# Kinematics Lab from Carolina Kits

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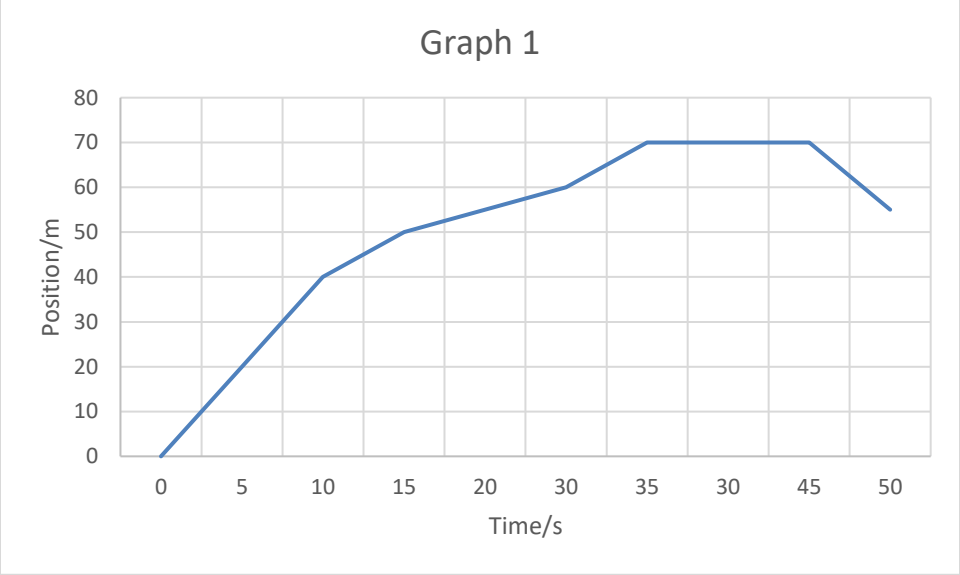
**Activity 1: Graph and interpret motion data of a moving object**

**Activity 1. Table 1**

| Time (x axis) (seconds) | Position (y axis) (meters) |
|---|---|
| 0 | 0 |
| 5 | 20 |
| 10 | 40 |
| 15 | 50 |
| 20 | 55 |
| 30 | 60 |
| 35 | 70 |
| 40 | 70 |
| 45 | 70 |
| 50 | 55 |

Insert your graph here for Distance vs Time of a Moving Object.




**Questions for Activity 1**

Question 1:

What is the average speed of the train during the time interval from 0 s to 10 s?

$(40 - 0) \div (10 - 0) = 4 \frac{m}{s}$

Question 2:

Using the equation: $v = \frac{s2-s1}{t2-t1}$, calculate the average speed of the train as it moves from position x = 50m to x = 60m.

$$v = \frac{s2 - s1}{t2 - t1} \rightarrow \frac{60m - 50m}{30 - 15} = .67\ \frac{m}{s}$$

Question 3:

What does the slope of the line during each time interval represent?

Velocity

Question 4:

From time t = 35 s until t = 45 s, the train is located at the same position. What is slope of the line while the train is stationary?

0

Question 5:

Calculate the average speed of the train as it moves from position x = 70m to x = 55m.

$$\frac{55m - 70m}{50s - 45s} = -3\ \frac{m}{s}$$

What does the sign of the average velocity during this time interval represent?

Direction

Question 6:

What is the displacement of the train from time t = 0s until t = 50s?

55m

Question 7:

What is the total distance traveled by the train from time t = 0s until t = 50s?

85m

Question 8. What is the slope of the line during the time interval t = 45 to t = 50?

$$\frac{55m - 70m}{50s - 45s} = -3\ \frac{m}{s}$$

Question 9: What does the sign of the slope in question 8 represent in terms of the motion of the train?

Motion is the negative direction

Question 10: What is the average velocity of the train during the interval t= 0s to t = 50s?

$$\frac{55m - 0m}{50s - 0s} = 1.1\ \frac{m}{s}$$

Question 11: Does the train's average velocity during the interval t= 0s to t = 50 s provide a complete picture of the train's motion during this time?

Yes, the average velocity during the interval provides a simple summation of the train's motion.

