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

The battery-operated car doesn't accelerate, but it moves at a constant speed of about 0.43 m/s.

Evidence

In order to collect our data, my group first selected three different distances: 217.85cm, 129.6cm, and 59.6cm for our y-values. We then did three trials for each distance and recorded how long it took the car to reach that spot for each trial. For example, for the distance of 217.85cm, the first trial took 5.03 sec, the second trial took 4.98 sec, and then third trial took 5.16 sec. Originally, we actually had Anyee and I both measure each trial and then we averaged all six numbers out, but then for the other distances I needed to mark the sports, so we only had Anyee time the car. Because of this, my data is a little different. I removed the times I collected for thes distance and only averaged Anyee's three times since she was the one that measured all the data, and I thought it would be more accurate to keep everything consistent. Moving on, in order to get one time for each distance we averaged all three trials. It took about 1.52 seconds to reach 59.6cm, it took about 3.04 seconds to reach 129.6 cm, and it took about 5.06 seconds to reach 217.85cm. I also included the points (0,0) in the table because at the beginning, the car hadn't moved yet, and therefore the time and distance were still 0. Before calculating the velocity, I converted the distance from centimeters into meters just because meters per second is generally more common.

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 formula for velocity is velocity = displacement/time. In this case the displacement and distance are the same because the car is moving in a straight line, but basically, in order to find the velocity, you would divide each position by its time. For example, in order to find the velocity of the car as it approaches 2.1785 meters, you would do 2.1785m/5.06 seconds (5.06 is the amount of time it took to get to that position.) I then did this division for all the numbers and recorded my quotient in the velocity chart. As you can see in the chart above, two of the velocities are roughly 0.43m/s while the last one is 0.39 m/s. This means that the constant velocity would be 0.43 since it is repetitive throughout the chart (2 out of the 3 values for 0.43m/s). Although 0.39 isn't the same number, this is likely due to human error since there is no way to get perfect numbers if you are measuring by hand and you also have to think about the error percentage that comes from reaction time. Another way you can look at the velocity is through the graph below. The graph below is a time vs position graph, but velocity is the derivative of position meaning that the slope of this graph is the velocity. If you look at the graph you can see that it is increasing at a constant rate which means the velocity is constant. When you look at the graph you can either plot two points and do the math out to find the slope, or you can zoom in on the graph to see that the rise/run is in fact about 0.43/1 since the line crosses 1 at just under 0. 5. Along with this, at the top of the graph you can also see the equation of the line of best fit in which the coefficient, m, is 0.43 4. Finally, one last ways for how you can figure out that the velocity is constant is because it was moving along a flat surface. There is no downward slope and since we can't change the speed of the wheels, we can say it is constant. To determine the acceleration, I did (V-V0)/T. My final velocity was 0.43m/s.

Claim-Evidence-Reasoning

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

Claim

The cart does not move at a constant speed, but it does have a constant acceleration of 0.442m/s^2.

Evidence

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

In order to collect our data, my group first selected three different distances: 211.65cm, 123cm, and 53cm for our y-values. We then did three trials for each distance and recorded how long it took the car to reach that spot for each trial. For example, for the distance 211.65cm, the first trial took 3.04 seconds, the second trial took 3.23 seconds, and the third trial took 3.01 seconds. Originally, we actually had Anyee and I both time each trial and then we averaged all six numbers out, but then, for the other distances, I needed to mark the spots where we wanted to time, so we only had Anyee time the car. I removed the times I collected for the distances from the data set and only averaged Anyee's three times since she was the one that measured all the data. I thought it would be more accurate to keep everything consistent. This was the same process as what I did when I removed the data for the toy car. In order to get one time for each car, we averaged the three time values from the trials (1 time value per trial.) It took about 1.57 seconds to reach 53cm, it took about 2.33 seconds to reach 123cm, and it took about 3.09 seconds to reach 211.65cm. I also included the points (0,0) in the table because at the beginning the cart started at rest. Since the car hasn't moved yet and therefore there is no time, the position and time would both be 0. Before calculating the velocity and acceleration, I converted the distance from centimeters into meters just because meters per second is generally more common. I graphed the position vs time graph.

Reasoning

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

I got my acceleration to be 0.442 m/s^2 by using the X= X0 +V0T + 1/2A(T)^2. To start off, I know that it's a constant acceleration because the graph of the displacement is curved which means it is growing exponentially. Because of this growth, we know that the velocity is also increasing as time goes on. If the velocity keeps on increasing, then the acceleration is moving at a constant rate. First, for my calculations, since the cart starts at rest, I set the initial velocity and initial distance to 0. This gave me, X = 0+0+ 1/2A(T)^2 which is the same as X = 1/2A(T)^2. Because the x-axis is time, in this case, I substituted the X in the equation with Y, and the T in the equation with X. This then got me Y= 1/2A(X)^ 2. Next, I looked at the position vs time graph below, and saw that the line of best fit's equation is a parabola meaning it also is a second-degree polynomial. The -2.77E-03 and 6.08E-03X would cancel out with the X0 and V0T, so this gave me 0.221X^2 = 1/2A(X)^ 2. The X^2s cancelled out on both sides and I was left with 0.221 = 1/2 A. In order to find A, the acceleration, I multiplied both sides by 2 and, in the end, I got acceleration = 0.442 m/s^ 2.