

Experiment #10 Lab Exam

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Table 4, left back corner

Physics 201

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Objective:

The purpose of the experiment was to determine the force produced by the dynamic cart fan accessory using any equipment that suited this purpose.

Theory:

Theory #1:

Since force is a unit that can be measured by simple instruments such as scales, determining the force of the fan should be no harder than locating an appropriate scale and setting up the experiment so that the thrust from the fan registers on the scale.

Theory #2:

Energy and force are related by means of the equation $W=fd$. Since work equals energy, once the value for energy is found, it can be substituted back into the equation, along with a measurable distance, to calculate the force. The energy equation that works best in this situation is $E_k = 1/2mv^2$. V can be found using a relatively simple experiment to find the time, and masses can be physically measured. The results of the experiment of Theory #2 should agree (within the error range) with the results of the experiment of Theory #1.

Methods:

For this experiment two methods were used, each with a varying set of lab objects.

Method #1, Force solution: A small length of string, two spring scales, the dynamic track cart, the fan accessory, the dynamic track.

1. The fan was set securely on the top of the cart, and the length of string was attached to the front edge of the cart. The other end of the string was tied to the 'S' hook on the bottom end of the spring scale.
2. Next the square shaped hook on the top end of the spring scale was attached to a pin on the end of the dynamic track. (For extra support, a second spring scale was placed underneath the first spring scale to hold it up so that the tension in the string would not be affected.)
3. When all the equipment was set up, the fan turned on, and the spring scale measured out a reading.

Method #2, Energy solution: dynamic track cart, the fan accessory, the dynamic Track, data studio, a stack of small round weights, a meter stick, the triple beam balance, a flag accessory, and a photogate motion sensor.

1. The flag accessory was attached (with tape) to the cart, and then the cart with the flag and the fan were massed individually using the triple beam balance.
2. A meter stick was used both to measure out a predetermined length of track, as well as the length of the flag.
3. The photogate sensor was set up so that the rod on the photogate was parallel to to the dynamic track, and it was propped up by a small set of circular weights.
4. The cart with the fan attached on top was then placed on the track at the start point previously designated.
5. In data studio, the photogate setup was selected, and the display set to show the time with extra precision.
6. When everything was ready, the time counter was started in data studio, and then the fan

accessory was turned on. When the flag passed through the center of the motion sensor, a time value was recorded in data studio. This last step was repeated as many times as necessary to produce additional data points.

Data:

Length of Flag accessory: 2.5 cm ± 0.04cm

Mass of Cart + flag: 501.5g ± 0.25

Mass of Fan: 302.0g ± 0.25

Combined mass total: 803.5g ± 0.5

Distance measured between two selected points on the Dynamic Track: 170cm ± 0.1

<u>Runs:</u>	
1)	0.02540s
2)	0.02620s
3)	0.02600s
4)	0.02600s
5)	0.02640s
6)	0.02550s
<i>Average Time: 0.02600s</i>	

Calculations:

$$v = d/t,$$

$$E_k = 1/2mv^2 \quad E_k = W,$$

$$F = W/d$$

$$0.025m/0.02600s = 0.9615m/s$$

$$(1/2)(0.8035kg)(0.9615m/s)^2 = 0.3714 \text{ J}$$

$$0.3714 \text{ J}/1.70m = 0.2185 \text{ N}$$

Results:

Method/Theory #1: The force of the fan accessory equals $0.2 \text{ N} \pm 0.05 \text{ N}$

Method/Theory #2: The force of the fan accessory equals $0.2185 \text{ N} \pm 0.014 \text{ N}$

Error analysis:

Error was introduced in a number of areas:

When reading the spring scale, the scale was not fine enough to make accurate measures beyond 0.05N. When releasing the cart, it may not quite have been at the same exact point on the dynamic

track for each run. The computer might be just generating close, instead of exact numbers.

The entire table is not level, and the track itself was bowed up slightly in the middle, so that it dipped down slightly while the cart ran across it. Additionally, the spring scale had to be supported from underneath, which gave the scale an initial off-zero reading that had to be accounted for.

If the supports for the dynamic track were positioned closer to the middle of the track (rather than set so far apart at either end,) and the table was completely level, then the cart may have had a slightly different velocity.

Conclusion:

Both methods for measuring the force were easy to set up and run, and both produced results that felt right given the small size of the fan, and the fact that the flow of air did not feel especially strong. As anticipated, the results of method #1 agreed (within the error range) with the results of method #2. Although the force produced by the fan is extremely small, the cart moves very quickly because the dynamic track/combination is set up so that friction is mostly eliminated.