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AP Physics C: Mechanics

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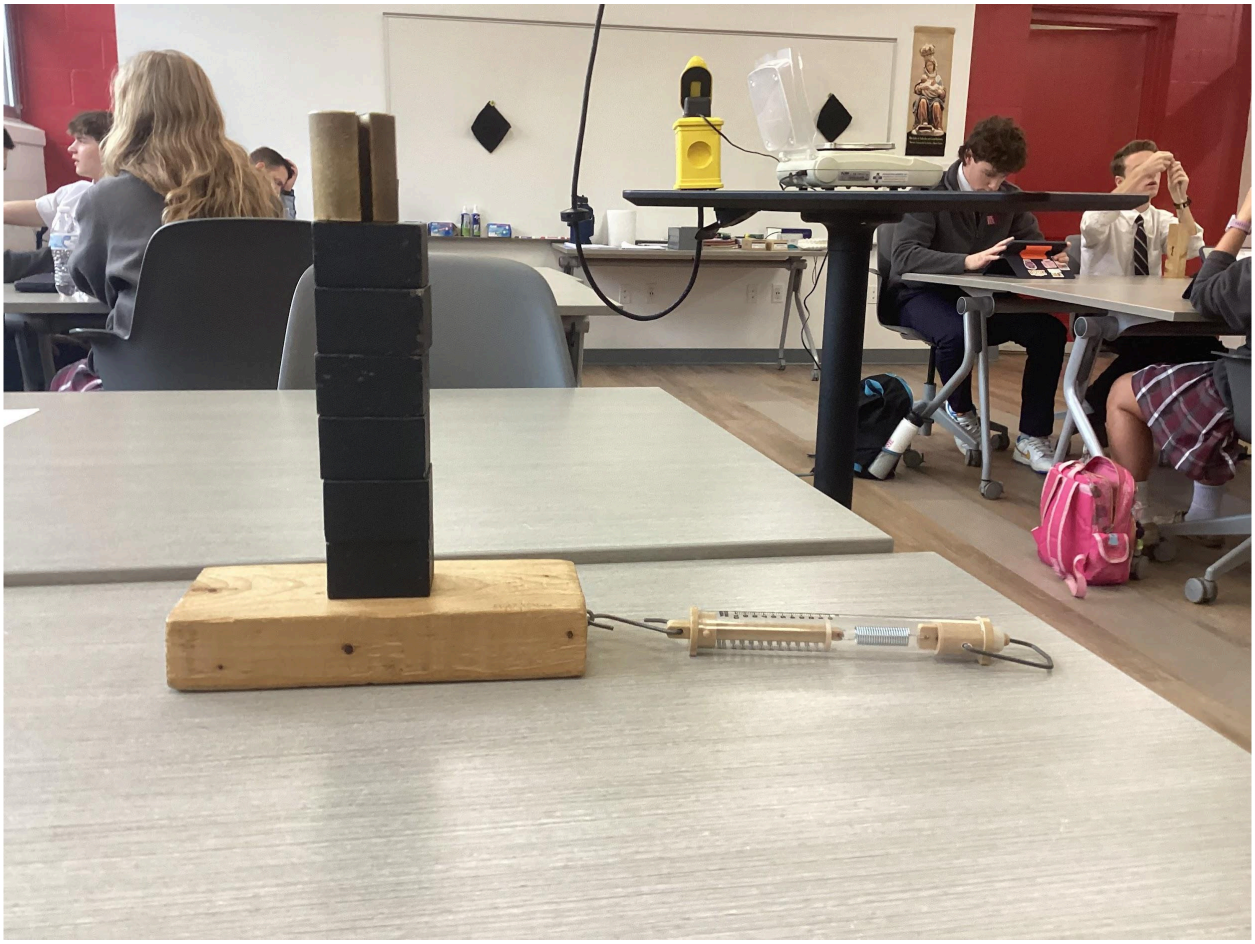
Friction Force Lab Report

Purpose:

To determine the graphical and mathematical relationship between normal force and the maximum static frictional force and the kinetic frictional force.

Apparatus:



Procedure:

1. Place the wooden block flat on the table with its wide side down.
2. Attach the spring scale to the block.
3. Zero the spring scale before each trial.
4. Add masses to the block to increase the normal force.
5. For static friction trials, pull gently with the spring scale and record the force just before the block begins to move.

