Lab #4

Determining the coefficient of friction (μ)

Mayer Adelman

12/16/2015

Purpose

To determine the coefficient of friction using the angle of uniform slip.

Theory

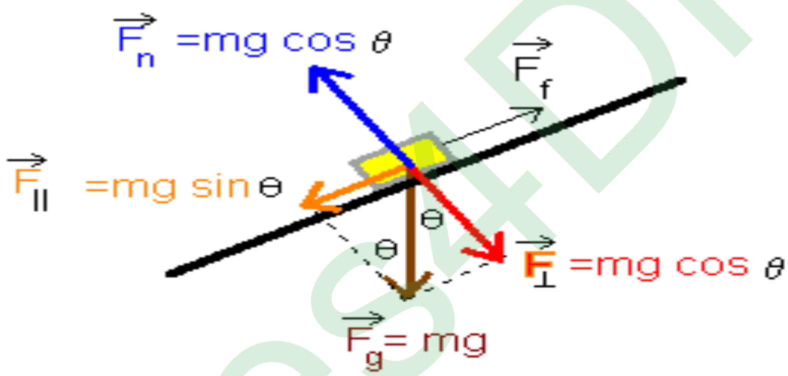
Part 1

Force should not be required to maintain constant speed. If one is pulling an object and it is at a constant speed, then the force of the friction must be EQUAL to the force being applied to the object. Therefore one can find the coefficient of friction by measuring the force being applied to the object

Part 2

Angle of uniform slip=the value of the angle of an inclined plane at which the object on the plane moves at a constant speed. Anything that starts on its own at all must be accelerating. If the angle is too low then even when the object is given a push then the object will stop. At the angle of uniform slip then the object won't begin to move by itself but with a nudge the object will move at a constant velocity down the slope. At the angle of uniform slip, the tangent value will equal the μ value (i.e. the coefficient of friction).

Proof that the tangent value will equal the μ value:



- At equilibrium the downhill=the force of friction
- Downhill=mg · sin(θ)
- Friction=μn
- mg · sin(θ)=μn
- mg · sin(θ)=μ · mg · cos(θ)
- $\mu=\frac{\sin(\theta)}{\cos(\theta)}$
- μ=tan(θ)

Materials

1. Adjustable inclined plane
2. Friction box with rubber bottom (the "object")

3. Spring scale
4. Protractor

Procedure

Part 1

1. Put cart on the steel surface of the plane (not inclined)
2. Pull cart (without an angle), using a spring scale, at a force which causes the speed is constant
3. Record the value of the pulling force being applied using the spring scale (which is equal to the force of friction)
4. Divide the force by the weight to obtain the value of the coefficient of friction (i.e. μ)

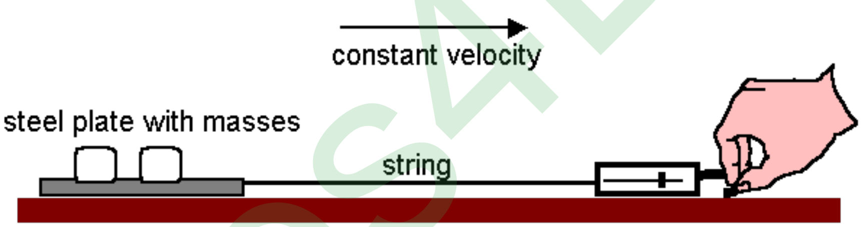
Part 2

1. Set cart down on inclined plane
2. Adjust the incline to an angle at which the object requires a push but then maintains a constant velocity (angle of uniform slip) and record the angle
3. Take the tangent of the recorded angle and that *should* equal the μ value from part 1

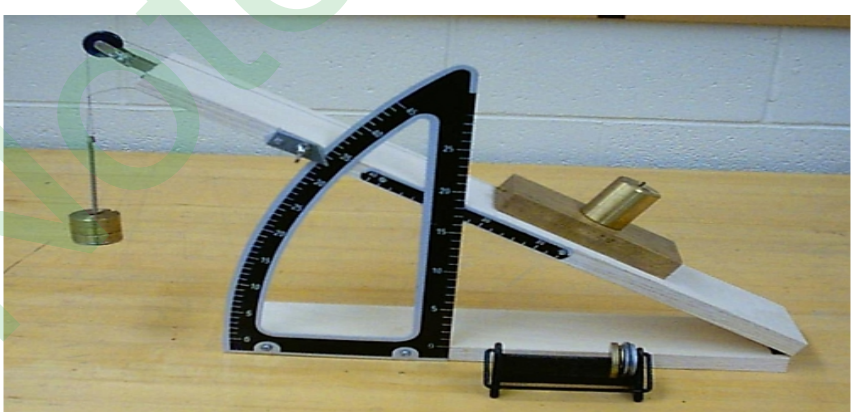
To calculate the percent error the μ calculated in part 2 will be used as the true value because the potential degree of error isn't as high as the potential degree of error in part 1

Diagram

Part 1



Part 2



Data

Part 1

Force which caused the speed to be constant=1.25 Newtons

Weight of the cart alone=.75 Newtons

Masses in cart=400 grams=.4 Kilograms

Weight of masses=.4x9.8=3.92 N

Total weight of the cart and its contents=3.92 N+.75 N=4.67 N

$\mu = \frac{f}{normal\ force} = \frac{1.25}{4.67} = .268$

Part 2

Angle of uniform slip=19^{o}

$\mu = \tan(19^{o}) = .344$

Percent error=$\frac{.344-.268}{.344}$=22.1%

Conclusions and Discussion of Results

We calculated the value of μ using two different methods. The 2 different μ values calculated from the two methods had a percent error of 22.1%.