Work and Energy

As you work through the steps in the lab procedure, record your experimental values and the results on this worksheet. Use the exact values you record for your data to make later calculations.

Work Lab – Simulation and Tools

Open the Dynamics Track simulation to do this lab.

IA. Predicted Δh from Conservation of Mechanical Energy

The cart mass = 0.250 kg.

1. Record your chosen ramp angle.

4. By trial and error, find an initial speed that will send the cart to approximately the 170-cm point. Record this as your initial velocity, v_0.

5. Calculate and record KE_0 in joules for the 0.250-kg cart. (Careful with units!)

Note: You'll need data from the lab apparatus data table later, so don't use the sensor again until you complete Part IA.

9. Record the cart's final velocity and kinetic energy, v_f and KE_f, respectively, at the top of the cart's travel. (There are no data required for this. Just think about it.)

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10. Using conservation of mechanical energy, calculate and record the cart's predicted change in height, $\Delta h = h_f - h_0$.

11. What Δh would you get if you added 0.250 kg to the cart? Try it to make sure of your answer. (No sensor! See the note above.)

12. That doesn't seem right. It appears that there would be no limit to how much mass could be sent through the same Δh. This would have to "cost" us somehow. Where must this extra energy be coming from?

IA. Experimental Δh from Δx Measurements on the Track and Geometry

14. Scroll through the position data in the right column of the apparatus data table. The initial and final positions of the cart are x_0 and x_f, respectively, for the trip up the ramp. How can you find x_0 and x_f from this data? Be careful, as the data includes the motion back down the track, which is not what you're looking for.

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15. Record x_0 and x_f.

16. Calculate and record Δh.

17. Calculate the percentage error between the experimental and predicted (theoretical) values of Δh.

IB. The Relationship Between Speed and Kinetic Energy – Proportional Reasoning

4. Calculate and record x_mid.

5. You first need to *experimentally* determine the proper v_0 to give the cart half of its previous KE. How about $v_0/2$? Try it and see how it works out.

(a) How'd that work out?

- too slow
- too fast

(b) Use trial and error to find your best value for the required initial velocity to just reach x_mid. Record $v_{0(\mathrm{mid,\ expt})}$.

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6. Now let‘s calculate the *theoretical* initial velocity. Here's the problem and how to think about it.

$$\mathbf{KE}_0 = \frac{1}{2}mv_0^2$$

So $\mathrm{KE_o}$ is directly proportional to v_0^2, not v_0. So $v_0/2$ won't give the cart $\mathrm{KE}_0/2$. So halving v_0 doesn't halve $\mathrm{KE_o}$, halving v_0^2 does! (If you halve v_0^2, you will also halve $\frac{1}{2}mv_0^2$, which gives $\frac{1}{2}m(v_0^2/2)$.) So if $v_{0\text{(orig)}}$ equals your v_0 from #4 in Part IA, what do $v_{0\text{(orig)}}^2$, $v_{0\text{(mid)}}^2 = \dfrac{v_{0\text{(orig)}}^2}{2}$, and $v_{0\text{(mid, theo)}}$ equal?

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II. Work by Friction

8. Record your data.

> Note: Sometimes the dT values are a bit iffy. You may find that one of the dT values is negative. Also, dT_2 should be almost twice dT_1. Please try again if you see any suspicious data. And be sure to note that you're recording dT, not eT.

9. Calculate your experimental value for $\mu_{\mathrm{k(expt)}}$ using $-\mu_{\mathrm{k}} mg\Delta x = \frac{1}{2}m(v_2^2 - v_1^2)$.

10. Calculate your percentage error between the two μ's ($\mu_{\mathrm{k(theo)}} = 0.10$).

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