Physics 230 Lab #8 – Linear Air Track

Notice how each rail is hung from the ceiling rack. When you return the track, the number meets the same number. Also, hangers are hand-made for each rail and they should stay where they are for the rail to be most stable (i.e. Do not move the hangers.) When you are lowering the rail, please be careful so that you won't scratch the rail. You can find the air supply on the floor (Two are not for the air tracks but for the air tables). Notice that different tracks have different shaped springs at the end. You will need two different size carts with the same shaped springs (colors don't matter.). Even though they might have the same shape, but they may not have correct angles so that they may not slide freely – you will have to test until you find two different mass carts that slides freely on the track. After you put an air track on the floor safely, level the track without using the level. It should be leveled/adjusted by using only one-legged side, not the two-legged side. For all the distance measurements on the track, use the tape measure mounted on the track.

Justification of levelness

After the track is leveled (but you won't be able to level it perfectly), place a block of aluminum (you can find it/them in a drawer) under the peg. By knowing the distance between the legs and height raised, you can calculate the inclined angle (This is different from the manual). From a force diagram you draw, you can calculate the acceleration of the cart on the tiled track is $a = g\sin\theta$. We can test this by running one of the carts. Easiest way to do this is by noting the distance when the cart hits the end of the rail and start exactly 1 or 2 m away from that point (don't forget to record them as data!). Measuring the time that the cart takes to slide for either 1 or 2 m (do this several times, of course) you should be able to calculate the acceleration of the cart. Those "a" values should be very close and it should be less than 2% to show other possible causes of errors, such as air friction and the friction between the cart and the track are negligible (If you have more than 2% error, you need to level again. 2.01% is more than 2%!).

Measurement of the coefficient of restitution

Once again, start the cart from 1 or 2 m away from the ending point and this time, let the cart rebound. Record the maximum bouncing back distances. Either using motion equations or energy equations, you should be able to calculate the impact speed and the recoil speed. Once you have those values, you can calculate the coefficient of restitution (of the springs) by $e = -\frac{v_{Af} - v_{Bf}}{v_{Ai} - v_{Bf}}$ where A is the cart and B is the rail in this case. Since B did not move at all, the calculation of "e" should be very easy. They are velocities we are dealing with so that is the reason why we have a negative sign (red in the equation). What are the ranges of "e" then? Also, a good question would be "Did momentum conserve? Can we use a conservation of momentum? Why? If not, what happened?" What does "coefficient of restitution" tell you? The big hint is that think about what velocity is associated with.

Collision of two carts

First, set a lighter cart (A) at 1 m away from the end of the rail (do not forget to record everything). Lightly push the heavier cart (B) from the other side and let B collides into A. Record the starting point of B (it should be the same every time.) and the position when A hits the end of the rail. Do this several times. Knowing the distances that A and B travel in the same time interval, you can calculate the mass ratio according to the given equation.

Second, reverse the carts so that A collides into B. Notice that in this case, A rebounds so that the distance that A travels is negative. Calculate the mass ratio.

Derivation of mass ratio

To derive the equation, think about what you can use and what you can't use – Did kinetic energy conserve? Did momentum conserve? Also, you learned how to calculate "e" – in this case, one of the carts' initial velocities is zero. Lastly, those carts traveled in the same time interval.