6. For kinetic friction trials, continue pulling so the block moves at constant velocity; record the steady force reading.
7. Repeat steps 4–6 for eight different mass values.
8. Convert each mass to normal force using N=mg.
9. Plot maximum static friction vs. normal force and kinetic friction vs. normal force and fit a line to analyze the relationship.

Data Table:

	Data Set 1		
	Mass (g)	Force at ... (N)	Force Bef... (N)
1	321.3	1.4	1.6
2	521.0	2.0	2.2
3	720.7	2.6	2.8
4	920.5	3.2	3.4
5	1120.1	4.0	4.2
6	1319.9	4.4	4.8
7	1517.9	5.4	5.6
8	1716.8	5.8	6.0

	Calculated
	Normal F... (N)
1	3.213
2	5.210
3	7.207
4	9.205
5	11.201
6	13.199
7	15.179
8	17.168

Sample Calculations:

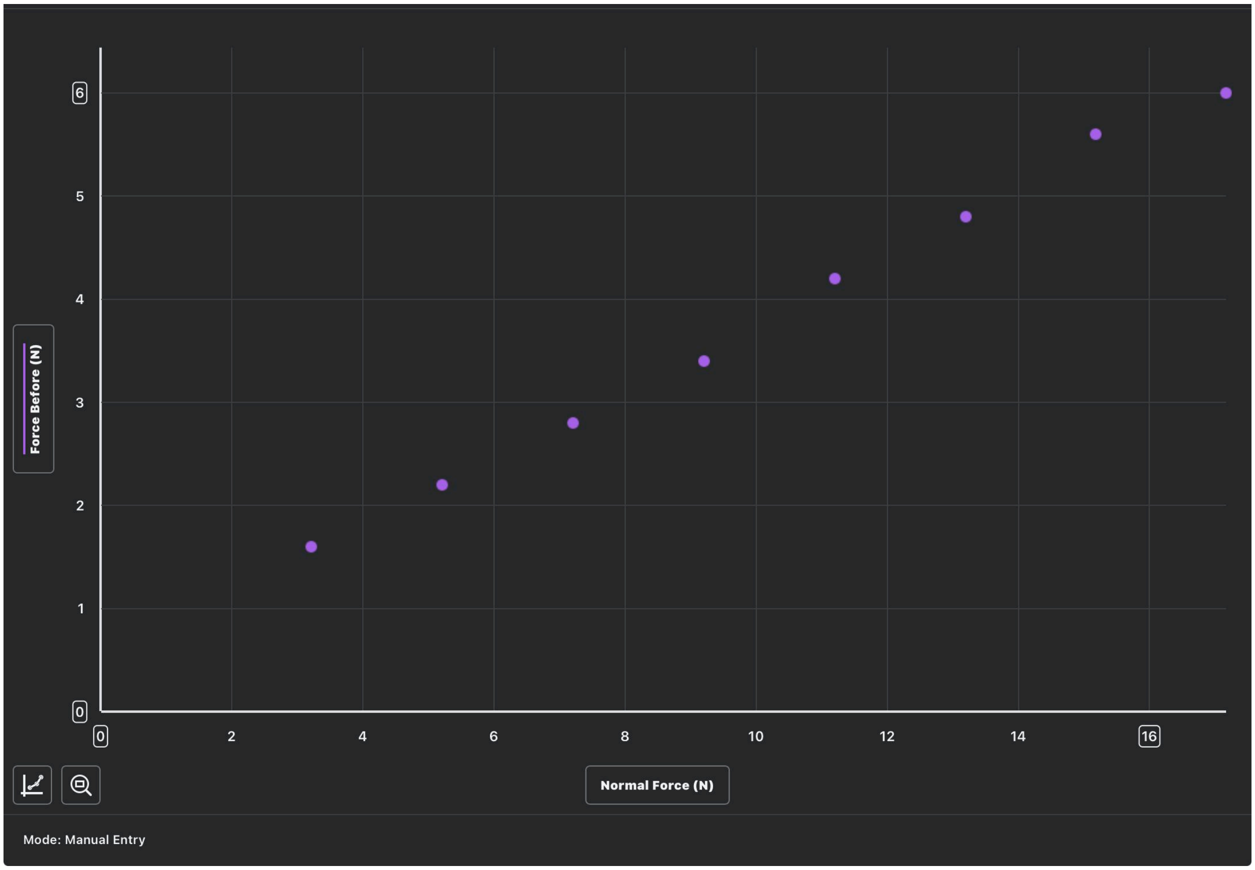
Normal Force= mg = kg x m/s^2

g : kg = 1000 : 1

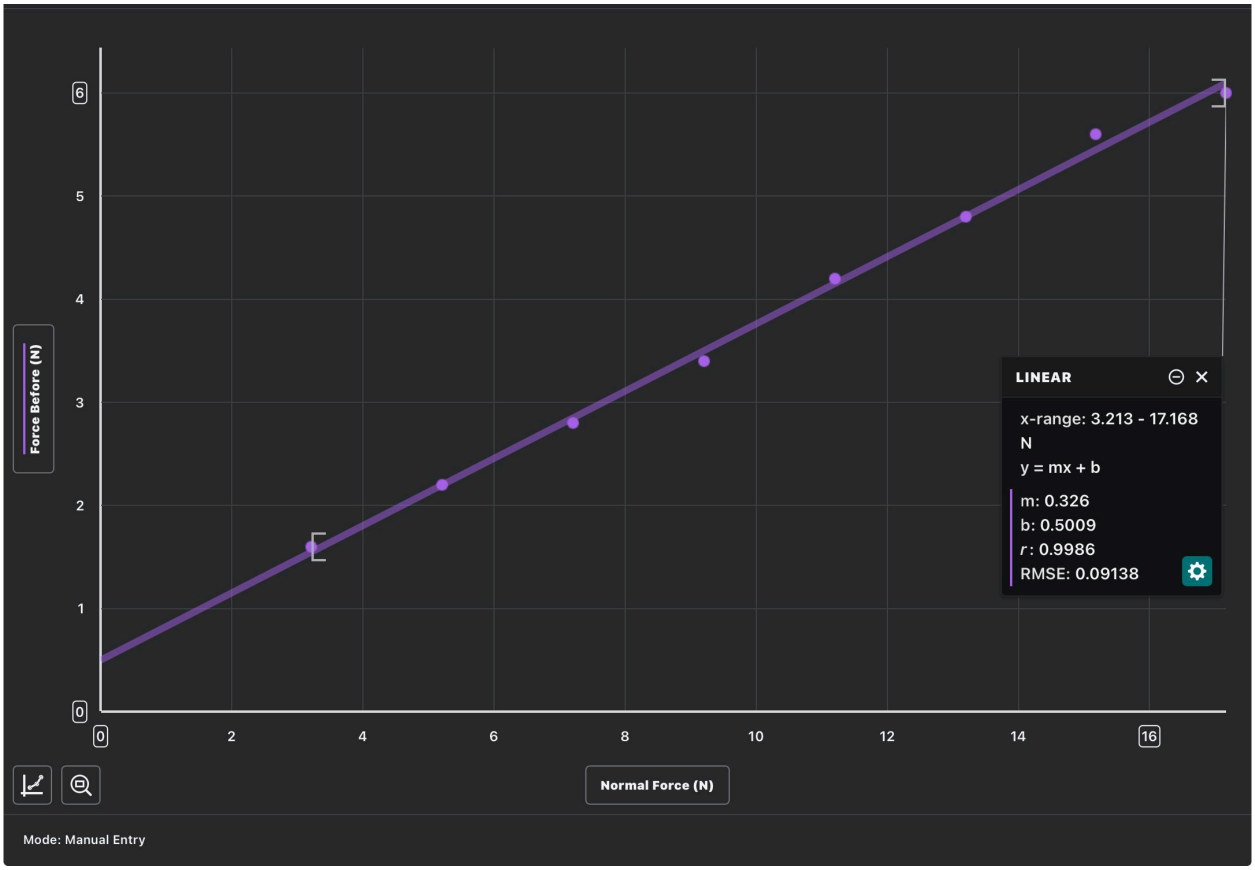
Normal Force= (m/1000) x g

Normal Force= (321.3g/1000) (10 m/s^2) =3.213 kg x m/s^2

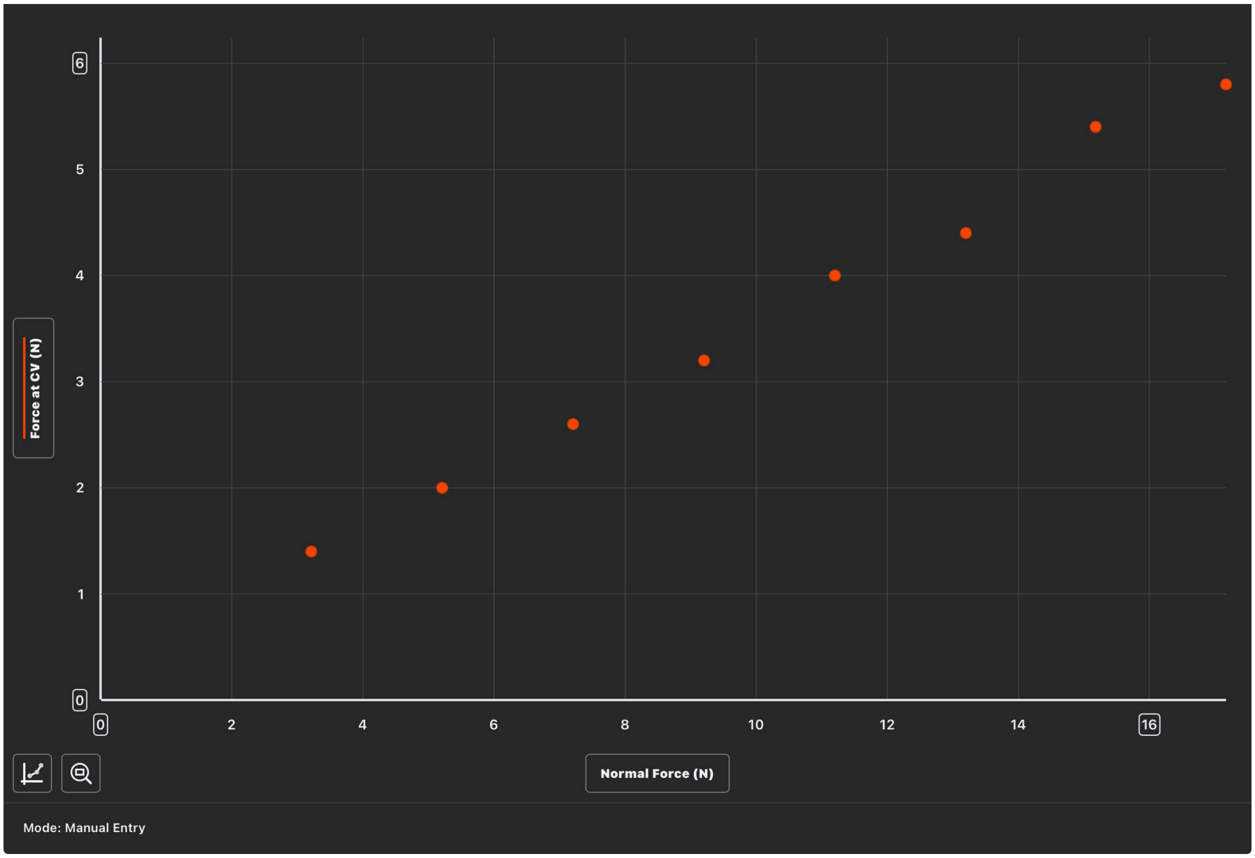
Graphs and Analysis:



