Phys 11A Lab - Eiteneer

Friction Analysis Redux

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Objective statement / purpose of the experiment -

We are going to design, carry out, and analyze an experiment by which we determine a coefficient of kinetic friction between a wooden slab and a wooden block, as well as the amount of work done by friction in this experiment (both static and kinetic friction). We will try our best to increase the angle of the inclined plane until the static friction reaches the maximum possible static friction for the object to start sliding. We are going to learn more about frictional forces and the work done on objects this time.

Theory/background and Experimental procedure –

We will use a wooden slab or a wooden board for one of the inclines, with possible consideration for other materials to be used as the incline, like a cardboard ramp, or a metal ramp. Other objects that we can use apart from the wooden block to slide down the incline could be a brick, a book, and a small cardboard box filled with coins. Tools that we can use involve a measuring tape to help us determine the length of the inclines as well as stopwatches to determine how long it took a certain object to slide down the incline. We will also be using a protractor to measure the angle of the incline and use books, paper, boxes to increase the incline angle by stacking them under one end of the so-called “sliding ramp”. We can also try measuring force with a spring scale. Some formulas that we can use, based on the previous lab, will be shown below:

Coefficient of Static Friction:

$$\mu_s = tan(\Theta)$$

Uncertainty of Coefficient of Static Friction:

$$\delta\mu_s = \left(\frac{1}{cos(\theta)}\right)^2 \delta\theta$$

Coefficient of Kinetic Friction:

$$\mu_k = tan(\Theta) - \frac{a}{g cos(\theta)}$$

Uncertainty of Coefficient of Kinetic Friction:

$$\delta\mu_k = \left(sec^2\theta + \frac{a tan(\theta)}{g cos(\theta)}\right)\delta\theta$$

Acceleration, which can be determined by rearranging the distance formula we were given:

$$d = \frac{1}{2}at^2 \Rightarrow a = \frac{2d}{t^2}$$

Uncertainty in Acceleration:

$$a = \frac{2d}{t^2}$$

$$\frac{\partial a}{\partial d} = \frac{2}{t^2} \qquad \frac{\partial a}{\partial t} = \frac{-4d}{t^3}$$

$$\boxed{\delta a = \sqrt{\left(\frac{\partial a}{\partial d}\delta d\right)^2 + \left(\frac{\partial a}{\partial t}\delta t\right)^2}}$$

*We couldn’t type that one symbol for some odd reason, so we wrote it.

Force:

Force = Mass * Acceleration

Work:

Work = Force * Distance

Work (With regards to force of static friction):

Work = $f_s * Distance$
$f_{s,max}$ = $\mu_s n$, where n = mass * gravity
$f_{s,max}$ = $\mu_s mg$
Work = $\mu_s * mass * gravity * distance$

Work (With regards to force of kinetic friction):

Work = $f_k * Distance$
f_k = $\mu_k n$, where n = mass * gravity
f_k = $\mu_k mg$
Work = $\mu_k * mass * gravity * distance$

Work (On an inclined plane):
W = F * $cos\theta$ * change in x

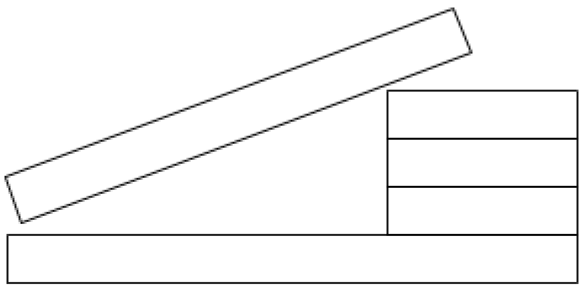
Friction (On an inclined plane):

$F_f = \mu n$

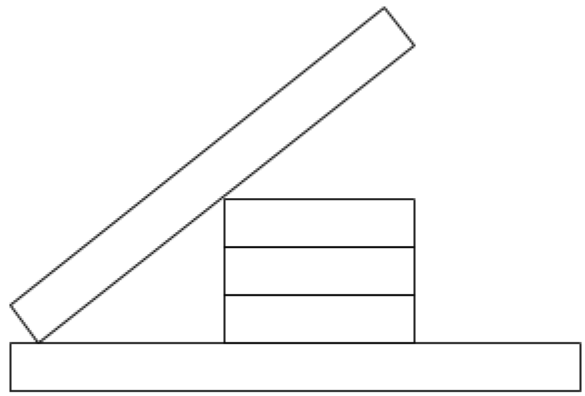
$F_f = \mu * m * g * cos(\theta)$

*And some other formulas if needed. We will know what we need when we get to it.

Some reference pictures below:



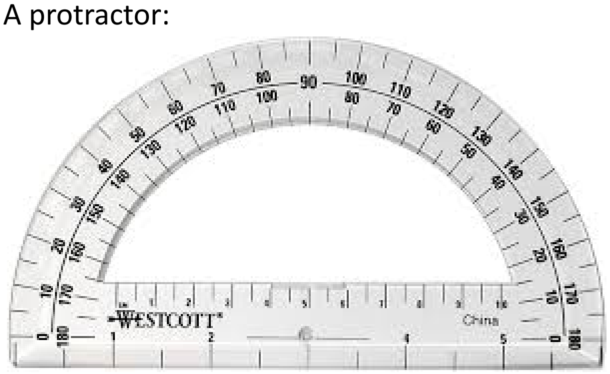
We will be using material like books and bricks to lift our incline.



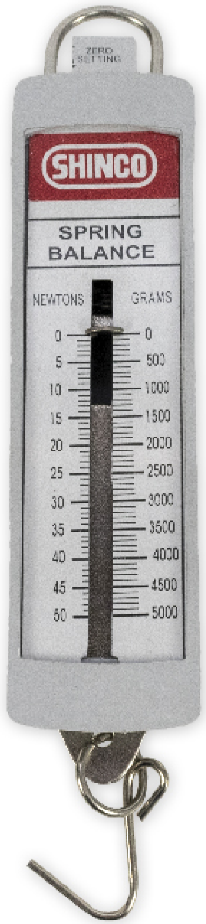
Should we need a steeper incline, we can always move that material more towards the middle.

Some of the tools we will be using:

A protractor:



A spring scale:



The box of coins that we could be sliding down our ramp (*Just for reference, we could end up using other items instead):

A long wooden board that could be used for our incline surface, with possible consideration for other materials as the “ramp” to slide objects on:

==***EVERYTHING ELSE YOU SEE BELOW CAN BE IGNORED. WE JUST HAVE IT FOR WHEN WE DO OUR ACTUAL PROJECT REPORT. WE WILL BE AWAITING YOUR APPROVAL AND GATHERING**==

SOME MATERIALS TO SET UP OUR EXPERIMENT BEFORE WE BEGIN. BUT AS FAR AS THINGS GO, THIS IS OUR OUTLINE. HOPEFULLY EVERYTHING GOES WELL.

Results / data and analysis -

Error analysis -

Conclusion -

Bibliography/sources -