Claim-Evidence-Reasoning

***Question**: Does the **battery operated** car 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

The battery operated car moves at a constant speed of around 43.4 cm/sec and does not accelerate.

Evidence

Velocity is calculated as the change in position over the change in time. For the most accuracy, when taking data, my group let the car run and noted the exact time the car hit a distance milestone. Then, to calculate velocity, we took the change in distance from one point to another and divided it by the change in time.

As seen in the tables below, the velocity of the car at each of our five points essentially remained constant. The velocity was determined at each of the six data points by dividing the distance by the time. The average velocity is around 43.4 cm/s and does not change much between points.

Acceleration is calculated by taking the change in velocity and dividing it by the change in time. Since our velocities did not fluctuate much, the acceleration is essentially zero and the digits in the hundredths place are most likely due to lab error.

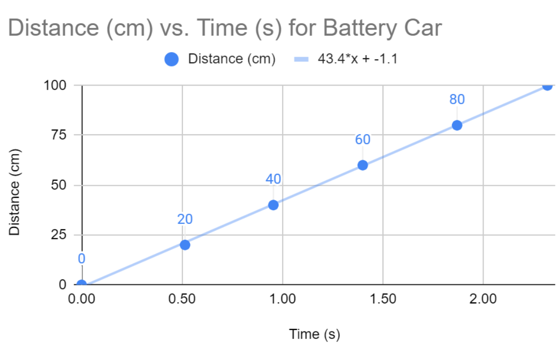
Distance (cm)	Time (sec)	Velocity (cm/s)
0	0.00	38.8
20	0.515	45.5
40	0.955	44.9
60	1.40	42.6
80	1.87	44.4
100	2.32	43.1

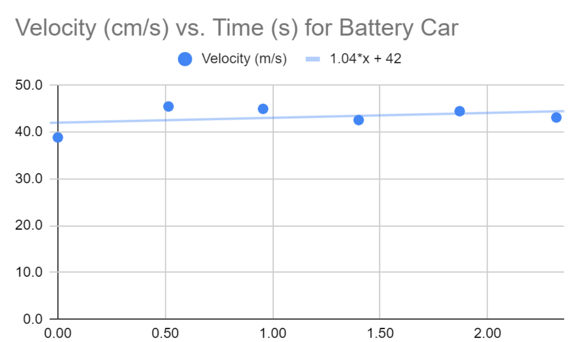
Velocity (cm/s)	Time (sec)	Acceleration (cm/s^2)
38.8	0.00	0.00
45.5	0.515	0.01
44.9	0.955	0.02
42.6	1.40	0.03
44.4	1.87	0.04
43.1	2.32	0.05

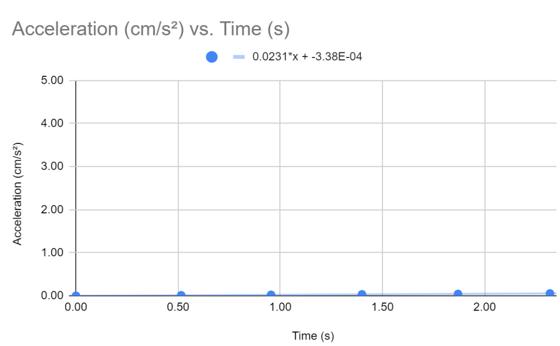
Reasoning

Looking at the time vs distance graph, as seen by the trendline, the graph is linear which means the velocity is constant with no acceleration. If there was a constant acceleration, the graph would have had a parabolic shape, rather than being linear. This is further supported as when graphing the velocity vs time graph for the battery car, the slope is essentially 0. When graphed again for acceleration vs time, it is clear that there is no acceleration and the car moves at a constant rate. Furthermore, by graphing the data, we can get a confirmation that our data values are correct. For the distance vs. time graph, when adding the trendline and showing the equation we see that the equation of the line is y = 43.4x+1.1. Since the slope is change in y over change in x, or rather the change is distance over the change in time (velocity), we know that the slope, 43.4 is the average velocity. Then, looking at the velocity vs time chart, we can see the equation is y = 1.04x + 42. Since the coefficient of X is very close to 1, it is clear that the velocity is essentially unchanging between data points. Finally, taking the slope of the velocity vs time graph and graphing it, the slope for the acceleration graph is 0.0231x. Since this number is very close to zero as well, we know that there is no acceleration.

Since the graphs match the data tables and provide a more precise slope, it backs up the evidence that the battery car does not accelerate but moved at a constant velocity of 43.4 cm/s







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

The cart does not travel at a constant speed but rather accelerates as it travels down the inclined track. The average acceleration is 68.3 cm/s^2.

