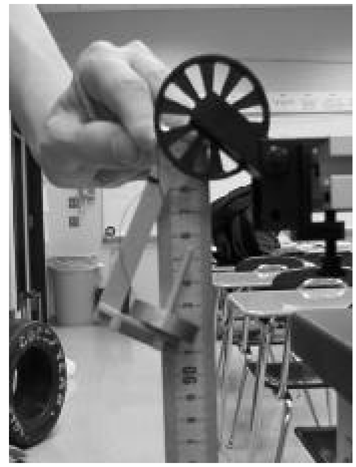
The Work-Energy Theorem with and without Friction - Mr. Ward and Mr. Gener - 12-04-01

Name ________________________ ___o

Purpose: To examine the work-energy equation in two situations: (**a**) **conservative forces or frictionless**, at least very low friction, and (**b**) **non-conservative forces, or with friction**. See photos



PART A: Setup

1. Find the mass of the plunger cart and RECORD it. Find the mass of your plastic mass hanger and RECORD.
2. Load the Data Studio file **WorkEnergy**.

PART B: Procedure

<u>Conservative Forces – no friction</u>

3. Wipe the track with your hand to remove dust and grit. Wipe the wheels. Roll the cart a few times to make sure it rolls smoothly and quietly. Also make sure the friction pad is <u>not</u> touching the track.
4. Place the cart on the track with the string over the pulley and the hanger hanging over. Place a 50 g mass on the hanger. Pull the cart back until the hanger gets near the pulley.
5. Place a meter stick zero end down on the floor, vertically, next to the hanger. Move the cart so the bottom of the hanger is at the 90 cm mark. Avoid parallax error when reading the meter stick.
6. Hold the cart. Click on 'Start' and, after about a second, release it quickly. Stop the cart about 10 cm before the pulley. Make sure the hanger hits the floor before you touch the cart. Click 'Stop'.
7. Turn on the smart cursor. Place the regular cursor on it until the crossed arrow show up, NOT the triangle. Drag the smart cursor to the highest data point on the velocity-time graph. RECORD this maximum velocity. Clear the data run. Don't leave multiple graphs on the screen!
8. Repeat steps 4-7 four more times.

<u>Determining the coefficient of kinetic friction, μ_k</u> - If you can't do steps 9-16 on the same day, don't start!

9. Although the carts are not frictionless, for the **'no friction'** section we will assume that $\mu_k = 0$. This means that if we push the cart on a level surface, it will experience zero acceleration. This is not exactly true.
10. For the **'friction'** section, we will need to find μ_k by finding the magnitude of the acceleration of the cart when it is pushed and allowed to come to a stop.
11. Turn the friction screw until the metal tab is about 3 mm below the cart body. Put the cart on the track near the pulley with the plunger facing the pulley. Push it lightly and make sure there is enough friction to make it stop. Adjust the friction screw if needed.
12. Starting near the pulley, push the cart so it travels about 1.5 m before it stops. Do not let it hit the motion sensor. Practice pushing the cart several times.
13. To record data, click 'Start', wait about a second, and push the cart. If your data run is not clean, repeat it.
14. For each clean data run, highlight the straight part of the curve. Do not include the ends if they are not straight. Click on 'Fit' and select 'linear'. RECORD the slope and then unselect 'linear'.
15. Repeat steps 12-14 to obtain four more clean runs.

<u>Non-conservative Forces – friction</u>

16. Repeat step 3 and steps 5-8 with the cart friction set the same as in the previous section.

PART C: Calculations

17. Perform the calculations to find μ_k using the information in the Data table. Show your FBDs and calculations at the bottom of the back page.

Data: **Name** ______________________ ___o

mass of cart (kg)	mass of hanger (kg)	total hanging mass (kg)	height (m)

No friction

Trial	v_f = velocity max (m/s)
1	
2	
3	
4	
5	
ave	

Friction

Trial	v_f = velocity max (m/s)
1	
2	
3	
4	
5	
ave	

No friction

Trial	acceleration (m/s^2)
1	~ 0
2	~ 0
3	~ 0
4	~ 0
5	~ 0
ave	~ 0

Friction

Trial	acceleration (m/s^2)
1	
2	
3	
4	
5	
ave	

Results:

Set up the work-energy equations and do the calculations BELOW the results tables or on a separate sheet. RECORD the values. If they are not equal, use a < or > sign.

Low friction

Work-energy comparison	% error

Friction

Work-energy comparison	% error

Conclusions: What did you learn?