Learning Goal
Analyze a simple machines efficiency by relating its efficiency to its energy input and energy output

Agenda
Minds-on: Efficiency of a light bulb
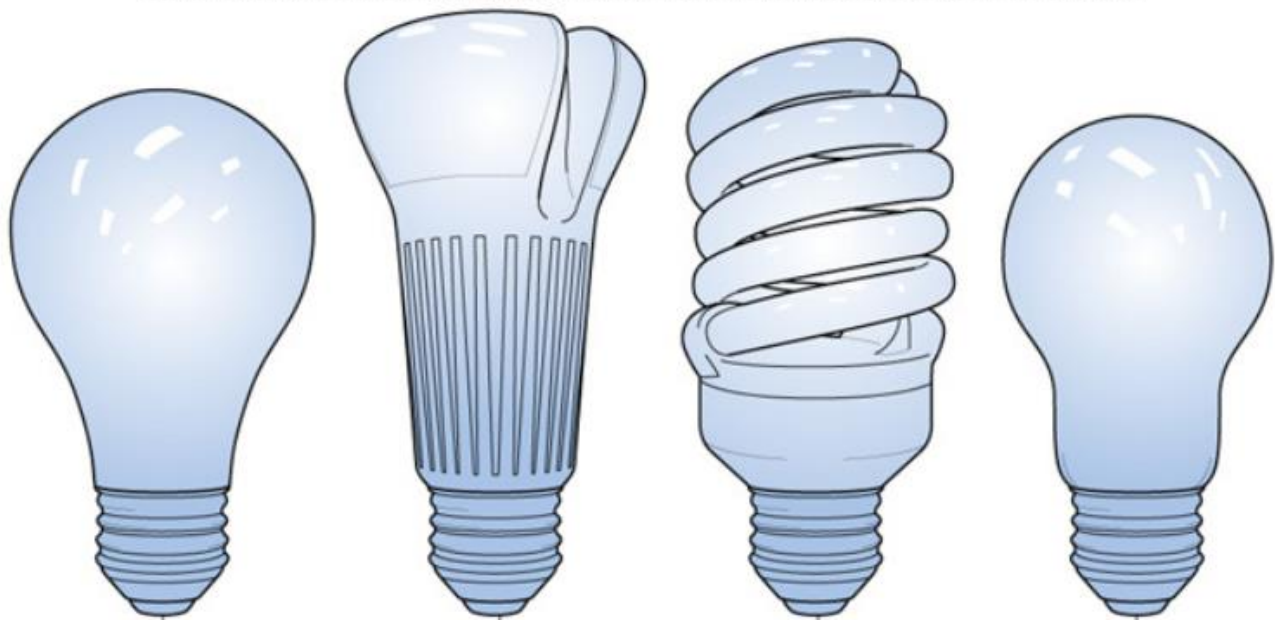Review: Mechanical energy in a roller coaster ride
Lab: Conservation of energy and efficiency of a system

Minds-on

What is an efficiency of a system?

HOW TO ASSESS THE ECONOMICS OF LIGHT BULBS

Comparison of the annual costs of four different light bulb technologies using Philips products

|	Philips 100 Watt Incandescent Soft White	Philips 19 Watt LED Soft White	Philips 23 Watt Compact Fluorescent Soft White	Philips 70 Watt EcoVantage Incandescent Halogen Soft White
Amount of light emitted in lumens	1,620	1,680	1,600	1,600
Watts consumed per hour	100w	19w	23w	70w
Estimated life in hours	750	25,000	10,000	3,000
Retail cost of bulb (pretax)	$0.30	$29.98	$6.50	$2.00
Annual cost of bulbs over (1)	$0.43	$2.49	$0.92	$0.77
Annual energy consumed (2)	109.6 kWh	20.8 kWh	25.2 kWh	76.7 kWh
Net annual energy consumption (3)	Base case	55.4 kWh	55.7 kWh	81.5 kWh
Net annual energy saved	-	54.2 kWh	53.9 kWh	28.1 kWh
Annual cost of energy (4)	$9.70	$4.90	$4.93	$7.21
Annual greenhouse gas cost (5)	$1.53	$0.78	$0.78	$1.14
Total annual net energy cost	**$11.23**	**$5.68**	**$5.71**	**$8.35**
Annual cost of bulbs	**$0.43**	**$2.49**	**$0.92**	**$0.77**
Total annual cost	**$11.66**	**$8.17**	**$6.63**	**$9.12**
Total annual savings	**$-**	**$3.49**	**$5.03**	**$2.54**

