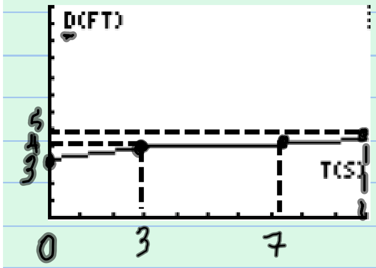
Objective: Graph matching d-t graphs using a CBR motion detector. Determine math relationship between d + t.

Procedure: The equipment used -- TI84 calculator, TI-CBR motion detector, CBL-CBR graph matching application, + USB cord to interface with TI-Connect software on computer.

1. Connect CBR to calc., start CBL/CBR application on calc. Select RANGER and ENTER. Under MAIN MENU select APPLICATIONS, then FEET. Under APPLICATIONS, select DIST MATCH, then ENTER.

2. Study the calc. screen, which is a d-t graph. Use the CBR to position yourself from the wall to match the graph's start point. Then holding the CBR, move forward/backward over time to match your motion with the graph.

3. Perform this for 5 graphs and capture each screen using USB cord + TI Connect on computer. Copy + paste the screen captures into a Word.doc + print for further analysis.

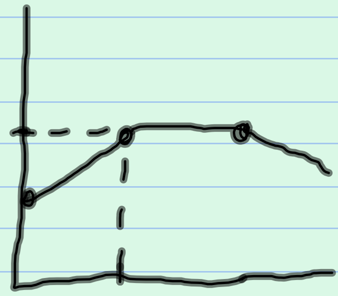


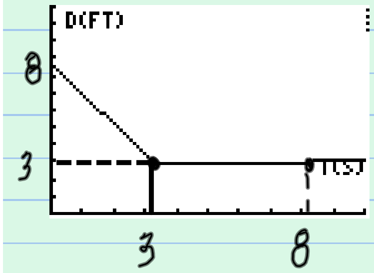
$v_{0\to3} = \frac{4-3}{3} = 0.33\ \frac{ft}{s}$

$v_{3\to7} = \frac{4-4}{4} = 0\ \frac{ft}{s}$

$v_{7\to10} = \frac{5-4}{3} = 0.33\ \frac{ft}{s}$

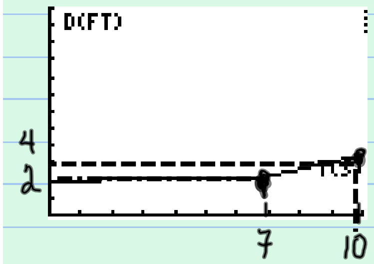
$\boxed{v = \frac{d_f - d_i}{t}}$





$v_{0-3} = \frac{3-8}{3} = -1.67\ \frac{ft}{s}$

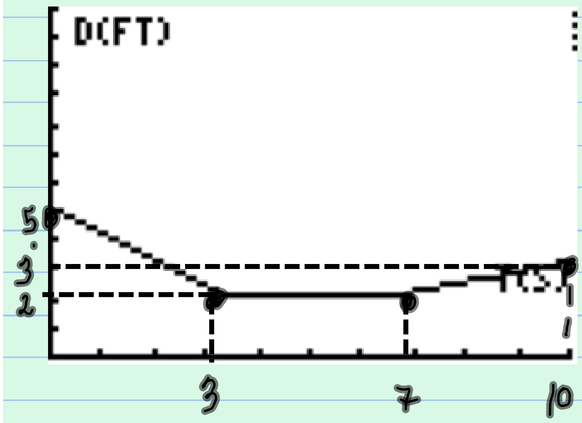
$v_{3-8} = \frac{3-3}{5} = 0\ \frac{ft}{s}$



