PHYSICS 230 LAB #3- Fletcher-Type Acceleration Apparatus

In this lab, you will be showing $\sum \vec{F} = m\vec{a}$, the second law of motion and the only equation you have to memorize in this course. There are total of five runs.

Preparation before actual runs

Notice the way the cart is stored in the drawer and understand why it is stored that way. When you put it back, make sure to store it back properly. The cart contains four weights that slip from the cart very easily if you tilt the cart. Do not tilt the cart when you pick it up. After examining the structure of the cart, you will notice that the weakest part of the cart is the metal hook for sparks. So, do not pick it up by holding the hook. The proper way to pick up is to hold the weights in the car with both of your hands. Also, pay extreme attention and caution to the copper wire. It will break very easily especially if there is a kink on the wire. Check it before you start. If there is a kink on the wire, replace the wire (ask the instructor). Use a cushion box to catch the hanger so that it will not crash onto the floor – that can break the wire. If the wire breaks during the experiment, you will lose 2 points per wire you break. You will also get two strips of waxed tape. Take extreme care of them as well. It can be scratched very easily, and it makes very difficult to read data because markings on the tapes are very small/faint. However, if you plan well, you can collect all the data you need on one tape. If you use only one tape, we will buy the unused one for a point. If you need more than two tapes, we will sell each extra tape for two points. Clean the rail before you start to remove any dust and rust. Also, because you don't want to connect and reconnect wires to the cart for different runs, measure the mass of the hanger (m_h) before it is connected to the cart.

Do not forget to estimate m_f for every run (Is there any rule for m_f as the total mass of the cart changes?)

$m_f = m_h + m_{addtion}$

Even though the manual suggests removing $m_{addition}$, do not remove it. Without removing it, add the asked mass (m_2= 200g for the first run).

Draw force diagrams for these two cases (Can you tell which two cases?). (You should know the steps how to analyze force vectors by now.) – then, derive "a" ($a=\frac{m_2 g}{(m_1+m_2+m_f)}$). However, for the real calculation of a, you must consider "i", the rotational inertia of the wheels. Since the lecture has not covered the rotation, you don't have to understand the meaning of rotational inertia completely yet, but the idea is same as linear inertia. If there is a mass (equivalent to linear inertia), it fights against changes. Apply this to rotational motions. If there is a rotational inertia, it tries to maintain whatever it is doing (If it is not rotating, it does not want to rotate. If it is rotating, it does not want to change its rotational speed.). There are three wheels on the cart and a pulley on the rail. They give an extra refusal to accelerate. The estimated value of this is given in the manual.

Each run

Align the wax tape so that a sparky makes points on one side of the tape.

Set the sparky 10 sparks/sec. Check the sparks – strong sparks? Same intervals? If not, fix it.

To analyze the tape, do not use first point.

For each run, measure Δx's (Somehow, students only collect 10 points, but they are not enough. The more data points there are the better result you get!)

From Δx's, calculate v's and then a's. (Table format is great for this!)

For each run, look at a's you calculated. Theoretically they should be the same. However, the reality is not. That is the reason why you are taking this step – to check if all the intervals have similar "a". Any calculated "a" values out of norm (I would suggest ±30 cm/sec^2), cross them off and calculate average acceleration.

If you have to move a 50g-weight from the hanger to the cart, make sure to put the weight so that it will not fly off when the cart is stopped.

How To Use Xplorer GLX For Lab # 3

Initial setup

1. Connect a sonar cable 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), and push "Home" button.

Estimation of Friction

1. Go to "Graph" mode, and hit the check key. A graph of "Position vs. Time" will appear.
2. Hit the check key to go to Position Axis, and hit the check key again.
3. It will give you options to graph "Position" or more. Choose "More" select and check.
4. It will give you options to graph "Velocity" and "Acceleration". Select "Acceleration and check.
5. The graph should be "Acceleration vs. Time" now.
6. Add mass onto the hanger and push the cart lightly.
7. Repeat the previous step until the cart moves at the constant velocity (a = 0) by visual inspection.
8. To be more accurate, push the "Play" button on the Xplorer (the sonar starts taking 10 samples per second) and push the cart.
9. If the line on the graph shows "near-zero" acceleration, the estimation is good.

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. It will show "Position" (the sonar stars flashing).
4. Hit the "Play" button and release the cart (the sonar flashes 10 times a second now). When the cart is at the end of the rail, hit the "Play" button to stop taking data.

Retrieving Data

1. Go back to menu by pushing "Home" button.
2. Go to "Table" and check.
3. The table should show positions of the cart at 0.1 second interval.
4. Use the data when the cart was moving (discard the data when the cart was not moving).
5. If you wish to go back to other sets of data, hit the "check" button and highlight "RUN #". Check again and it will give you options. Go to the set you wish to retrieve and check. Make sure to keep a good record of which run is which set.

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.