April 17, 2014   *Name:* _____

Review

What is the relationship between potential and kinetic energy?

http://www.pbslearningmedia.org/asset/mck05_int_rollercoaster/

Energy in a roller coaster ride:
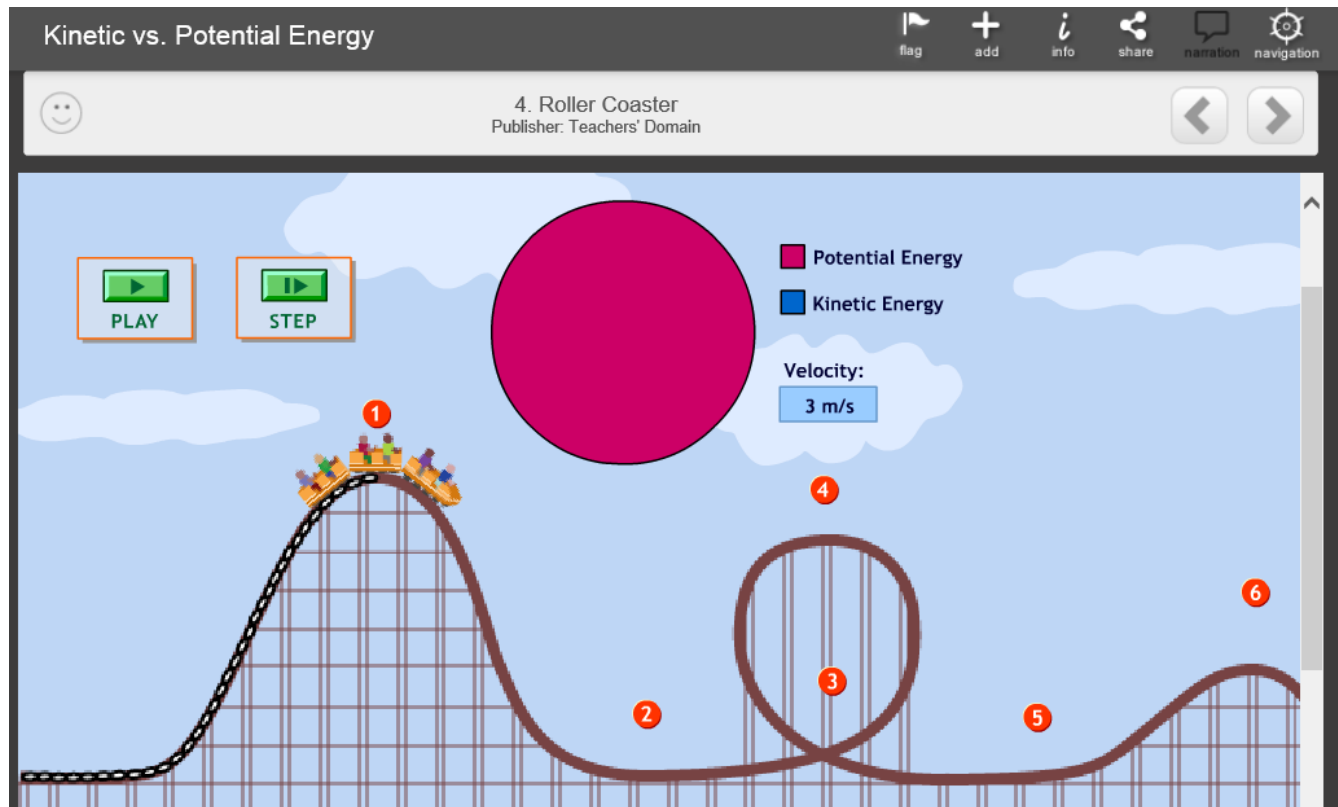
Conservation of mechanical energy

$$E_k + E_p = E'_k + E'_p$$

$$\Delta E_k + \Delta E_p = 0$$

Conservation of Energy & Efficiency of a System
SPH3U

Purpose: To determine the efficiency of a ramp as it is used to accelerate a marble.

