Claim-Evidence-Reasoning

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

Claim

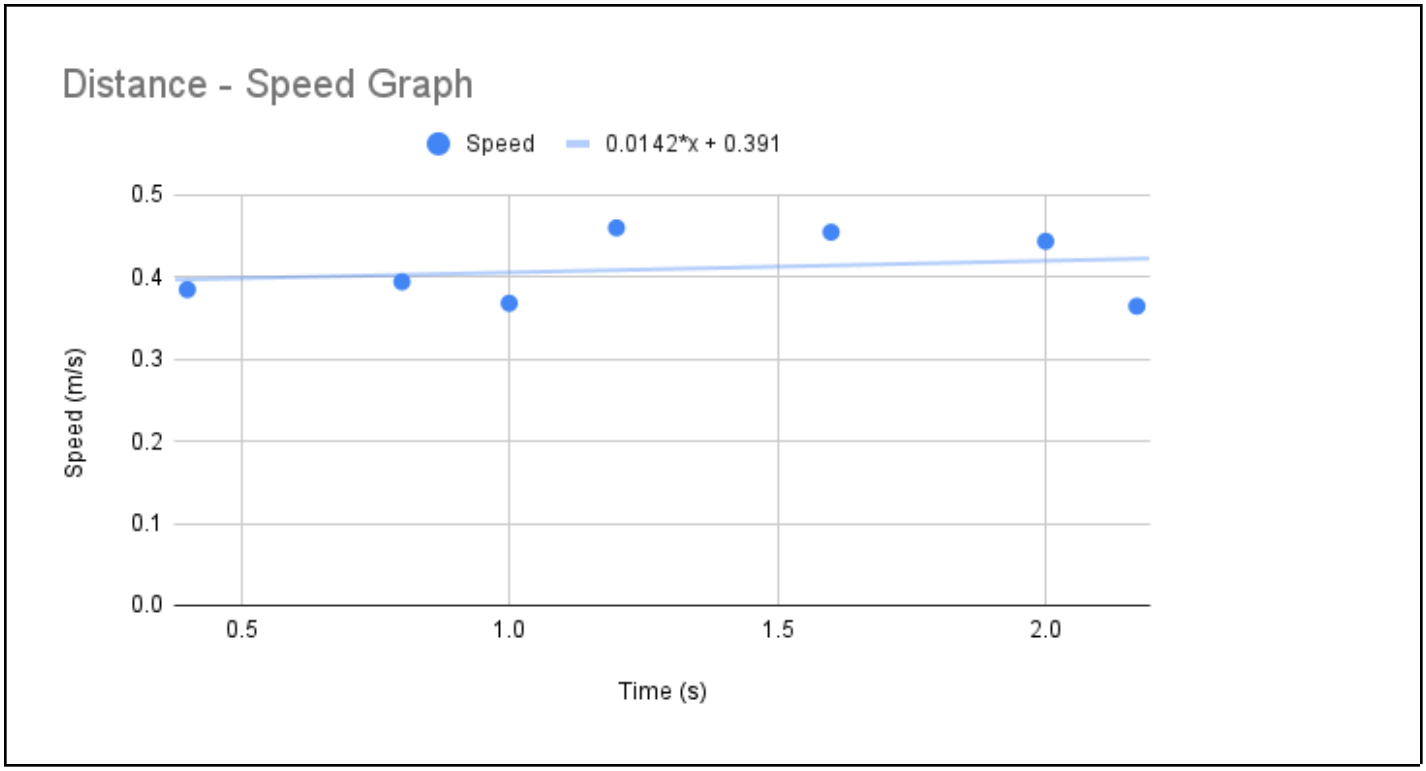
The battery-operated car moves at a constant speed of 0.41 m/s.

