Claim-Evidence-Reasoning

Question: Does the battery operated move at constant speed or does it accelerate? If it moves at constant speed, what is its speed? If it accelerates, what is its acceleration?

Claim

Write a statement you believe to be true that fully responds to the question.

The battery operated car moves at a constant speed of 44.6 centimeters per second.

Evidence

Provide enough relevant data to support your claim. Data may include numbers or observations. It should be clear to someone else what the data represents. Organize with tables when appropriate and be sure to label the data including units.

Key:
Initial and final distances are highlighted in **pink**
Times are highlighted in **yellow**

The battery operated car was 10.4 cm long. (Initial distance)

	Final distance of 70.0 cm	Final distance of 140.0 cm	Final distance of 228.25 cm
Trial 1 change in time (seconds)	1.51	3.02	5.03
Trial 2 change in time (seconds)	1.60	3.02	4.98
Trial 3 change in time (seconds)	1.44	3.09	5.16

Reasoning

Explain why your evidence supports your claim. If appropriate, graph your data and show and explain any calculations you made with your data.

An object's average velocity can be calculated by the equation velocity (v) = displacement (x)/ change in time (t). As the battery-operated car travels in a straight line, its displacement, how far away it ends from its initial position, equals its distance traveled, the length of its route. Thus, substituting distance traveled for displacement, the car's velocity can be calculated by dividing its distance traveled (d) by its change in time, which is also the equation for calculating an object's speed (s). Thus, since, in the case of the car, v = d/t = s, our car's velocity equals its speed.

1. Velocity(v)=displacement(x)/time(t)
2. The car moves in a straight line. In its case, x = distance traveled (d)
3. Substituting 2) into 1), we get v=d/t
4. Speed(s)=d/t
5. Substituting 4) into 3), we get v=s

If the car is moving at a constant speed, its velocity will not change (even in cases where velocity does not equal speed, since velocity is just speed with a direction). On the other hand, if it accelerates, its velocity will change, as acceleration (a) = (change in v) / t. Therefore, to determine whether the car moves at a constant speed or accelerates, we

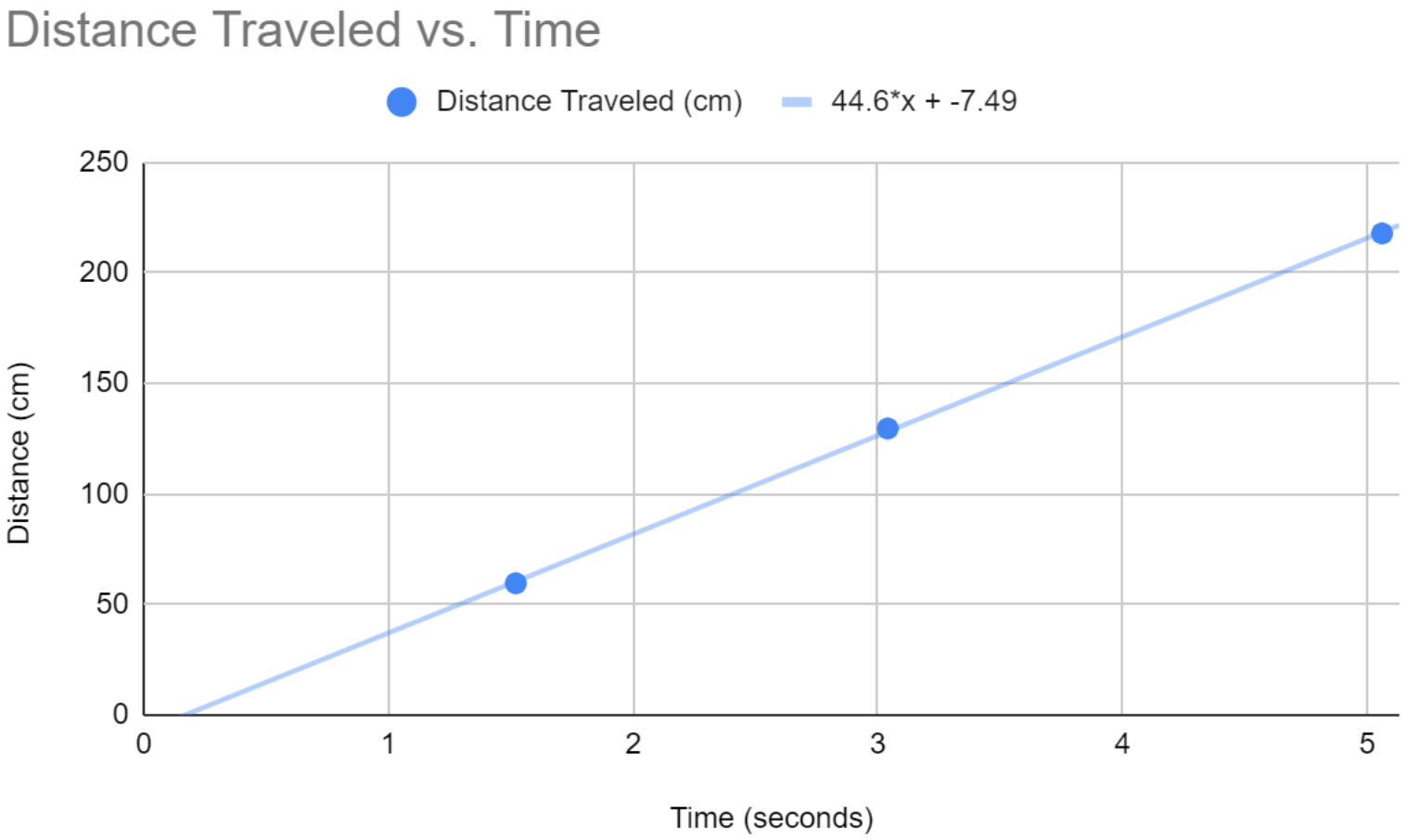
must first determine its change in velocity. If its change in velocity equals zero, then its acceleration will also equal zero and its speed will be constant. Otherwise, the car will accelerate.