Hypothesis:

hypothesis a possible explanation for a question or
   an observation, which is subject to testing, and
   verification or falsification (1.1)

Materials: Metal ramp, marble, meter stick, stop watch, balance, caliper, PASCO Capstone (software), photogate head, digital adapter, USB link, and cables
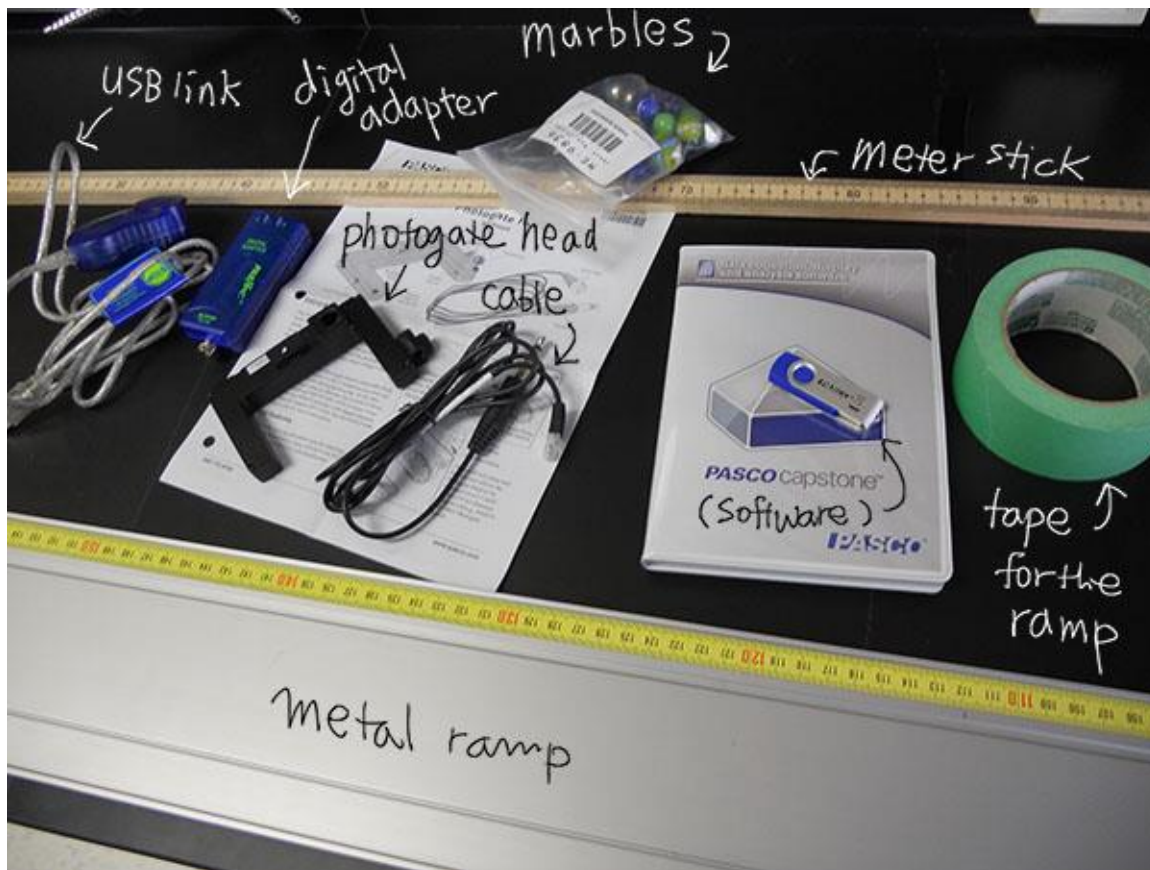
Procedure and Data:

1. Set up the computer with PASCO Capstone and assemble in order of photogate, cable, channel 1 on digital adapter, USB link to the computer.

2. Set up a ramp and raise one side to a certain height and put a piece of tape on the other end of the ramp to protect the desk surface from the sharp edges of the metal ramp.

