Ryan Prendergast

Objective:

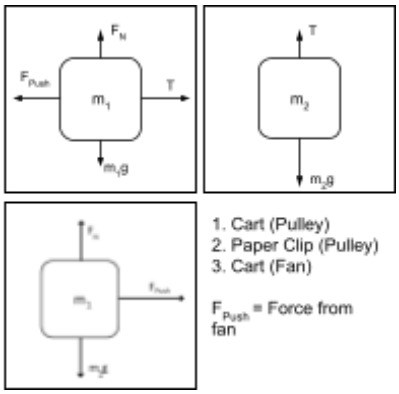
Determine the relationship between the mass of a cart and its acceleration when a constant force is applied.

Hypothesis:

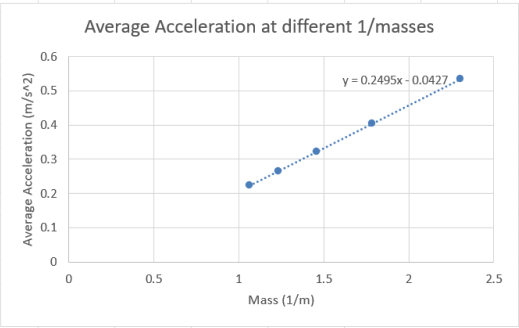
If the mass of the cart is increased while the net force from the fan is constant, then the cart's acceleration will decrease because acceleration is inversely proportional to mass as described in Newton's Second Law (F = ma).

Strategy/Procedure

1. **Setup:**
- Place the fan securely onto the cart on the track.
- Must be a level surface.
- Place the cart at one end of the track. Attach a string to a pulley with a paperclip at the other side of the string.
- Turn the fan in the opposite direction of the string.
2. **Baseline:**
- Attach 2 washers to the paperclip to start.
- Turn on the fan to level 4. If the cart moves away from the pulley, then increase the weight and try again. If the cart moves towards the pulley, then decrease the weight and try again.
- Repeat until the cart moves neither towards or away from the pulley.
3. **Calibration:**
- Remove pulley, string, and weights.
- Turn on fan to level 4.
- Measure and record the acceleration without any added mass.
4. **Data Collection:**
- Repeat the above process, but increase the mass of the cart by 126g (1 block) every time.



- With the pulley baseline, we are able to determine the pulling force (in newtons) using just the pulley and weights. Since the cart is not moving, a=0. Therefore $m_2g = F_{Push}$ (Newtons). (0.0243kg) * (9.8m/s^2) = 0.238N. This was then validated by using a source sensor that also measured 0.238N.



- At the lowest mass (433.5 g), the cart experienced the highest average acceleration (0.533 m/s²).
- As mass was incrementally added, the average acceleration consistently decreased (as shown with the graph). This proves the hypothesis - acceleration is inversely proportional to mass with constant net force.
- Slope: ~0.25 (meters * mass/s^2). ~ 0.24 Newtons (measured force of the fan at level 4 from weight).
- Y-intercept: While shown as a = -0.04 (see source of error), it technically does not exist because m cannot be 0 and 1/0 is undefined. In a perfect experiment, the hypothetical y intercept would be 0.
- Source of error: 4.16% One source of error could be a not perfectly flat track. If the track was tilted even half a degree (incline ≠ 0), then there would be a difference between the Newtons value found from the pulley/force sensor (cart moved: left ← right) and the value found from the acceleration with different masses (cart moved: left → right).

Data

	Total Mass (G)	Acceleration Trial 1	Acceleration Trial 2	Acceleration Trial 3	Average Acceleration
No Added Mass	433.5	0.526	0.536	0.537	0.533
+126g	559.5	0.409	0.392	0.408	0.403
+251.7g	685.2	0.326	0.320	0.320	0.322
+377.5g	811	0.273	0.261	0.259	0.264
+504g	937.55	0.219	0.225	0.228	0.224

Analysis

- Cart mass (with fan): 433.5g → 0.4355 kg
- Friction is assumed to be zero.