Evidence

During the lab, we recorded the distance the car traveled (Δx), the time it took to travel that distance (t) and we know the initial velocity is zero (V_0). Because of this, we have enough data to use one of the big four acceleration equations. Since we are trying to find the acceleration and we don't know the velocity, we can use the no V equation: $\Delta x = V_0 t + at^2/2$. By plugging in our initial velocity of zero, we can simplify this down to $\Delta x = at^2/2$. Then, at each point, the distance would be Δx and time would be t.

The results were as follows:

Distance (cm)	Time (s)	$\Delta x = V_0 t + at^2/2$ $\Delta x = at^2/2$	Acceleration (cm/s²)

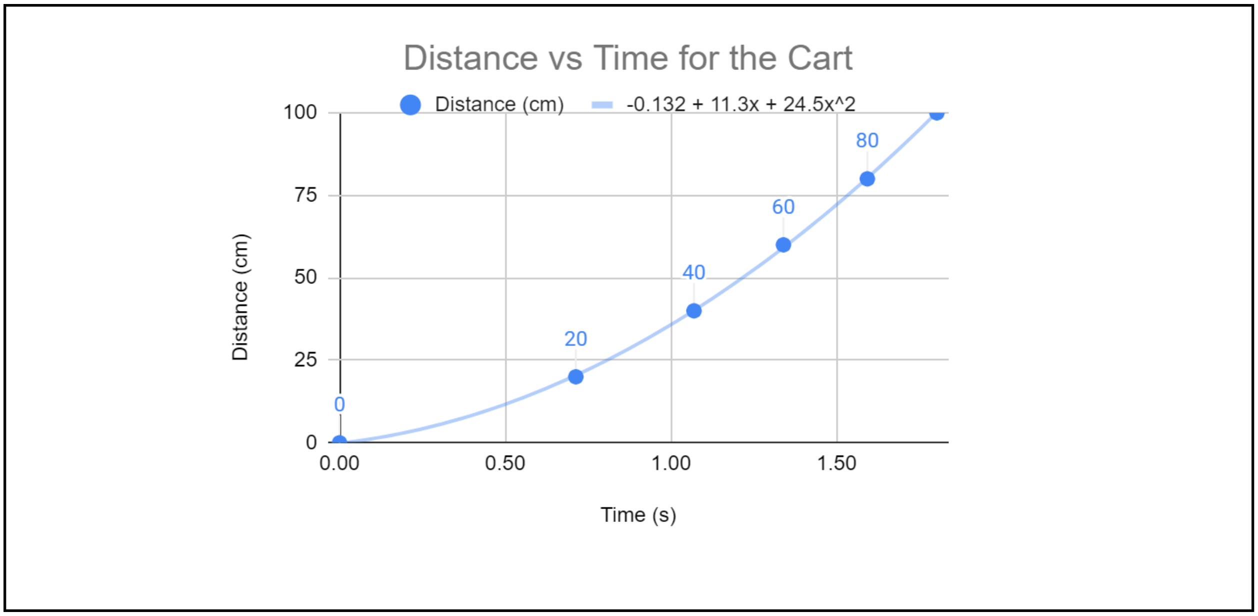
20	0.71	$20 = (0.71^2)(a)/2$	79.3
40	1.07	$40 = (1.07^2)(a)/2$	69.9
60	1.34	$60 = (1.34^2)(a)/2$	66.8
80	1.59	$80 = (1.59^2)(a)/2$	63.3
100	1.79	$100 = (1.79^2)(a)/2$	62.4

Here, we see that the acceleration ranges from 62.4 to 79.3 meters per second. This is probably due to human or lab error. However, if we average out the acceleration, we find that the car was accelerating at about 68.3 cm/sec^2. Even so, if the car was traveling at a constant velocity with zero acceleration, the calculations would not have worked, and would not have yielded fairly consistent answers within 10 units of each other.

Reasoning

In addition, looking at the Distance vs. Time graph, instead of a linear line like the battery car, we have a parabolic curve in this graph. Because the graph is not linear, that means the velocity is not constant. Instead, the car is accelerating. This, combined with the calculated acceleration, proves that the cart did not move at a constant velocity, but instead accelerated down the ramp.

Since the cart was moving pretty fast, our data points were not so accurate. This is evident in the equation for our curve in the graph. The coefficient for the x term is supposed to be the initial velocity, which is zero. However, for our data, it says the initial velocity is 11.3 cm/sec. This is probably due to lab error.


Distance vs Time for the Cart
Distance (cm)
-0.132 + 11.3x + 24.5x^2
100
75
50
25
0
0.00
0.50
1.00
1.50
Distance (cm)
Time (s)
0
20
40
60
80