3. Measure the vertical distance from the table to the top of the ramp, in meters.
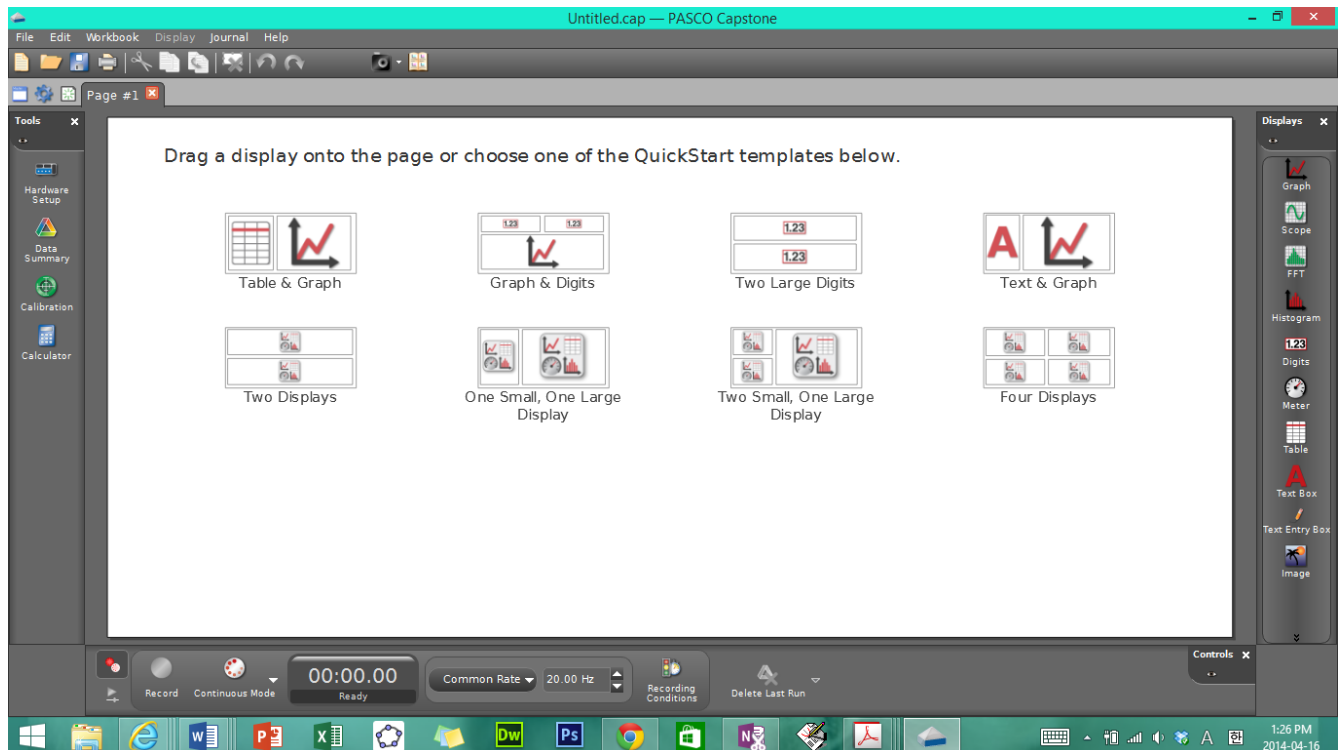
    Vertical distance = _____ m