$v = \frac{d_f - d_i}{t}$

$v_{0-7} = \frac{2-2}{7} = 0 \frac{ft}{s}$

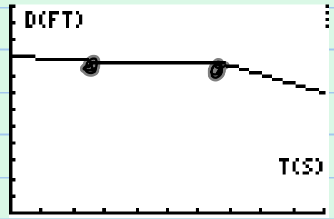
$v_{7-10} =$ finish



$v = \frac{d_f - d_i}{t}$

$v_{0\to3} = \frac{2-5}{3} = -1 \frac{ft}{s}$

$v_{3\to7} = \frac{2-2}{4} = 0 \frac{ft}{s}$



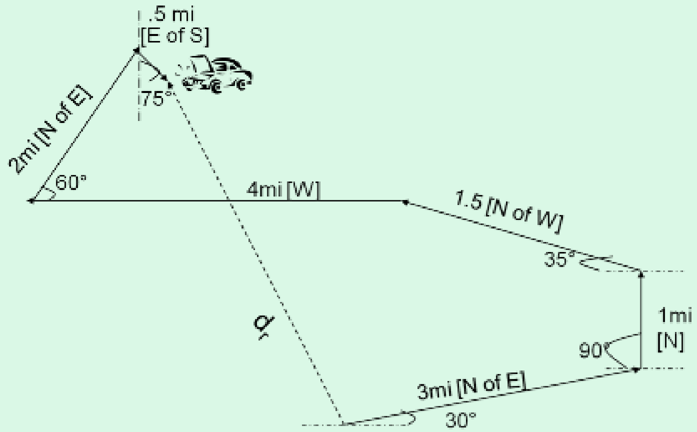
finish

Conclusion: if $y = mx + b$, m is slope; then on a d-t graph $d = vt$ where v is slope. $\left(v = \frac{d}{t}\right)$

Objective: Design a practice problem for finding resultant displacement of 6 vectors.

Procedure: Create a "story" problem by using examples from problems in the textbook. Six vectors were added tip-to-tail. All but 2 vectors must contain an angle. The story, scaled-diagram, and solution was then typed into a Word.doc.

A bank robber named Bubba Joe is fleeing from the police. Driving 3 miles at 30° North of East, he veered North for one mile. He then veered 35° North of West to avoid a blockade. After going 1.5 miles, he turned West and drove for 4 miles on the highway. He takes an exit and drives into the country on a dirt road at 60° North of East for 2 miles. Finally he turns into a pasture and drives half a mile at 75° East of South before hitting a tractor resulting in his capture. How far did Bubba Joe get from the bank before hitting the tractor and getting caught by the authorities (find the resultant)?

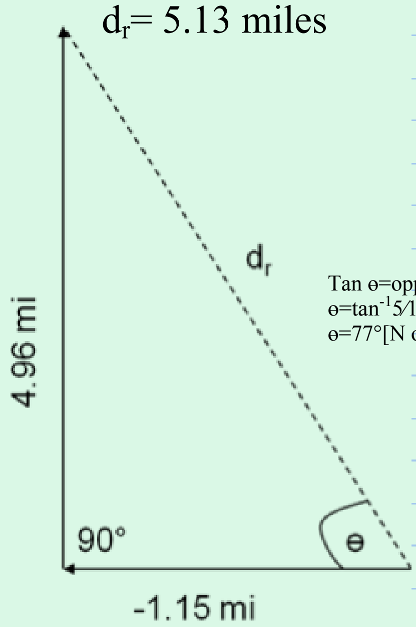


$\Sigma d_x = 3\cos 30 - 1.5\cos 35 - 4 + 2\cos 60 + 0.5\cos 15 = -1.15$ miles

$\Sigma dy = 3\sin 30 + 1 + 1.5\sin 35 + 2\sin 60 - 0.5\sin 15 = 5$ miles

$d_r = \sqrt{(5^2 + 1.15^2)}$

$d_r = 5.13$ miles



Tan θ=opp/adj

$\theta = \tan^{-1} 5/1.15$

θ=77°[N of W]

ANSWER: 5.13mi77°[N of W]

Conclusion: Vector addition is the sum of components in the x and y direction. So the sum of the components are the two sides of a simple right triangle where the resultant magnitude and direction can be found.

Objective: Find the resultant Force vectors and the equilibrants. Use Newton's 2nd Law, F=ma. For static equilibrium, the sum of the force components in each direction =0.

Procedure: Using a force table, hanging masses, and mass hangers, set up three Force vectors. Physically, graphically, and mathematically find the resultant (F_r) and equilibrant (F_{eq}) Force of the three vectors. The equilibrant is equal in magnitude but opposite in direction to the resultant force of the three individual vectors.