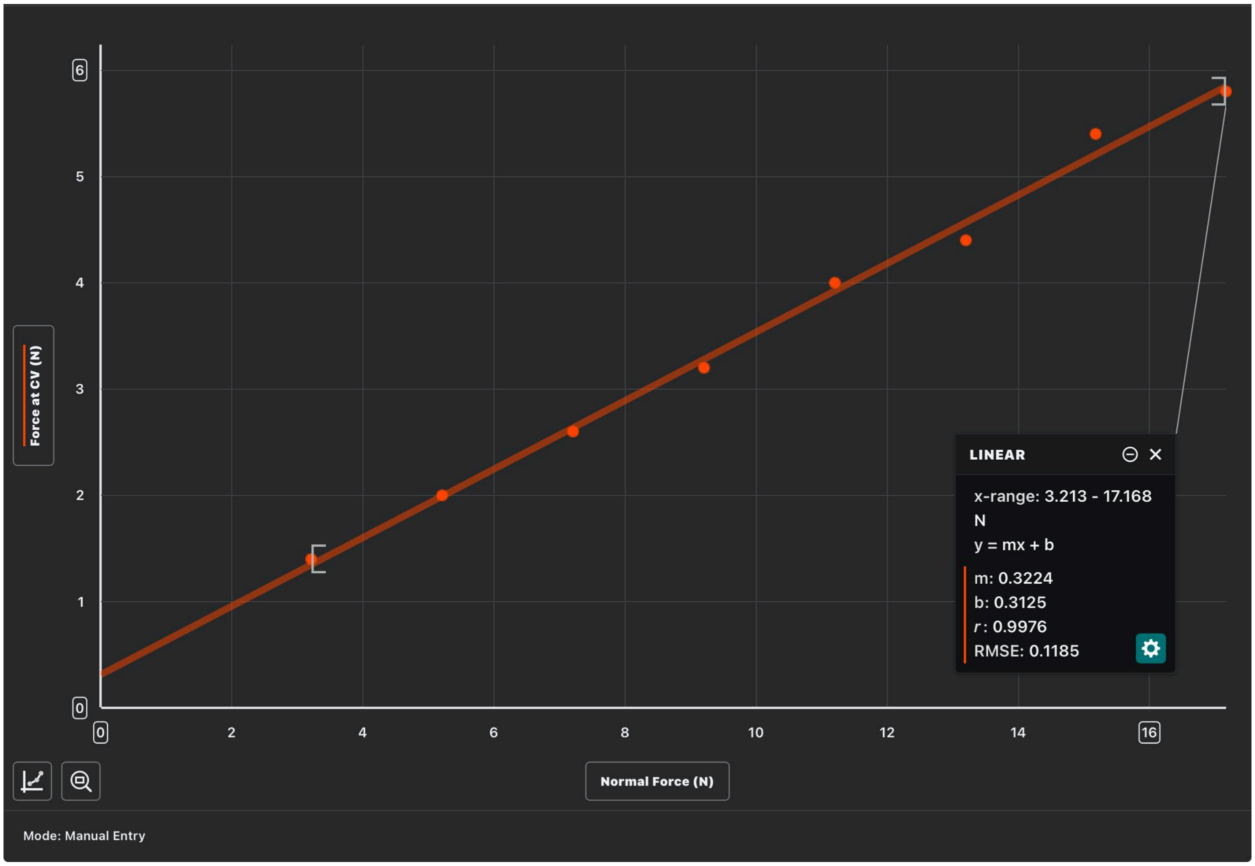
Force Before (N)
6
5
4
3
2
1
0
0
2
4
6
8
10
12
14
16
Normal Force (N)
Mode: Manual Entry