4. Measure the mass of the marble, in kg.

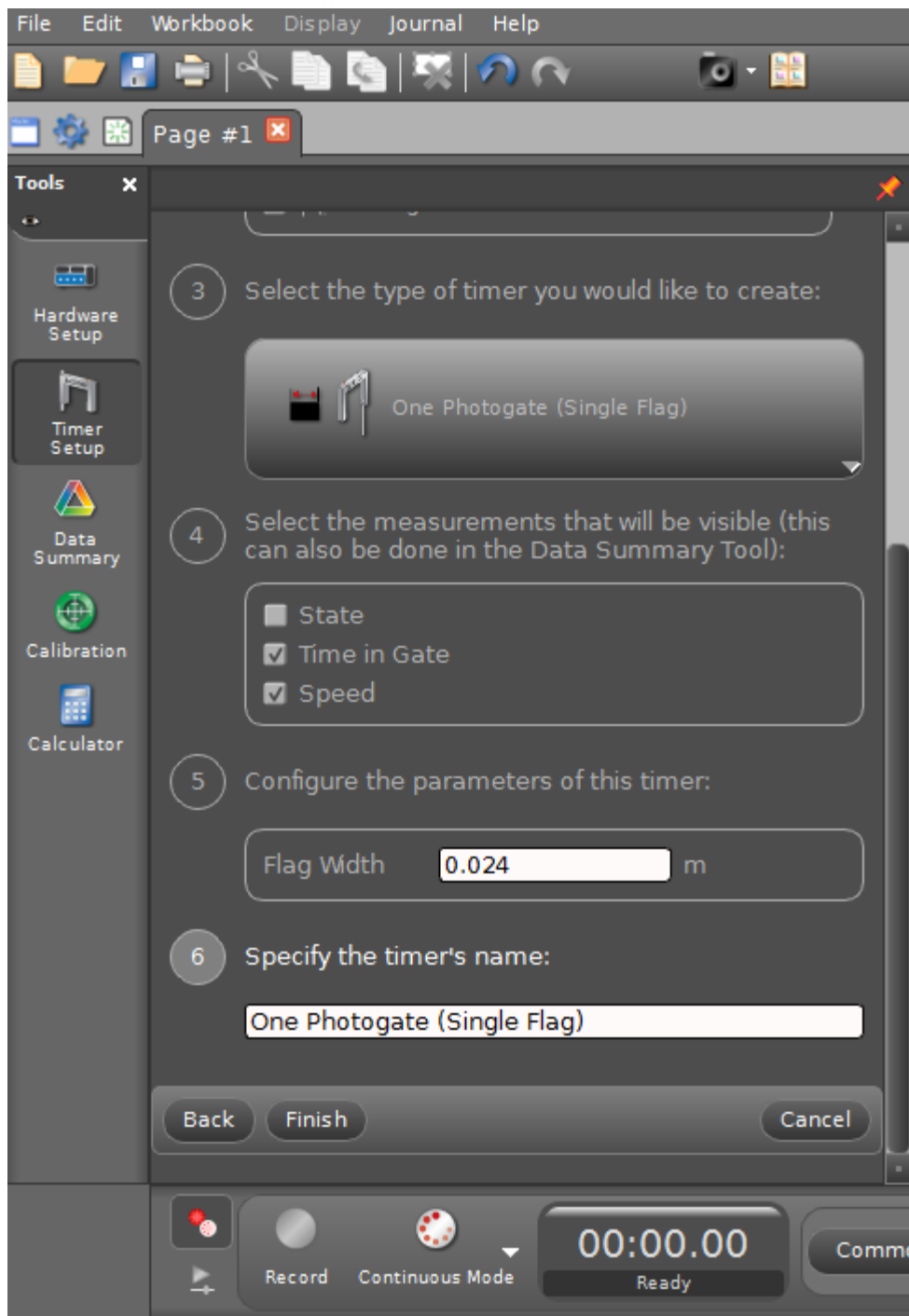 m_{marble} = _____ kg

5. Calculate the potential energy the marble has when it is at the top of the ramp.
    Show your calculation here.

    Is this the energy input or the energy output? _____

6. Open PASCO Capstone and choose 'Table & Graph' as a display onto the page.

7. Click Hareware Setup under tools menu on the left column. Click the hole for the channel 1 on digital adapter and choose Photogate on the drop down menu. .

8. Click Timer Setup and follow directions: ① Pre-Configured Timer; ② Photogate, ch1:1; ③ Click 'Select a Timer' and choose 'One photogate (Single Flag); ④ Make sure 'Time in Gate' and 'Speed' are checked and click next; ⑤ Measure the diameter of the marble and record it in meters, then click next; ⑥ Name the timer and click save or click finish. Click Timer Setup again to close it.

File   Edit   Workbook   Display   Journal   Help

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Tools ✖

Hardware Setup

Timer Setup

Data Summary

Calibration

Calculator

③ Select the type of timer you would like to create:

One Photogate (Single Flag)

④ Select the measurements that will be visible (this can also be done in the Data Summary Tool):

☐ State
☑ Time in Gate
☑ Speed

⑤ Configure the parameters of this timer:

Flag Width   0.024   m

⑥ Specify the timer's name:

One Photogate (Single Flag)

Back   Finish   Cancel

00:00.00

Record   Continuous Mode   Ready   Commo

9. Click 'Select Measurement' on the right column and choose 'Speed (m/s)'

File   Edit   Workbook   Display   Journal   Help

Page #1

Tools ✕

Hardware Setup

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[Table title here]

	<No Data Selected>	<No Data Selected>
	Time in Gate (s)	<Select Measurement>
1		Create New ▶
2		Rename
3		▪ One Photogate (Single Flag)
4		Time in Gate (s)
5		Speed (m/s)
6		Equations/Constants
7		Constants ▶
		Time
8		Time (s)
9		Index
10		Index
11		
12		