Data & Calculations

$35g = .035 Kg (9.8 \frac{m}{s^2}) = .343N$

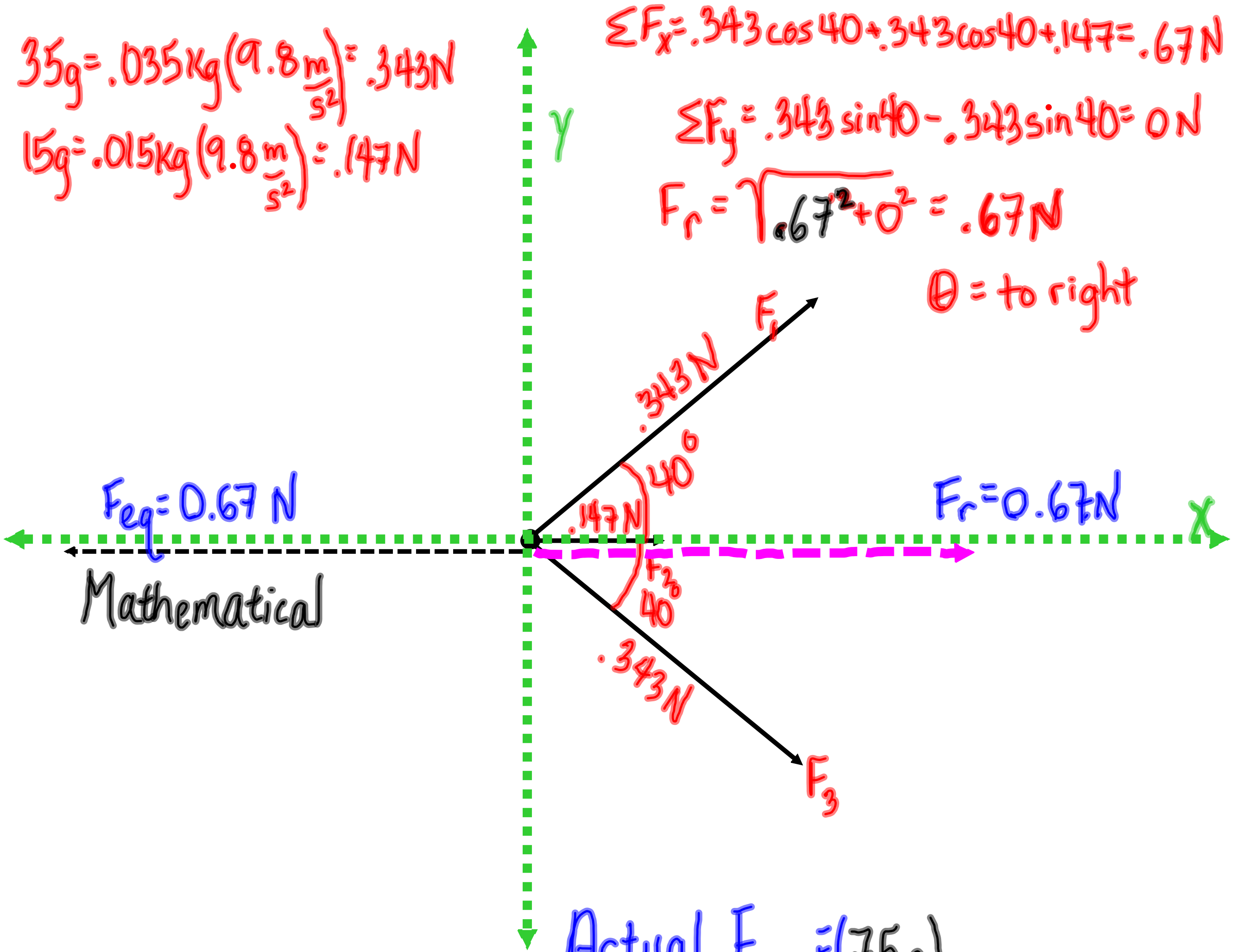
$15g = .015 Kg (9.8 \frac{m}{s^2}) = .147N$

$\Sigma F_x = .343 \cos 40 + .343 \cos 40 + .147 = .67 N$

$\Sigma F_y = .343 \sin 40 - .343 \sin 40 = 0 N$

$F_r = \sqrt{.67^2 + 0^2} = .67N$

θ = to right



Actual F_{eq} = (75g)