1. Constant speed when (change in v)=0
2. a=(change in v)/t, so car is accelerating if (change in v)/t does not equal 0
3. For (change in v)/t to equal 0, the numerator, change in v, has to equal 0

To calculate the car's change in velocity, we will need to calculate its distance traveled and then its initial and final velocities. Distance traveled = final distance - initial distance. We measured the car's distance by the position of its front end; we always started with the car's tail end at 0 cm, so its initial distance was always its length, 10.4 cm. When the car had a final distance of 70 cm, it had a distance traveled of (70 cm -10.4 cm = 59.6 cm); when the final distance was 140 cm, using the same equation, its distance traveled was 129.6 cm; and when the final distance was 228.25 cm, it had a distance traveled of 217.85. We performed three trials for each distance to improve the accuracy of our times. The average change in time was found by adding the three times for a distance then dividing the sum by three. For example, the average change in time for a distance of 59.6 cm = (1.51 seconds+1.60 seconds+1.44 seconds)/2=1.52 seconds. The rest of the average times were found in the same way and inputted into the middle column in the table below. Then, the velocities, found by dividing the distances by the times, were inputted in the last column.

Distance traveled (cm)	Average change in time (s)	Velocity = distance traveled / time (cm/s)
59.6	1.52	39.21
129.6	3.04	42.63
217.85	5.06	43.05

To better visualize the data, I made a graph comparing distance traveled (cm) to time (s).



As the slope of the graph = distance divided by time, and velocity equals distance divided by time, the velocity at any point can be found by identifying the slope of the graph at that point. Though our velocity values from our trials weren't exactly the same, they were very similar, and, when our points are graphed, they appear linear, with the line of best fit having a slope of 44.6cm/s. Thus, Our automatic car moved at an average speed of about 44.6 cm/second.

Claim-Evidence-Reasoning

Question: Does the cart move at constant speed or does it accelerate as it travels down the inclined track? If it moves at constant speed, what is its speed? If it accelerates, what is its acceleration?

Claim
Write a statement you believe to be true that fully responds to the question.

The metal cart accelerates at 23.4 cm/second^2.

Evidence
Provide enough relevant data to support your claim. Data may include numbers or observations. It should be clear to someone else what the data represents. Organize with tables when appropriate and be sure to label the data including units.

Key:
Initial and final distances are highlighted in **pink**
Times are highlighted in **yellow**

The metal cart was 16.6 cm long. (Initial distance)

	16.6 cm (Anyee)	70.0 cm (Anyee)	140.0 cm (Anyee)	228.25 cm (Average of Anyee and Nihitha)
Trial 1 change in time (seconds)	0	1.57	2.38	3.13
Trial 2 change in time (seconds)	0	1.52	2.30	3.16
Trial 3 change in time (seconds)	0	1.61	2.30	3.16

