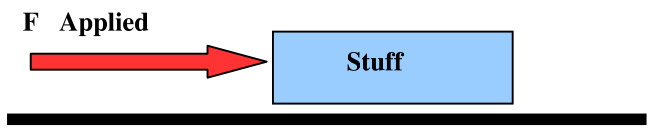
9

Friction n' stuff

When we push (apply force) on an object, assuming it is not bolted to the floor or otherwise to massive to be pushed, it will cause it to accelerate. We have seen this before and used the equation $F = m * a$. With this simple equation you can predict nifty things like the acceleration of an object if you know its mass and the applied force. Heck, you can even figure out the mass of an object if you know the applied force needed to achieve an acceleration. You can do all kinds of cool experiments....If you happen to like sucking star dust while holding your eyeballs in as you try to remain composed in the vacuum of space!



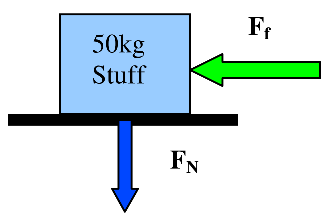
Frictionless surface......in your dreams

Fact is, it ain't happening here. We've got gravity. And when we have gravity, we have a force pushing down on our object. So, the above simple explanation just does not cut it here. For $F = m * a$ to work, we can't have any other forces, and let me tell ya, if you've got gravity...you've got friction.

Since gravity pushes down on stuff, and stuff will always have some friction between it's surfaces, there will always be some force acting against you as you push on your stuff.

Frictionful Surface......Real Life

Let's check out how gravity messes with our stuff.



Okay, we've got 50kg of stuff. Gravity sucks strait down on it, eager to pull it strait to the center of the Earth. However, our stuff is not pulled half way to China because an equal force from the ground or table is pushing it back up. Right at the interface of our stuff and the surface it is sitting on is where friction takes its toll.

Alrighty, Let's work through this. F_N in the above diagram is just the darn weight of an object. As you know, we can calculate it by simply using our warm and fuzzy $F = m * g$. You might recall that g is equal to about $9.8 m/s^2$. So for our example above it would work out something like this:

$$\mathbf{F_N = (50kg) \cdot (9.8m/s^2) = 490\ N \quad (Newtons).}$$

Now we need to talk about the coefficient of friction. The coefficient of friction is designated by the symbol μ.. μ is a number that represents the measured friction between your stuff and the surface on which it sits. μ depends completely on what the surfaces are and their condition.

So, you can calculate the force of friction ($\mathbf{F_f}$) as presented in our diagram above if you know the coefficient of friction (μ) and the normal force ($\mathbf{F_N}$) with this nifty equation:

$$\mathbf{F_f = \mu * F_N}$$

Soooooooooooooooooooooooooooooooooooo
How are we gonna calculate the coefficient of friction (**μ**)??

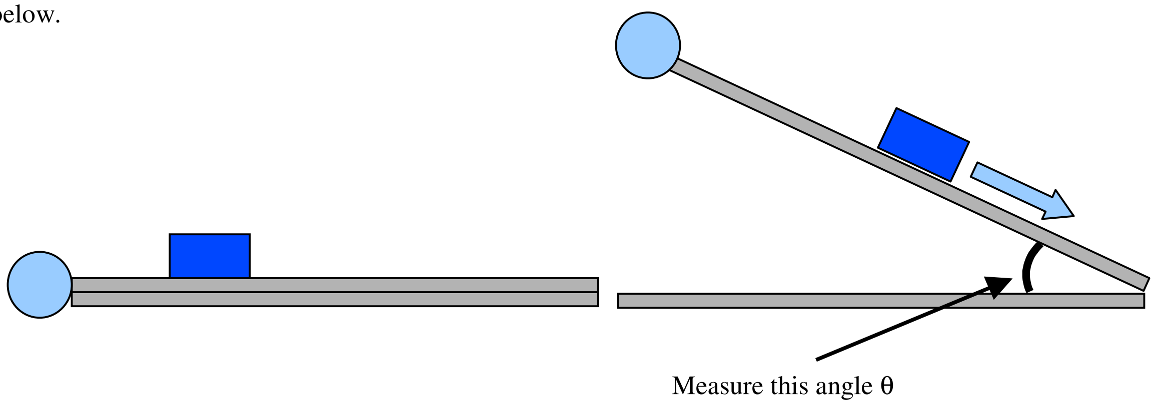
I am Sooo glad you asked!