$.075 kg (9.8 \frac{m}{s^2}) = 0.735N$

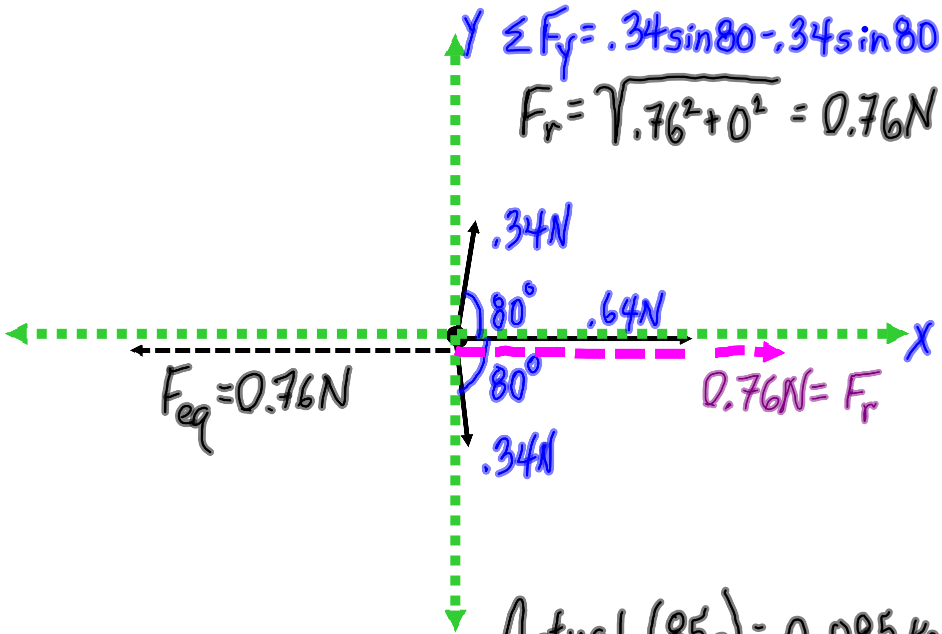
$65g = 0.065kg(9.8\frac{m}{s^2}) = 0.64N$

$35g = 0.035kg(9.8\frac{m}{s^2}) = .34N$

$\Sigma F_x = .34\cos 80 + .34\cos 80 + .64N = .76N$

$\Sigma F_y = .34\sin 80 - .34\sin 80 = 0$

$F_r = \sqrt{.76^2 + 0^2} = 0.76N$ to right



Actual $(85g) = 0.085\,kg(9.8\frac{m}{s^2})$
$= 0.833N$

$$0.085kg\left(9.8\frac{m}{s^2}\right) = 0.833N$$

$85g = 0.085kg(9.8\frac{m}{s^2}) = 0.833N$

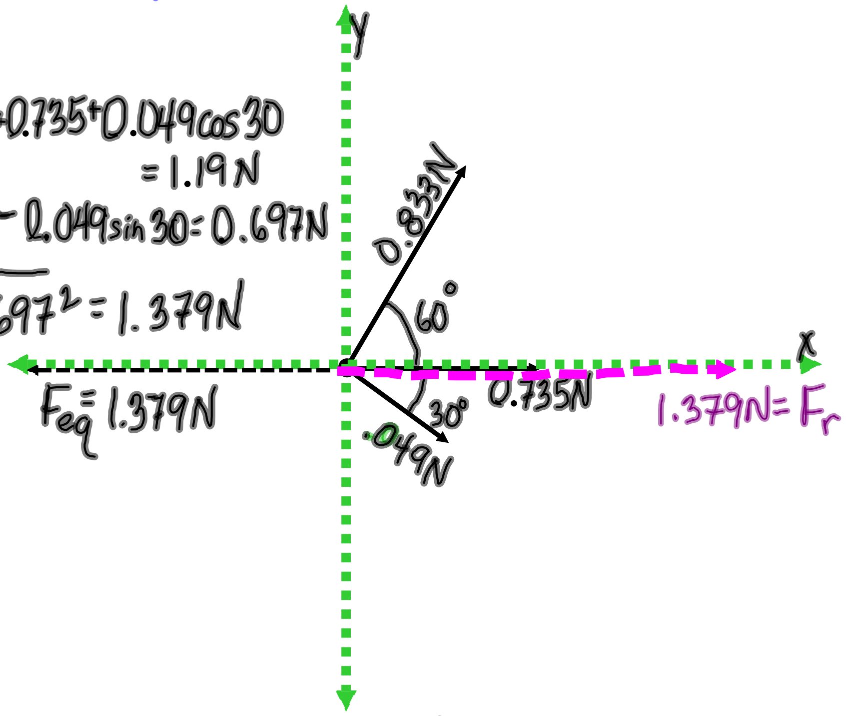
$75g = 0.075kg(9.8\frac{m}{s^2}) = 0.735N$