Evidence

The battery-operated car was tested along a 2.27m flat beam. Tests were conducted by varying the distance (meters) the car drove along a flat beam. The car's time (seconds) to drive the given distance was recorded. The distances tested include 2.00, 1.60m, 1.40m, 1.00m, 0.60m, and 0.20m. The time taken for each car to cover the respective distance in seconds were 4.51, 3.52, 2.61, 2.03, and 1.04s. The average velocity was calculated using the formula average speed = total distance / total time for each scenario, which resulted in speeds (m/s) of 0.44, 0.45, 0.46, 0.39, 0.38.

Reasoning

Using the formula average speed = total distance / total time for each scenario and averaging the speeds, the average speed of the car was determined to be 0.41 m/s. The standard deviation of the calculated speeds is 0.041, which shows that the speed is held constant when distance changes. If the acceleration were constant, then the average speeds would change based on the distance traveled by the battery-operated car due to the formula. Therefore, if acceleration was held constant, then the average speeds would not all be held constant. Included below is a graph of the average speeds from the battery-operated car. Since the slope of the best line to fit graph is near zero, it shows that speed is held constant at around 0.41 m/s.


Distance - Speed Graph
Speed
0.0142*x + 0.391
0.5
0.4
0.3
0.2
0.1
0.0
Speed (m/s)
0.5
1.0
1.5
2.0
Time (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 accelerates at a constant rate of 0.37 m/s^2.

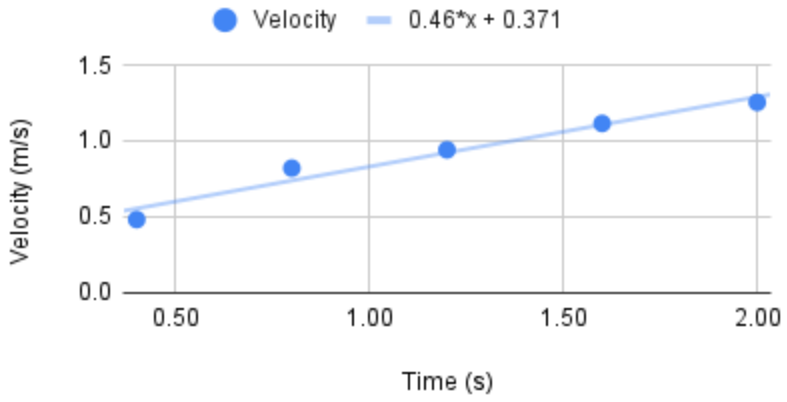
Evidence

The cart was tested along a 2.27m inclined beam. Tests were conducted by varying the distance (meters) the cart slid down a low friction inclined beam from a resting start. The cart's time (seconds) to slide down the given distance was recorded. The distances tested include 2.00, 1.60m, 1.40m, 1.00m, 0.60m, and 0.20m. The time taken for each cart to cover the respective distance in seconds were 3.19, 2.87, 2.55, 1.95, and 1.66s. The final velocity of the cart was calculated using the formula $\Delta x = (v + v0) \times t / 2$. The final velocities (m/s) of the cart were calculated to be 1.25, 1.11, 0.94, 0.82, and 0.48 respectively. Then, the cart's acceleration (m/s^2) of each distance was calculated using the formula $\Delta x = v0 \times t + \frac{1}{2} a \times t^2$ to be 0.39, 0.39, 0.37, 0.42, and 0.29, respectively.

Reasoning

Using the formula $\Delta x = (v + v0) \times t / 2$ to find the final velocities for each scenario, the final velocities were not held constant when tested using different distances. However, when the final velocities are graphed below, the points indicate a linear positive correlation between final velocity and distance, which indicates that the cart has constant acceleration. Next, the formula $\Delta x = v0 \times t + \frac{1}{2} at^{2,}$ showed that the accelerations were closely correlated and were held constant when the distance was varied. The average of the accelerations for the five tests was 0.37 m/s^2, and the standard deviation was 0.049, which again shows that the acceleration does not differ much from the average. When the acceleration is graphed out, it can be observed that the line of best fit has a slope close to zero, which indicates constant acceleration.

Velocity Graph



Acceleration Graph