Playing with Resistance

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1 Aim

The aim is to determine both the static and kinematic coefficients of a cart with a friction pad on an incline.

2 Apparatus

See lab sheet.

3 Procedure

See lab sheet.

4 Variables

Independent Variable

- θ: angle of the incline (deg)

5 Data Collection

See Table 1 for static friction measurement and Table 2 for kinetic friction measurement.

Table 1: Raw Data (Static)

θ **angle** (deg)	**uncertainty**
5.07	-0.33
5.69	0.29
5.16	-0.24
5.60	0.20
5.52	0.12
5.38	-0.02

Table 2: Raw Data (Kinetic)

θ **angle** (deg)	**uncertainty**
4.05	-0.01
3.97	-0.09
4.06	0
4.15	0.09
3.93	-0.13
4.20	0.14

6 Data Analysis

We can calculate our raw data into different statistical values by using:

- mean, $\bar{x} = \dfrac{1}{n}\left(\sum_{i=1}^{n} x_i\right)$
- relative uncertainty, $\delta = \pm(\max|x_i - \bar{x}|)$

  in words: for each data in dataset, subtract the data with the mean, then use the absolute value of that. After doing this for every data in dataset, pick the maximum one and assign $\pm$ to it, and this is the relative uncertainty of such dataset.
- absolute uncertainty, $\sigma = \dfrac{\tan(\bar{x}+\delta) - \tan(\bar{x}-\delta)}{2}$
- friction coefficient, $\mu = \tan\bar{x}$ (μ_s for static friction and μ_k for kinetic)

thus we can calculate the analytical data of the static friction as following:

$$\bar{x} = \frac{1}{6}\left(\sum_{i=1}^{6} x_i\right) = \frac{1}{6}\cdot 32.42 = 5.40$$

$$\delta = \pm 0.33$$

$$\sigma = \frac{\tan(5.40+0.33) - \tan(5.40-0.33)}{2} = 0.006$$

$$\mu = \tan 5.40 = 0.095$$

The analytical data of Kinetic Friction can also be calculated using the same methodology. The result has been shown in Table 3.

Type of Friction	$\bar{x}$	δ	μ
μ_s (Static)	5.40	± 0.33	0.095 ± 0.006
μ_k (Kinetic)	4.06	± 0.14	0.071 ± 0.002

Table 3: Analytical Data

Also, the mass is having no effect on the coefficient of friction. In equation $\mu = \frac{F_f}{F_N}$. where F_f and F_N will all be fixed due to the mass added will not apply additional friction on the cart, so that way μ will be fixed too, and therefore it should not change.

7 Conclusion

We can observe from the data that the static friction of the cart is greater than its kinetic friction, indicating the bond between the contact surface of friction pad on cart and the vernier track needs a much larger energy to break, comparing to constantly breaking the bonds when it is moving. Also we can see that whenever the mass is, it will not effect the coefficient of friction.