$50g = 0.050kg(9.8\frac{m}{s^2}) = 0.49N$

$\Sigma F_x = 0.833\cos60 + 0.735 + 0.049\cos30$
$= 1.19N$

$\Sigma F_y = 0.833\sin60 - 0.049\sin30 = 0.697N$

$F_r = \sqrt{1.19^2 + 0.697^2} = 1.379N$



Actual = 143g = $.143kg(9.8\frac{m}{s^2})$
= 1.4N to right

Conclusion: The resultant Force vector is the vector sum of the x and y components of each individual vector. Pythagorean theorem is used to find the magnitude of the resultant vector F_r. The equilibrant, F_{eq}, is opposite in direction but equal in magnitude to the F_r. The equilibrant balances out the resultant. In this lab, the mathematical resultant and equilibrant were found. Also, the force table and masses were used to find the physical (actual) equilibrant. The mathematical calculation is more correct, but errors in actual data were due to the force table not being completely level and hanging masses were only as small as 5 grams.

Objective: To find the coefficient of static and kinetic friction between two surfaces. The two surfaces that come in contact are wood and sandpaper (or painted steel and unpainted steel).

Procedure: (list step by step what group did-use the following terms in the descriptions: EasyData application, CBL device with cradle (calculator-based laboratory), TI-84Plus, Vernier Force probe (setting 10N), zeroed force probe, inclined plane, friction block, brass weight, interfaced with computer, USB cord, TI-Connect application, copy/paste, Word.doc, coefficient of friction both static and kinetic, constant velocity (a=0), applied force was parallel to plane, static region, kinetic region, etc.)
Diagram of set-up with free body diagram. Use straight edge whenever possible. **Label all forces**, normal force, force applied, force of friction, weight or mg, and angle, etc.

Data/Calculations: Cut out screen captures of calculator. Show $\sum F=ma$ for both x and y under free body diagram. Solve algebraically for coefficient of friction, μ. Do first for static region of graph and then kinetic region of graph. Use a data table to organize it. See example below.

Data table	Static Region	Kinetic Region
m (kg)		
weight (N)		
F_n (N)		
F_f (N)		
μ	$\mu_s=$	$\mu_k=$

Conclusion: Make a statement of the result for μ_s and μ_k.

Objective: To find out if total energy is conserved when bouncing a basketball up and down.

Procedure: Use the following terms in a description of the process followed while performing this lab----TI-84 graphing calculator, CBR, Ball Bounce application, basketball (556 g) or tennis ball (59 g), TI-connect, computer, usb cord, meter stick, and screen capture. Use the procedure in the handout given in class.

Data and Calculations:
paste 5 screen captures with position label below each, then data table-drawn with straight edge by hand, with units after each value. Show how to do each type of calculation below data table. Do calculations for all 5 positions, but only have to show work for one position.
Next respond to preliminary questions in complete sentences as a statement.
Next respond to conclusion questions in complete sentences as a statement.

Conclusion: Discuss if energy was conserved. Why or why not? Be specific.

Objective: Make quantitative measurements of circular motion and find the magnitude of the centripetal force on a string.

Draw a labeled diagram of the apparatus used.

Procedure: (Use all the names of the equipment used and listed on the handout. Without using word-for-word from the handout, describe the procedure with NO PRONOUNS.

.

