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Question: What is the relationship between the level of the fan speed running on the cart in the opposite direction of motion and the acceleration of the cart travelling down a fixed incline?

Hypothesis: The relationship between the fan speed level and acceleration of the cart will be linear with a negative slope. (The slope of the graph of fan speed vs. acceleration will be equal to the cart's acceleration per unit increase in the opposing force of the fan.)

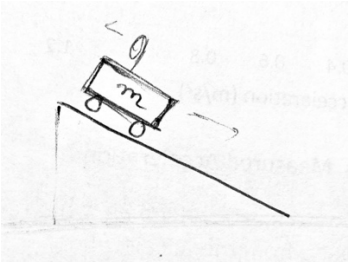

Fig 1: Modified Atwood's machine

Strategy:

- The force of the wind created by a fan mounted on the cart was varied by changing the fan speed level. The resulting acceleration was measured using a Vernier motion detector.
- The total mass was kept constant by having the same fan mounted on the cart so that the sum of the fan and cart was always the same.
- The force created by the fan was graphed vs. the measured acceleration to verify that the slope was equal to the negative combined mass of the cart and fan.

Data:

Starting Height: 10.25 inches

Fan Speed Level	Fan Level Force (N)	Acceleration avg. (m/s^2)
Level 1	0.102	2.2465
Level 2	0.162	2.1155
Level 3	0.191	1.9665
Level 4	0.243	1.839

The acceleration values are averages of two trials for each fan speed level.

Analysis:

The free body diagram in Figure 2 shows the forces on the cart on the inclined plane.

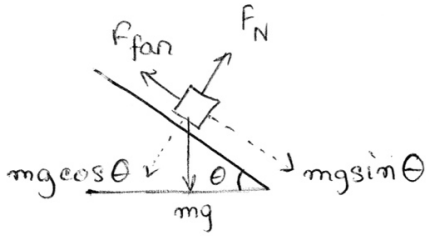

Figure 2: Free Body Diagrams

Friction between the cart and the track is negligible because the cart's wheels spin freely. The following equations are based on the free body diagrams. Positive motion is defined as to the right for the cart.

$$F = ma$$
$$mgsin(theta) - Ffan = ma$$
$$a = -\frac{Ffan}{m} + \frac{mgsin(theta)}{m}$$

$$a = -\frac{1}{m}(Ffan) + gsin(theta)$$

This equation indicates that there is a linear relationship between the force of the fan wind in the opposite direction and the acceleration, with the negative slope representing a negative relationship. The slope represents the negative inverse of the cart and fan's mass. The y-intercept represents the acceleration of the cart solely due to gravity (if the fan was off).

A graph of the fan force vs. acceleration data for this experiment shows that it is indeed linear, and that the slope is equal to -2.98 (1/kg).

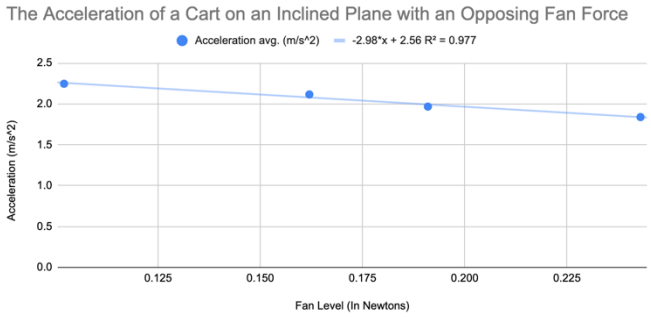

Figure 3: Fan Level Force vs. Measured Acceleration

The actual negative inverse of the cart's mass is -3.258, which means that the value found from the graph is 8.53% smaller than expected. This indicates that the measured acceleration values were greater than expected. This could be due to the table surface on which the experiment was conducted on not being level, being slightly raised on one side.