<Select Measurement>
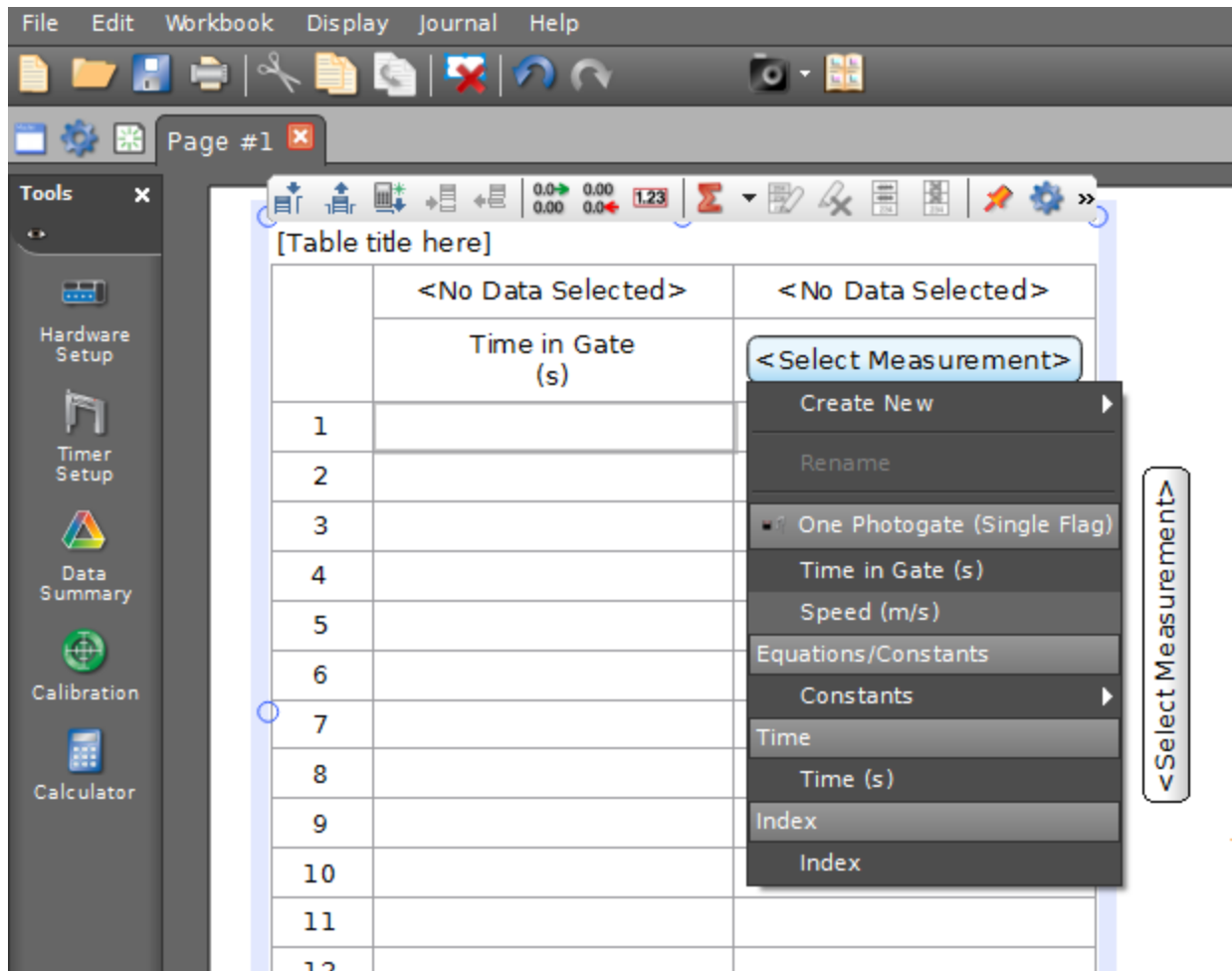
10. Place the marble at the top of the ramp. When you are ready click 'Record' at the bottom as you release the marble. Another student can hold the position of the photogate at the bottom of the ramp and measure time interval from the time at the marble is released to the time it passes photogate.

Trials	1	2	3	4	5	Average
Δt (s)						
V (m/s)						

11. Calculate the kinetic energy of the marble at the bottom of the ramp. Show your calculation here.

12. Is this the energy input or output? _____

13. Calculate the efficiency for this process.

Discussion:

Describe a physical change you could make to this system to improve the efficiency.

Explain why it is impossible to achieve an efficiency > 100% for any such system.

Conclusion:

Example problem

Calculating Efficiency

A model rocket engine contains explosives storing 3.50×10^3 J of chemical potential energy. The stored chemical energy is transformed into gravitational potential energy at the top of the rocket's flight path. Calculate how efficiently the rocket transforms stored chemical energy into gravitational potential energy if the 0.500 kg rocket is propelled to a height of 1.00×10^2 m.