Data & Calculations: (Make a data table to hold all the data and the calculated values. Show work for calculations below the data.)

	mass (kg)	time (s) 5 revs	radius (m)	period (s)	weight (N)	circ (m)	v_t (m/s)	F_c (N)
1a								
1b								
1c								
1d								
2a								
2b								
2c								
2d								
3a								
3b								
3c								
3d								
4a								
4b								
4c								
4d								

do show Calculations 1 from each set.

$$\tau = \frac{\text{time } 5 \text{ rev}}{5} = \_\_\_\ s$$

$$\text{Weight} = m \cdot a_g$$

$$\text{Circumference} = 2\pi r$$

$$v_t = \frac{\text{circ}}{\tau}$$

$$F_c = m\frac{v_t^2}{r}$$

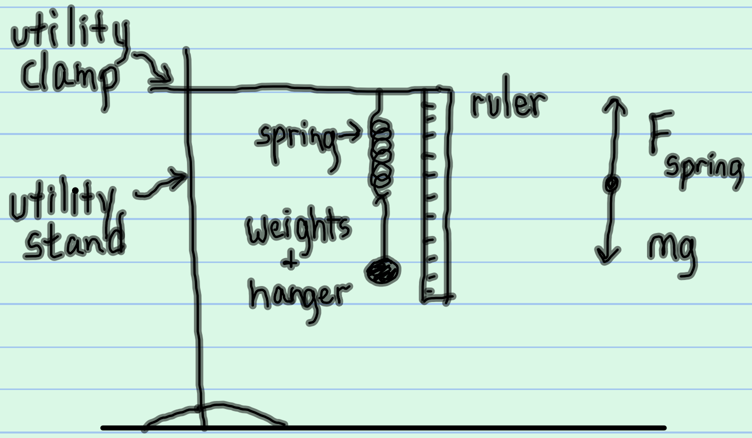
Conclusion: To mathematically derive Newton's second law starting with $F=mv^2/r$. The final formula will have variables of F, m, π, r, and T.

$$F = \frac{mv^2}{r} = \frac{m\left(\frac{circ^2}{T^2}\right)}{r} = \frac{m(2\pi r)^2}{T^2 r} = \frac{m4\pi^2 r^{\cancel{2}}}{T^2 \cancel{r}} = \frac{4m\pi^2 r}{T^2}$$

if $v = \frac{d}{t} = \frac{circ}{T}$

Objective: Find the spring constant of a given spring. Using Hooke's Law, F=-kx, where F is the force in Newtons of the spring, k is the spring constant in N/m, and x is the amount of displacement the spring is stretched in meters.

Procedure: (Draw a labeled diagram of equipment setup. Use the following terms in the procedure: utility stand, utility clamp, spring, weight hanger, slotted weights, ruler. Use concise descriptions with NO PRONOUNS.

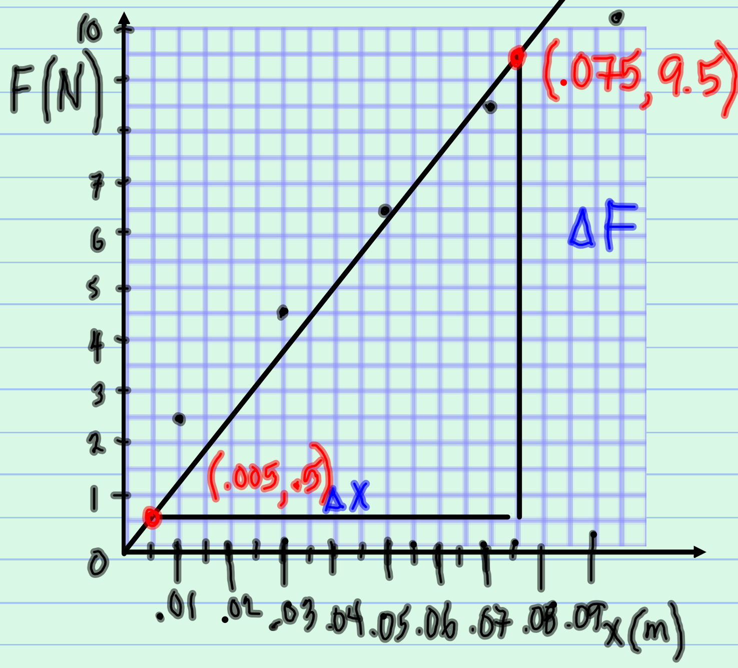


Data and Calculations:

mass (kg)	Force=mg (N)	x (m)
0.25	2.45	.01
0.45	4.41	.03
0.65	6.37	.05
0.85	8.33	.07
1.05	10.29	.09