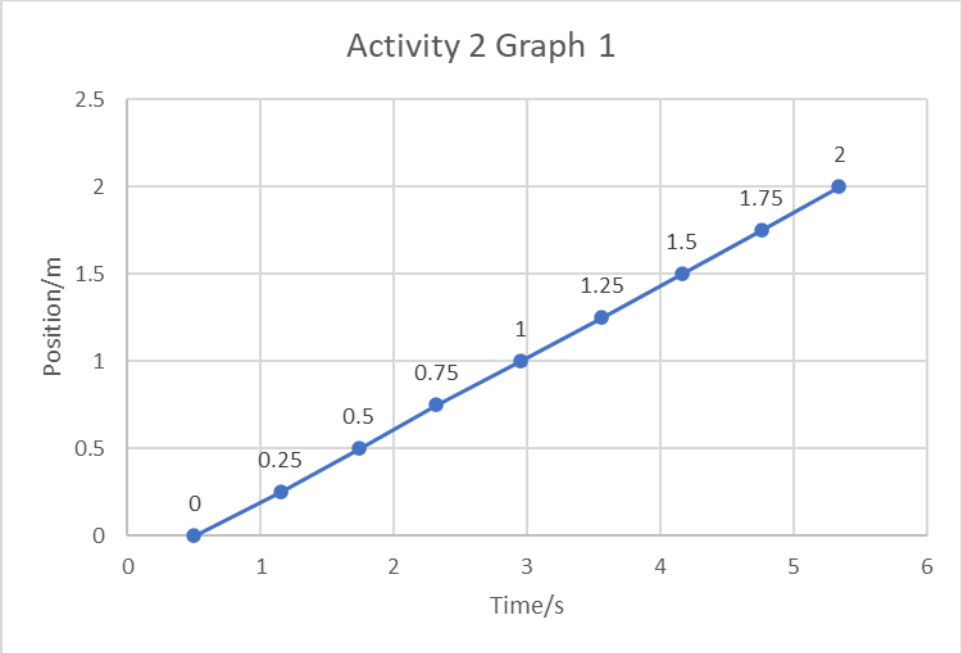
**Activity 2. Calculate the velocity of a moving object.**

**Activity 2. Table 1**

| Time (s) | Displacement (m)* |
|---|---|
| .50 | 0.00 |
| 1.15 | 0.25 |
| 1.74 | 0.50 |
| 2.32 | 0.75 |
| 2.95 | 1.00 |
| 3.56 | 1.25 |
| 4.16 | 1.50 |
| 4.76 | 1.75 |
| 5.34 | 2.00 |

***Note that 0.25 m = 25 cm**

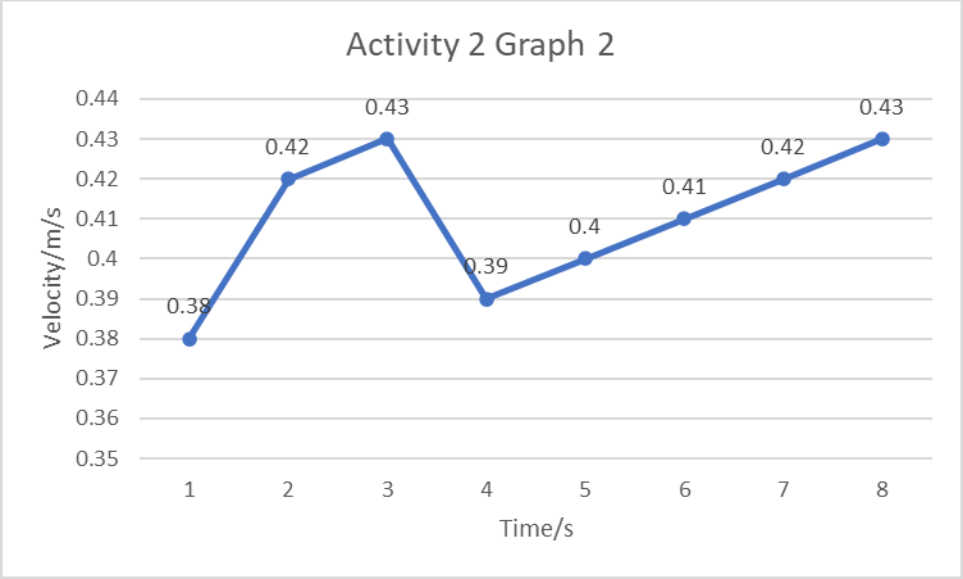
Insert a graph of Table 1 here. Include a chart title, axes titles and units.




**Activity 2. Table 2**

| Time (s) | Velocity (m/s) |
|---|---|
| 1 | .38 |
| 2 | .42 |
| 3 | .43 |
| 4 | .39 |
| 5 | .40 |
| 6 | .41 |
| 7 | .42 |
| 8 | .43 |

Insert a graph of Table 2 here. Include a chart title, axes titles and units.



