FRICTION LAB with PENNY (L-7)

Consider a body sitting on a secondary surface. You apply a very small force to the body parallel to the surface expecting the body to move, but it doesn't. Why? Because there is a static frictional force between the body and the surface, and the force you are applying isn't enough to break the body loose. You apply a little more force. Still no motion. You continue doing this until, voila, you finally overcome what is essentially the maximum static frictional force the two surfaces can muster, and the body breaks free.

That maximum static frictional force has been found, through experimentation, to be proportional to the normal force on the body due to the secondary surface. And to make that proportionality into an equality, the *coefficient of static friction* μ_s is used giving us the relationship $f_s = \mu_s N$. This lab is designed to give you the opportunity to determine the *coefficient of static friction* between a penny and a piece of paper using two different approaches.

Object: To give you a chance to use two different approaches, one utilizing N.S.L. and an incline plane and one utilizing N.S.L. and the idea of centripetal forces, to determine the *coefficient of static friction* between a penny and a piece of paper.

Equipment:
1 penny
1 piece of paper
1 book (this will be used to create an incline plane)
1 a way to measure the angle of the book (a meterstick to use the rise/run method, or an "iHandy Level" iPhone app or its equivalent)

Procedure:

<u>Part A:</u> (the turntable)

1.) To begin with, the mass of a penny is *m = .0025 kg*. (We could have made you look this up, but to save time we're giving it to you.)
2.) During lab, during your ZOOM session, you will see an old fashion turntable (a record player) that has a piece of paper glued to its face. With the turntable rotating, the trick will be to find the distance out from the center where a penny placed on the paper face will lose traction, break loose and slide. Once the teacher has found that spot, you will need to determine:
   a.) The distance out from the center that the penny was sitting when it broke loose; and
   b.) The speed of the turntable.

<u>Part B:</u> (the incline)

3.) AT HOME, tape onto a book a piece of paper that is similar to the paper used on the turntable (Xerox paper was used in class—get as close as you can to that at home).
4.) Make a shallow incline with the book. Place the penny on the book. Begin to tilt the book so the incline's angle becomes larger and larger. Record the angle at which the penny finally breaks free (this will be the angle at which the maximum static frictional force will just be acting)

Calculations:

<u>Part A:</u> (the turntable)

1.) Draw a f.b.d. for the forces acting on the penny when it is on the turntable. Be careful about the direction of the frictional force (think about the direction a force would have to have for the penny to follow the curved path it was taking).
2.) Use the definition of frictional force (i.e., that $f_s = \mu_s N$), N.S.L. and the idea of centripetal acceleration to determine the coefficient of static friction between the penny and the paper. Call this $\mu_{s,t}$ (for turntable).

Part B: (the incline)

3.) Draw a f.b.d. for the forces acting on the penny when it is on the tilted book.
4.) Again, use the definition of frictional force (i.e., that $f_s = \mu_s N$) to determine the coefficient of static friction between the penny and the paper. Call this $\mu_{s,i}$ (for incline).
5.) Do a % comparison between the two coefficient values. Remember that a % comparison is the difference of the values, divided by the average of the two values, times 100.

Comparison:

6.) It would be nice to find that the two values were essentially the same, but the chances of that are not good. Discuss where the most likely, significant experimental errors are to be found in both experiments.