Dynamics

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.

Velocity Lab – Simulation and Tools

Open the Dynamics Track simulation to do this lab. You will need to use the VPL Grapher to complete this lab.

IB. Accelerated System of a Cart on a Level Track With Mass Hanger and No Friction

8. Upload the screenshots of your x-t and v-t graphs as "Dyn_IB1a.png" and "Dyn_IB1b.png". (Submit a file with a maximum size of 1 MB. *You will upload this file in the WebAssign question.*)

9. Record the acceleration, the slope from the v-t graph.

10. Compare this with the theoretical (calculated) value found in your lab manual by calculating the percentage error.

11. Show calculations for percentage error. Use the calculated value as the theoretical value.

IC. Accelerated System of a Cart on a Level Track With Two Mass Hangers and No Friction

2. Complete the following tables with your data and the results of your calculations. (Take the positive direction to be upward for the left hanger, downward for the right hanger, and toward the right for the cart. Indicate the direction with the sign of your answer as necessary.)

Table 1: Masses

Quantity	**Mass (kg)**
Mass of left hanger	
Mass of right hanger	
Mass of cart	
Total mass of system	

Table 2: External and Net Forces (If the force is an internal force, enter INTERNAL in the answer box.)

Quantity	**Force (N)**
Weight of left hanger, W_l	
Tension on left hanger, T_{lh}	
Tension on left side of cart, T_{lc}	
Weight of right hanger, W_r	
Tension on right hanger, T_{rh}	
Tension on right side of cart, T_{rc}	
Net force on the system	

Table 3: Acceleration

Quantity	**Acceleration**
Calculated acceleration	
Experimental acceleration	
Percentage error	

3. Upload the screenshots of your x-t and v-t graphs as "Dyn_IC1a.png" and "Dyn_IC1b.png". (Submit a file with a maximum size of 1 MB. *You will upload this file in the WebAssign question.*)

IIA. Free Fall Acceleration

4. You may have noticed that the brake doesn't work in Z-mode. Check it out. Why doesn't it work in Z-mode?

6. Record your data and calculations in Table 4.

Table 4: Free Fall Acceleration (for Part IIA)

Mass, m (kg)	**Time, t (s)**	**Position, x (m)**	**Δt (s)**	**Δx (m)**	**a (m/s^2)**
0.050					

7. Record the system mass (mass hanger m), ΣF (mg), and predicted a (F/m).

8. Show calculations using equation 1 for the acceleration with just the mass hanger.

9. Show calculations for percentage error here. Assume that the F/m value for acceleration is correct.

IIB. Free Fall – The Effect of the Weight of the Falling Object on Its Acceleration

2. Record your data and calculations in Table 5.

Table 5: Free Fall Acceleration (for Part IIB)

Mass, m (kg)	**Time, t (s)**	**Position, x (m)**	**Δt (s)**	**Δx (m)**	**a (m/s^2)**
0.100					

3. Hmm. Doubling the force did not seem to double the acceleration. If $a \propto F$, we must be missing something. Complete the following sentences.

(a) The ________________ of a body is directly proportional to the net force acting on it.

(b) So if you double the force on it, its acceleration should ____________ .

(c) When you doubled the mass in this case, the acceleration ________________ .

(d) This is because doubling the weight also doubled the ____________ .

IIIB. Apparent Weight

4. How does your apparent weight ($\mathbf{T_r}$) at rest compare to $\mathbf{T_r}$ when moving at a constant velocity?

From this you should conclude that your apparent weight, $\mathbf{T_r}$, should be your normal weight. This means that if you were hanging from the string, you wouldn't feel any more stretched out moving at a constant speed than when at rest. Likewise, if you were standing on the scale, you wouldn't feel any more squished down by gravity than usual.

6. Answer the following questions.

   (a) When you release the cart, what happens to your *apparent* weight, $\mathbf{T_r}$?

   Your apparent weight ______________ .

   (b) When you release the cart, what happens to your *actual* weight, $\mathbf{W_r}$?

   Your actual weight ______________ .

   (c) What would it be like, *relative to when you were riding at a constant speed*, if you were hanging from the string or standing on the hanger?

   If you were hanging from the string you would feel ______________ stretched.

   If you were standing on the hanger you would feel ______________ compressed.

7. Answer the following questions.

   (a) When you release the cart, what happens to your *apparent* weight, $\mathbf{T_r}$?

   Your apparent weight ______________ .

   (b) When you release the cart, what happens to your *actual* weight, $\mathbf{W_r}$?

   Your actual weight ______________ .

   (c) What would it be like, *relative to when you were riding at a constant speed*, if you were hanging from the string or standing on the hanger?

   If you were hanging from the string you would feel ______________ stretched.

   If you were standing on the hanger you would feel ______________ compressed.

8. When you accelerate upward, your apparent weight ______________ .

9. When you accelerate downward, your apparent weight ______________ .

10. When you are at rest or moving at a constant speed, your apparent weight is ______________ .

IV. Kinetic Friction

8. Clearly, the cart slows down. What about the friction vector, $\mathbf{F_f}$, tells you *why* it slows down?

9. What about the velocity vector tells you that it *does* slow down?

10. Got it? Take the data you need and record it. If your value for μ_k is not close to 0.12, then you've done something wrong with your technique or your calculations. You should get a negative value for the acceleration. (Use $g = 9.80\ \mathrm{m/s^2}$.)

Show calculations below for a and $\mu_{\text{k(experimental)}}$.

11. Let's try an unknown friction coefficient. Change the "μKS?" value to 1 using the numeric stepper. You'll quickly find that your 2.00 m/s is not a good choice this time. You can change it to whatever you like. But letting the cart go most of the way along the track will give better results than a short run. Note also that the new μ_k should be much smaller than the previous value. (Use $g = 9.80\ \text{m/s}^2$.)

Show calculations below for a and $\mu_{\text{k(experimental)}}$.