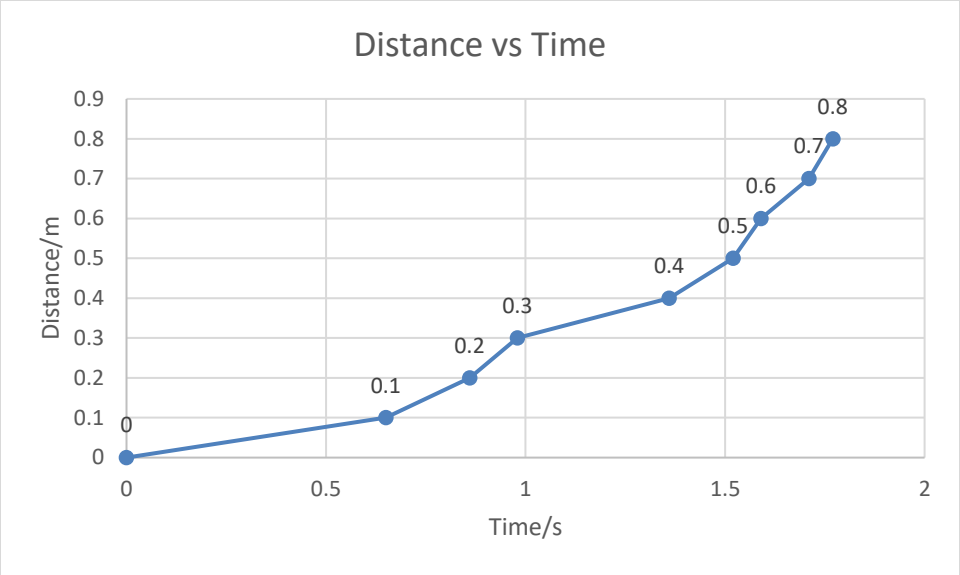

**Activity 3 Graphing the motion of an Object with Constant Acceleration**

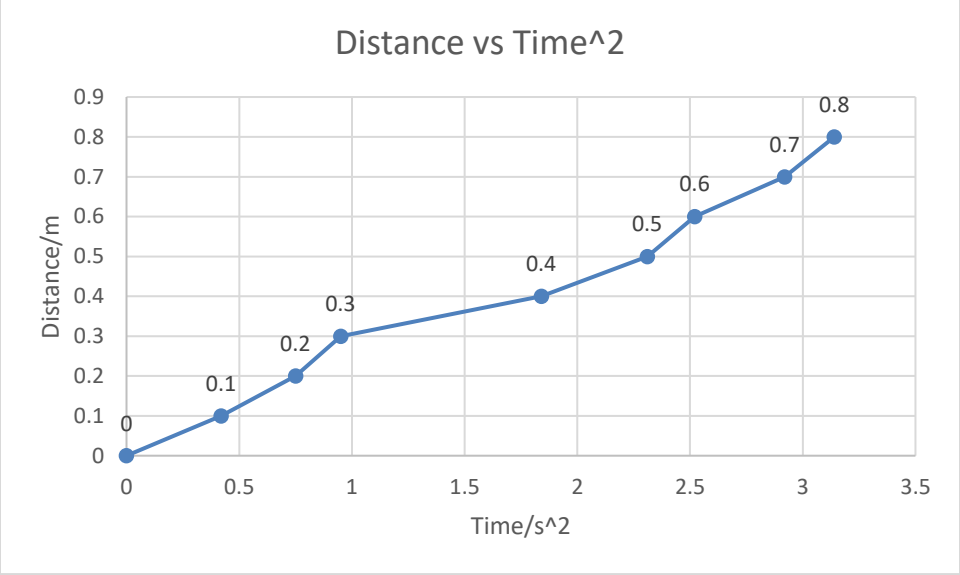
**Activity 3. Data Table 1.**

| Time (s) | Average Time (s) | Average Time$^2$($s^2$) | Distance (m) |
|---|---|---|---|
| Trial 1 = 0.00<br>Trial 2 = 0.00<br>Trial 3 = 0.00 | 0 | 0 | 0 |
| Trial 1 = 0.71<br>Trial 2 = 0.57<br>Trial 3 = 0.67 | 0.65 | 0.42 | 0.1 |
| Trial 1 = 0.87<br>Trial 2 = 0.84<br>Trial 3 = 0.88 | 0.86 | 0.75 | 0.2 |
| Trial 1 = 0.94<br>Trial 2 = 1.01<br>Trial 3 = 0.98 | 0.98 | 0.95 | 0.3 |
| Trial 1 = 1.35<br>Trial 2 = 1.34<br>Trial 3 = 1.38 | 1.36 | 1.84 | 0.4 |
| Trial 1 = 1.52<br>Trial 2 = 1.55<br>Trial 3 = 1.49 | 1.52 | 2.31 | 0.5 |
| Trial 1 = 1.59<br>Trial 2 = 1.59<br>Trial 3 = 1.58 | 1.59 | 2.52 | 0.6 |
| Trial 1 = 1.72<br>Trial 2 = 1.72<br>Trial 3 = 1.69 | 1.71 | 2.92 | 0.7 |
| Trial 1 = 1.76<br>Trial 2 = 1.78<br>Trial 3 = 1.78 | 1.77 | 3.14 | 0.8 |

***Note that 0.10 m = 10 cm**

Insert your graphs of Distance vs Time (m) and Distance vs Time Squared here:


Distance vs Time
Distance/m
Time/s
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
0.5
1
1.5
2
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0


Distance vs Time^2
Distance/m
Time/s^2
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
0.5
1
1.5
2
2.5
3
3.5
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0

**Questions for Activity 3**

Question 1: What is the shape of the graph when displacement is graphed vs. time?