Lab1

Weigh your block.

Record the weight of your block in your lab book.

Simply place your block of wood on the inclined plane while it is flat (horizontal) and SLOWLY raise the inclined plane until the block starts to move. As soon as it starts to move, measure the angle at which the inclined plane. See below.



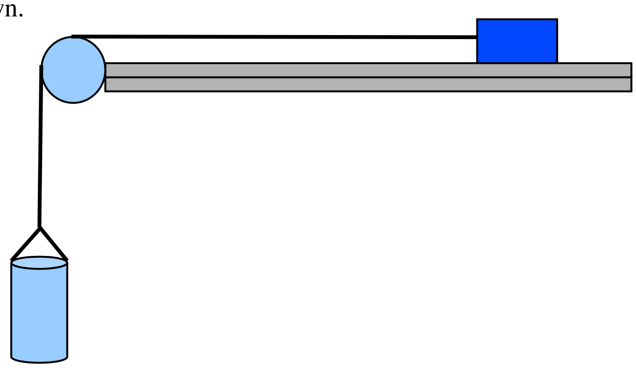
Record the angles in your lab book.

Repeat this 3 times and average the angles.
Enter the average of the three angles into your calculator and hit the tan button.

Record the tangent of the angles in your lab book.

Believe it or not, μ is the tan of θ!

Okay, let's see if it works!
Now, lay your inclined plane flat and hook the cup and string to the hook on the front of the block. Drape the string and cup over your bench as shown.



Slowly, while holding the cup, add one nut at a time to the cup and test it to see if there are enough nuts to pull the bock along the flat surface. Once you have enough nuts, weigh them.

Record the weight of the nuts in your lab book.

Repeat this 3 times and average the weight of the nuts.

Record the average weight of the nuts in your lab book.

Okay, let's see where we are.
Now, using the formula from page 1 we should see that:

$$F_f = \mu * F_N$$

So, if we translate that to what we just did, it should mean..........

Mass of nuts needed to move the block should equal the Tan of the inclined angle * the weight of the block
or
Mass of nuts = μ * weight of the block
or

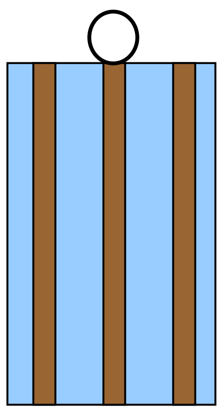
$$F_f = \mu * F_N$$

Did it work?
Did you get a pretty close measure of the amount of force needed to start the block moving along a horizontal surface?
Can you believe you got that by measuring the angle at which the same block started to slide down an inclined plane?
Isn't your teacher simply the best?

Write your Lab1 conclusion in your lab book!

Lab2

Now wrap three large rubber bands around the block like so....:

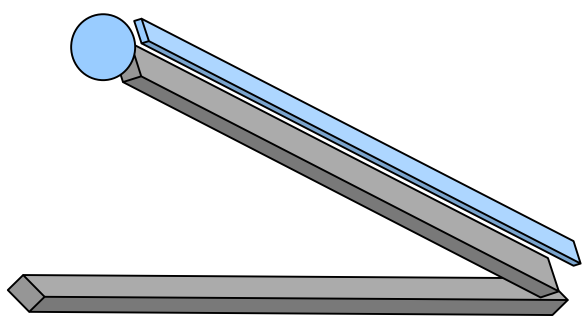


and repeat everything you did in Lab1

Write your Lab2 conclusion in your lab book!

Lab3

Remove the rubber bands and lay a slippery piece of plastic on the plane like so. You might need to tape the edges to keep it in place



and repeat everything you did in Lab2

Write your Lab3 conclusion in your lab book!

Lab4

Surprise me! Use any of the stuff I bring in with any combination of blocks with rubberbands. Just be sure to record your setup and data. Pictures and diagrams would also help.

Write your Lab4 conclusion in your lab book!

Give me an overall conclusion to this lab!