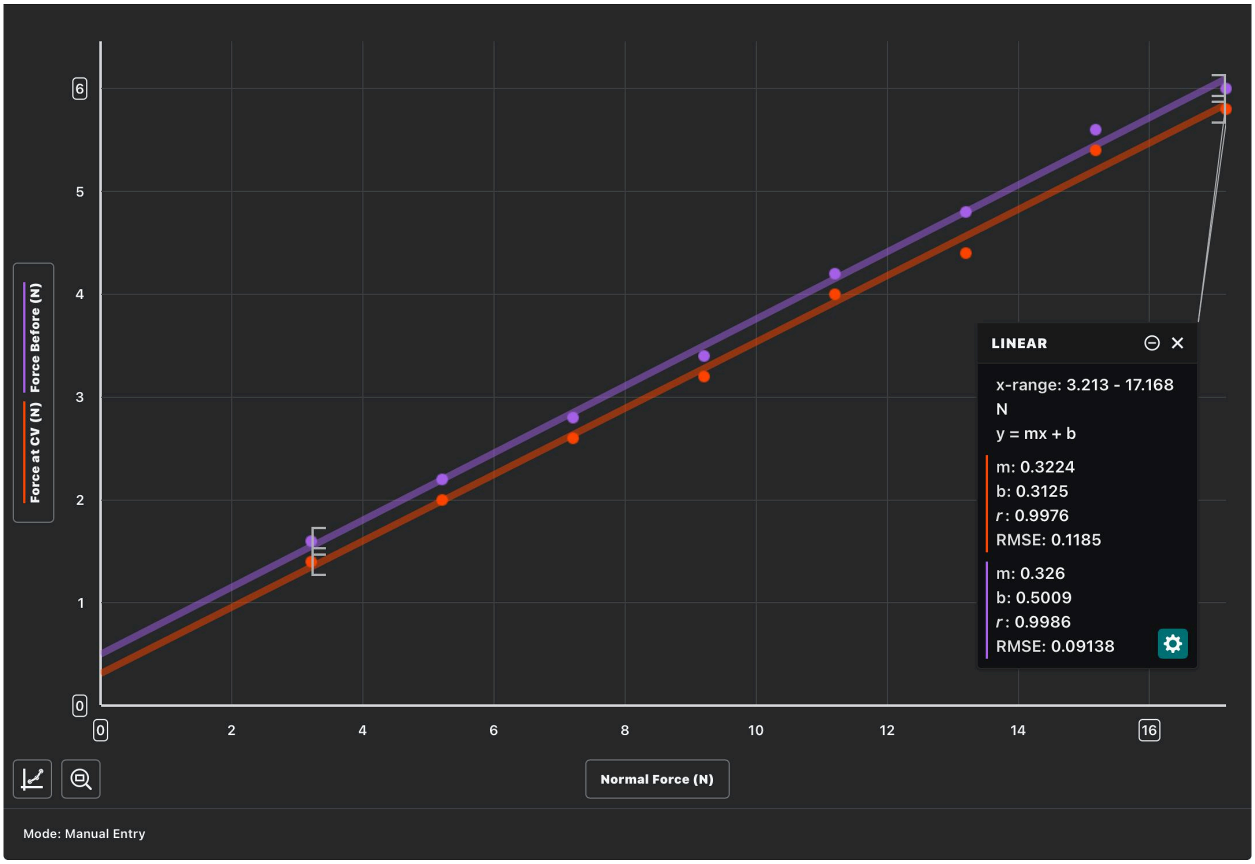
Force Before (N)
Normal Force (N)
LINEAR
x-range: 3.213 - 17.168 N
y = mx + b
m: 0.326
b: 0.5009
r: 0.9986
RMSE: 0.09138
Mode: Manual Entry



Force at CV (N)
Normal Force (N)
0
1
2
3
4
5
6
0
2
4
6
8
10
12
14
16
Mode: Manual Entry



Force at CV (N)
6
5
4
3
2
1
0
0
2
4
6
8
10
12
14
16
Normal Force (N)
LINEAR
x-range: 3.213 - 17.168 N
y = mx + b
m: 0.3224
b: 0.3125
r: 0.9976
RMSE: 0.1185
Mode: Manual Entry



Ff, static =(0.326) N+0.5009

Ff, kinetic =(0.3224) N+0.3125

Conclusion:

The experiment demonstrated a strong linear relationship between frictional force and normal force, confirming the theoretical model Ff=μFN. The slope of the static friction graph (μs≈0.326) and the slope of the kinetic friction graph (μk≈0.322) represent the coefficients of friction for the block–table system. The generalized equations are therefore: Ff, static =μsFN and Ff, kinetic =μkFN with μs and μk as dimensionless constants. The small positive y-intercepts (≈0.3–0.5 N) are not physically meaningful in the ideal model and arise from a combination of human error, namely, difficulty reading the spring scale precisely and maintaining constant velocity, along with inconsistent equipment calibration. These systematic offsets explain why the relationship is not perfectly proportional, even though theoretically the line should pass through the origin. Other sources of error included calibration drift in the spring scale, uneven distribution of added masses, and surface irregularities that affected motion. To improve accuracy, the procedure could be refined by re-zeroing the scale before each trial, using a smoother surface, or by using much more precise techniques and/or equipment. Despite these imperfections, there is a strong correlation which demonstrates an excellent agreement between experimental and theoretical values, validating the generalized friction model.