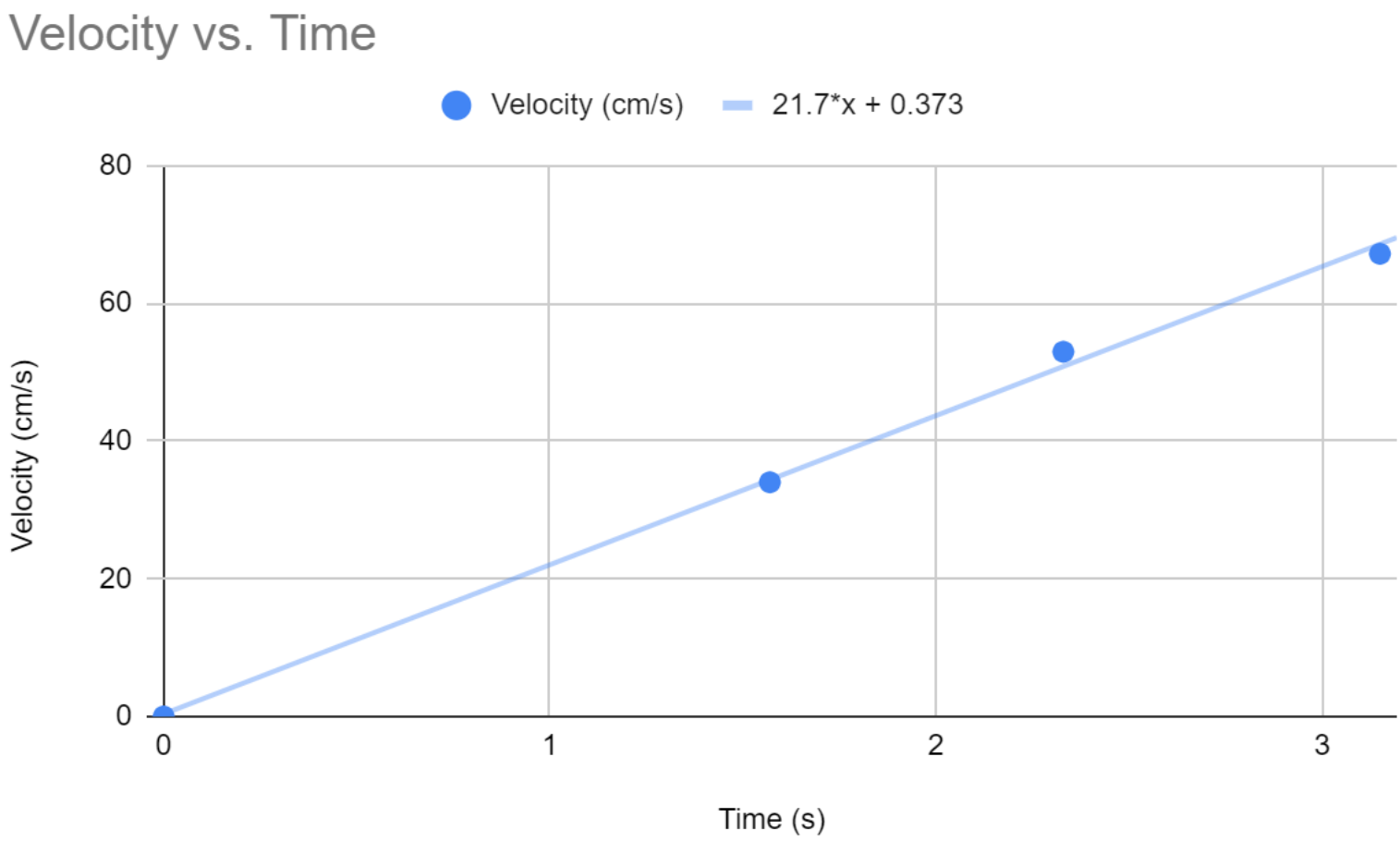
Reasoning
Explain why your evidence supports your claim. If appropriate, graph your data and show and explain any calculations you made with your data.

The last distance's times are averages because my group had two people timing.

Using the same reasoning as for the car, the cart's velocity at a point can be calculated by dividing its distance traveled by its change in time. Even without calculations, we know that the metal cart accelerated, since it began not moving, with a speed of 0 m/s, and ended moving.

To prove the cart accelerated, we can show that its velocity changed. Below, I have calculated the velocities of the cart at each distance. The distance traveled was calculated by subtracting the cart's length, the initial distance, by the final distance it traveled, the average change in time was found by finding the sum of the times and dividing it by three, and the velocity was found with the equation v=d/t.

Distance traveled (cm)	Average change in time (s)	Velocity = distance traveled / time (cm/s)
0	0	0 (because cart is not moving)
53.4	1.57	34.01
123.4	2.33	52.96
211.65	3.15	67.19



To better visualize the data, I made a graph comparing velocity (cm/s) to time (s).

As the slope of the graph = change in velocity divided by time, and average acceleration also equals change in velocity divided by time, the average acceleration of the metal cart can be found by finding the slope of the line of best fit: 21.7 m/s^2. I know the cart doesn't have a constant speed because then the velocity would remain the same the whole time, with a slope and acceleration of 0 m/s^2.