It appears that the shape of the graph has a steeper slope than when graphed vs time squared. The shape will be a parabola.

Question 2: What is the shape of the graph when displacement is graphed against time squared?

It appears that the shape of the graph has a flatter slope than when graphed vs time.

Question 3: What do the shapes of these graphs tell you about the relationship between distance and displacement for an object traveling at a constant acceleration?

The velocity increases as the object is displaced from greater distances. Thus, an equation can be used to predict the displacement at any given time.

**Activity 4: Predict the time for a steel sphere to roll down an incline.**

| | | Steel Sphere | Acrylic Sphere |
|---|---|---|---|
| A | Length of Track (cm) (s)<br>(Step 1, use 80 cm) | 80 cm | 80 cm |
| B | Angle of Elevation (θ) in Degrees $^0$<br>(Step 1) | 5 | 5 |
| C | Calculated Time from s=0 to s=80<br>(formula from step 2) | 1.62 | 1.62 |
| D | Measured Time from s=0 to s=80<br>(step 3 with stopwatch) | 1.75 | 1.88 |
| E | % Difference (step 4)<br>$percent\ difference = \left\lvert \frac{first\ value - second\ value}{\left(\frac{first\ value + second\ value}{2}\right)} \right\rvert \ x\ 100\%$ | 7.69% | 14.86% |

A. Length
   i. Steel: 80
   ii. Acrylic: 80

B. Angle

i. Steel: 5
ii. Acrylic: 5

C. Calculated Time from s = 0 to s = 80cm

i. Steel: $t = \sqrt{\frac{2*.8}{.71*9.8*\sin 5}} \rightarrow \sqrt{\frac{1.6}{.61}} \rightarrow \sqrt{2.62} \rightarrow 1.62$

ii. Acrylic: $t = \sqrt{\frac{2*.8}{.71*9.8*\sin 5}} \rightarrow \sqrt{\frac{1.6}{.61}} \rightarrow \sqrt{2.62} \rightarrow 1.62$

D. Measured Time from s = 0 to s = 80cm

i. Steel: 1.75
ii. Acrylic: 1.88

E. % Difference

i. Steel: $percent\ difference = \left|\frac{1.62-1.75}{\frac{1.62+1.75}{2}}\right| * 100\% = \left|\frac{-.13}{1.69}\right| * 100\% = 7.69\%$

ii. Acry: $percent\ difference = \left|\frac{1.62-1.88}{\frac{1.62+1.88}{2}}\right| * 100\% = \left|\frac{-.26}{1.75}\right| * 100\% = 14.86\%$

Question for Activity 4: What effect does the type of the sphere have on the time of the object to travel the measured distance, explain?

Relative to Newtons law, F = ma (after solving for a), we can deduce through classical physics that a heavier object will have a greater force rolling down an incline. Increasing the mass will increase the acceleration vector quantity.

**Activity 5: Demonstrate that a sphere rolling down the incline is moving under constant acceleration.**

Questions for Activity 5:

1. Describe your observations of the sounds made as the sphere crosses the equally spaced rubber bands (procedure step 4)? (If the sounds are too fast to discern, lower the angle of the ramp.)
    a. Following along with the instructions, I marked and placed rubber bands on the foam board at equal lengths. The board was placed at a 7-degree angle. I placed the steel ball at the top and observed the sound that the ball made as it rolled down the incline.
    b. I noticed that the frequency of the sound increased as the steel sphere traveled down the ramp. This gave me an audible indication that the sphere was accelerating.
2. Describe your observations of the sounds made as the sphere crosses the unequally spaced rubber bands (procedure step 9)? (Use same angle as step4).

    a. Following along with the instructions, I proceeded to mark and place rubber bands at unequally spaced locations. The board remained at a 7-degree angle. Concurrently, I placed the steel ball at the top and repeated the activity.
    b. I noticed that the frequency of the sound did not increase. Instead, the sounds made by the steel ball were at equal intervals.
3. Explain the differences you observed if any between the sounds with equal spacing and sounds with unequal spacing.
    a. For question 1, the spaces were at equal lengths and the sounds increased in frequency. Thus, I can deduce that it took less time for the sphere to travel the same distance as the sphere accelerated.
    b. For question 2, the spaces were at unequal lengths, but the interval between sounds was the same. Thus, I can deduce that as the sphere accelerates, it can move a greater distance in the same interval.