PHYSICS 230 LAB #4 – Force and Motion

In this lab, you will be showing frictional forces in various forms. There are two different experiments. **Everyone in the group has to do the each experiment – do not separate your group into two sub-groups to save time. You are here to learn.**

μ_s and μ_k

Notice that the inclined plane is scratched and therefore, both μ_s and μ_k are not constant. You will have to perform the lab to get the best average values.

Check the inclined plane for level. The angle indicator may be pointing 0^0 when it is not. Get three trials each at top, at middle, and at bottom for μ_s.

For μ_k, let the block accelerate on the plane. Set the plane at an angle so that the block will accelerate, but not so fast. Start the block (lightly drop it on the plane) at the top of the plane. Make sure you start from the same location and repeat this at least six times. Measuring the time and distance that block slides on the plane, you should be able to calculate its acceleration, which will help you to find out μ_k.

Since there is not theoretical values for those, on the conclusion, compare those values and discuss if they make sense.

Atwood Machine- this is the case when tensions are not equal

Atwood machine consists of four different diameter pulleys. Knowing how to read a venire caliper (if you have never seen it before, go to one of the following sites to learn how to use it.)

http://www.upscale.utoronto.ca/PVB/Harrison/Vernier/Vernier.html

http://www.tresnainstrument.com/how_to_read_a_vernier_caliper.html

http://www.phys.hawaii.edu/~teb/java/ntnujava/ruler/vernier.html

www.ronblond.com/M10/Vern.APPLET/

– You are not allowed to measure diameters of pulleys before the actual lab. You will find pulley system is chipped. This is because past students were not careful and did not treat the equipment with respect. For each run, adjust the height so that when m_1 hits the floor, m_2 does not hit the pulley. As the manual indicates, both masses should be fairly large and the total mass ($m_1 + m_2$ = constant, but it is okay to exchange mass as long as the total mass remains the same.) needs to be constant throughout the experiment (you will discuss about this at the conclusion.). Also to protect the floor, use two sheets of plywood stored in the second bottom drawer.

Tensions are not the same between the right and left side. This tension difference is called "retarding force" which delays the machine from spinning. The retarding force comes from two reasons; one is because of "rotational inertia" which was introduced in the lab #3. Once again, we still have not covered the topic in the lecture yet. So, its value is given in the manual. Another reason comes from the friction within the pulley – ball bearings and axle. You can't measure the diameter of the axle. Instead, you are going to use so called "Effective Friction" which is as if the frictional force exits on the surface where other tensions exist. (The good example of this is unscrewing a bolt. When you try to unscrew a tightly screwed bolt, there is friction between thread and the bolt. Imagine unscrewing the bolt with your fingers, a short-armed wrench, and a long-armed wrench. The real friction does not change but effective friction does. You can see the relation between the effective friction and radius of outside force applied – you are going to graph this relation. The graph should be nice and large – do not forget to label axes, scale and units. Also, do not connect dots with straight lines – think about how they should be related and that should give you a guide as to how the line should look like. Helpful hints: keep taking times until you have consistent data values for each pulley (0.1 second makes a huge difference.). Do not turn in the lab report if you get a negative friction.

How To Use Xplorer GLX For Lab # 4

Initial setup

1. Connect a Rotary Motion Sensor to the Xplorer.
2. Turn on the switch (right bottom, green button – push it about a second).
3. If the screen does now show menu, push "Home" button.
4. Using <, >, /\, and \/ keys, move to "sensors" and hit the check key.
5. Make sure the rate is "10 samples per second" (if not, change it to 10), Linear Position Scale is "Lg. Pulley", and Angular Position is "Visible". Then push "Home" button.

Actual Run

1. For each run, set the masses accordingly.
2. Push "Home" button on Xplorer to go back to menu.
3. Choose "Digits" and check. If it does not show "Angular Position", hit the check key twice. It will give you a menu. Choose "Angular position" and check. Now, it will show "Angular Position".
4. Hit the "Play" button and release the mass. When the mass hits the protector on the floor, hit the "Play" button to stop taking data.

Retrieving Data

1. Go back to menu by pushing "Home" button.
2. Go to "Graph" and check.
3. The graph shows angular positions at 0.1 second interval.
4. Note the data number and angular position when the mass starts moving. The circle can be moved with <, and > keys. (This is n_i and θ_i).
5. If locating the beginning point from the graph is difficult, go to "angular velocity" by pushing the check key twice. Locate the beginning of the motion (the line should be a straight line), note the data point, and go back to the position graph to locate both n_i and θ.
6. Also, note the data number and angular position of the mass just before it hit the protector (n_f and θ_f).

Conversion

1. $\Delta t = (n_f - n_i)/(10 \text{ samples per second})$
2. d (distance that mass moved) = $R(\theta_f - \theta_i)$, where "R" is the radius of the graduated pulley used.

Turning off Xplorer

1. When you push the on/off button (right bottom, green button), it will ask "Save Changes to the file 'Untitled (2)'?" Choose "No" by pushing F2 button.
2. After it turns off, disconnect a sonar cable from the Xplorer.