L_0 spring = 0.075m

K is the slope of the best fit line through the 5 points and (0,0)



$F = kx$

$$k = \frac{\Delta F}{\Delta x} = \frac{9.5 - .5}{.075 - .005}$$

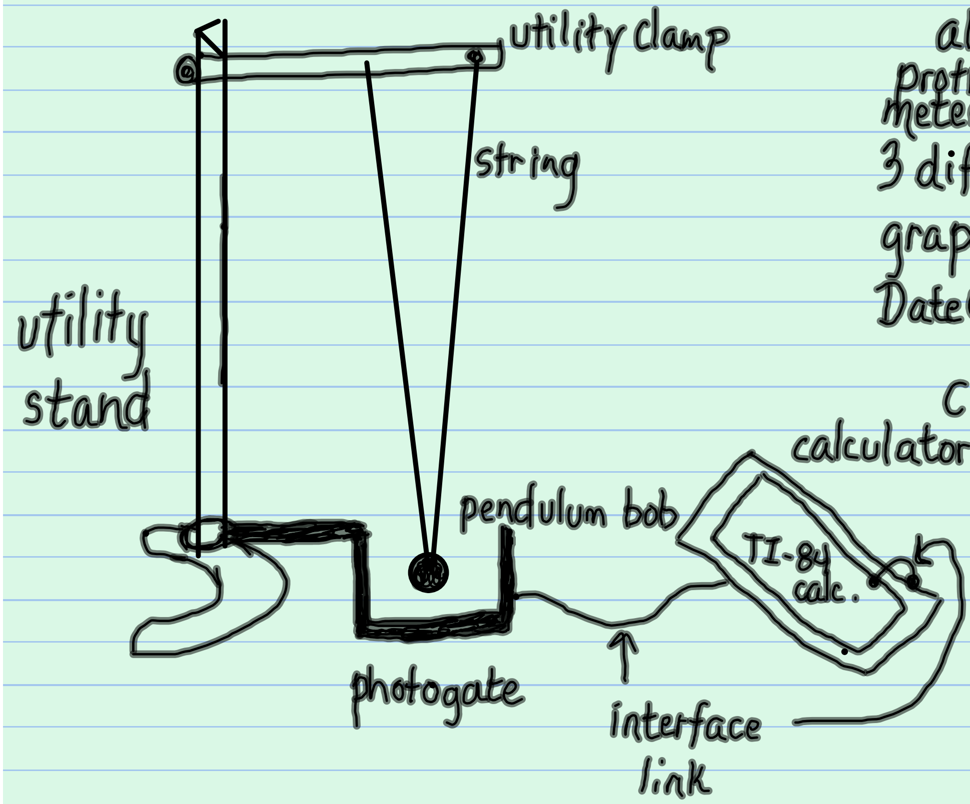
$$= \frac{9}{.07}$$

$$k = 129 \frac{N}{m}$$

Conclusion: The slope of the best fit line is equivalent to the spring constant. The graphical value for this spring is 129 N/m.

Objective: To determine if changing the amplitude (A), length (l), or mass (m) will effect the period of a pendulum (T). Also, the math relationship of $T=2\pi\sqrt{(l/g)}$ is verified with lab results.

Procedure: Set up equipment as shown in diagram.



also needed:
protractor
meterstick
3 different mass bobs
graphing software
DateGate calculator program

use the terms - explain controlled experiment,
amplitude - 5 different angles,
equilibrium position

length - 6 in meters

mass - 3 materials of lead, brass, wood

use DATAGATE, CBL, photogate,

Data + Calculations:

tape 4 graphs in order
in caps, label graphs

Period vs. Amplitude

Period vs. Length

Period vs. mass

Period^2 vs. Length

Conclusion: In this controlled experiment, the data shows there is no relationship of amplitude and mass to the period of a pendulum. Length has a relationship to period, shown by a power curve (power = 0.5 or square root).

To linearize the power curve, period values were squared and plotted against length.

The slope of the best fit line for this graph should be the constant $\left(\frac{4\pi^2}{g}\right) = 4.02$

$$T = 2\pi\sqrt{\frac{l}{g}}$$

$$T^2 = \boxed{\frac{4\pi^2}{g}}\, l$$

Actual lab data for this slope = 4.15

This verifies the formula relating period and length.

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