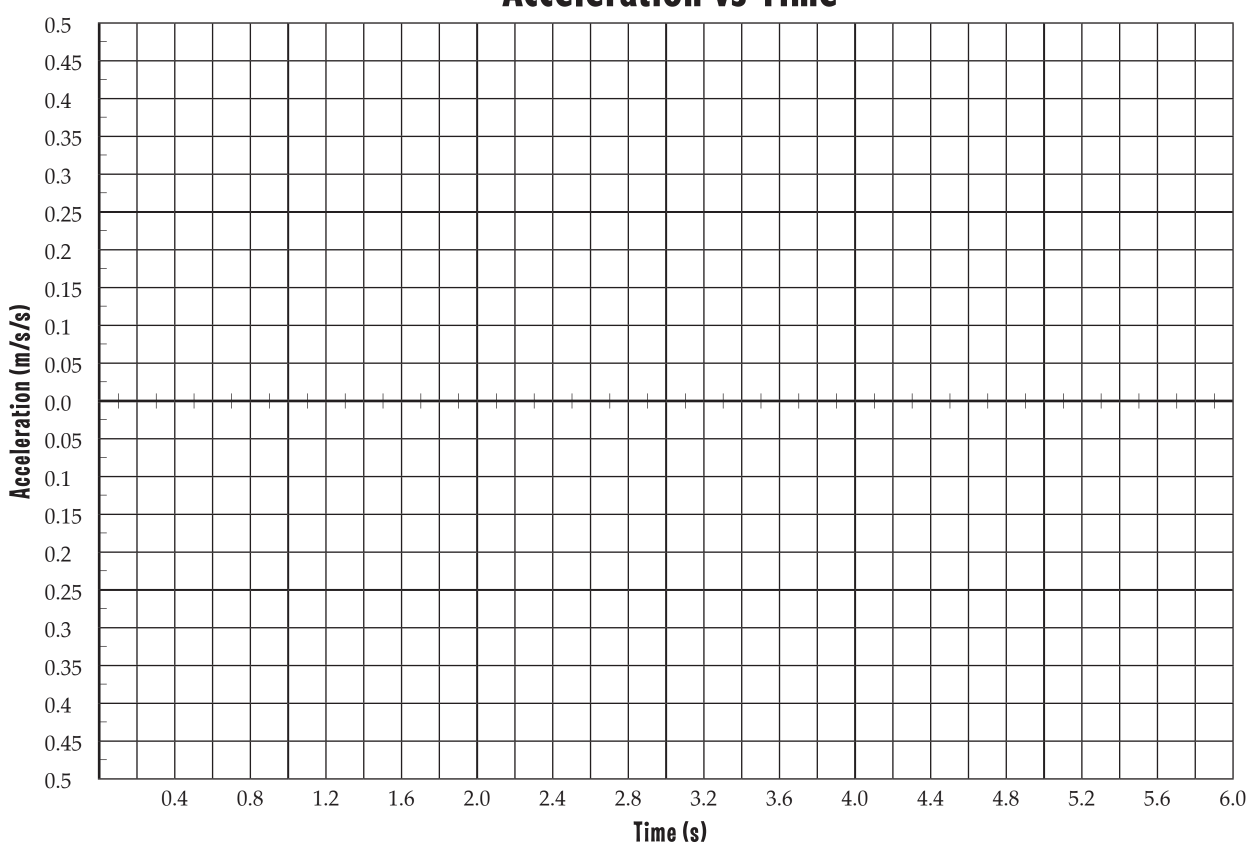
Velocity vs Time



Acceleration vs Time



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