Student's Name: ______________________________ Student's Name: ______________________________

Lab day & time: __________________ Date: _________________

Work and Energy (M6) - Data Sheets

(Show all calculations and write all results on the data sheets in ink)

In Activities 1, 2 and 3 we will analyze what happens to the cart located in two locations: at the top of the incline and at the bottom of the incline. In Activity 1, we calculate the change of gravitational potential energy between these two locations. In Activity 2 we estimate the work needed to move the cart from the bottom location to the top of the incline. In Activity 3 we measure the kinetic energy of the cart at the bottom of the incline when it is released from the top of the incline. Potential energy change, work and kinetic energy are all forms of energy and are linked together by the conservation of energy principle. Activities 4 and 5 are about the potential energy stored in a stretched spring and its conversion into kinetic energy.

Activity 1: Potential Energy *(1 p.)*

Mass of the cart with the force sensor attached:

$m_{\text{cart with the force sensor}} = 0.890$ kg - if you are using "Force Sensor" (model CI-6537) or

$m_{\text{cart with the force sensor}} = 0.635$ kg - if you are using the "Economy Force Sensor" (model CI-6746).

Be sure to fill-in the correct units in the space provided: (   )

	Initial position (#1 - upper)	Final position (#2 - lower)
Vertical height (Δh)	h_1 = ( )	h_2 = ( )
Potential energy (PE)	( )	( )

Change in vertical height ($\Delta h = h_1 - h_2$) = ______________ (   )

Change in potential energy ($\Delta PE = m_{\text{cart with the force sensor}} g \Delta h$) = ________________ (   )

Activity 2: Work *(1 p.)*

	Initial position (#1 - upper)	Final position (#2 - lower)
Position (x)	x_1 = ( )	x_2 = ( )

Distance traveled $|\Delta x| = |x_1 - x_2|$ = _______________ ( )

Write values of the pulling force for five locations along the incline. This force should be equal to the gravity force component that is parallel to the incline.

	Measured mean force values: F ( )	Deviations from the average force: $\Delta F = F - F_{AV}$ ( )	Squared deviations from the average force: $(\Delta F)^2$ ( )
1			
2			
3			
4			
5			
Average	F_{AV} =		Sum =

Average force F_{AV} = _______________ ( ) (*use only two significant figures*)

Standard deviation of the force measurements s_F = ______________ ( )

Work done W = ____________ ± ____________ ( )

Use only two significant figures and assume that the experimental error in distance measurements is negligible compared to error in force measurements, i.e., $s_W = s_F * \Delta x$ (see also the "Experimental Uncertainties (Errors)" file).

Calculate what should be the theoretical value of the pulling force neglecting friction. Show your calculations!

Theoretical value of the pulling force: F_P = ______________ (   )

Does the average measured force agree with the theoretical value within experimental error? (in other words - is it true that: $\boldsymbol{F_{AV} - s_F < F_P < F_{AV} + s_F}$)? Show your work!

YES or NO _______________

Activity 3: Kinetic Energy *(1 p.)*

Maximum absolute value of velocity: $|\, v_{max} \,|$ = _______________ (   )

Kinetic energy: KE = _______________ (   )

Energy lost: |ΔPE| - KE = _______________ (   )

Percentage energy loss $\left(100\% * \frac{\left||\Delta PE| - KE\right|}{|\Delta PE|}\right)$ = ____________ (%)

Since all the energy lost is due to work done by the friction force, we may use the following equation to estimate the average friction force $F_{FRICTION}$.

$$|\Delta PE| - KE = F_{FRICTION}\,\Delta x$$

Average friction force $F_{FRICTION}$ = _______________ (   )

Activity 4: The Spring Constant k *(1 p.)*

Equilibrium position: _____________ (   )

Absolute value of the displacement from the equilibrium position: $\|\Delta x\|$ (m)	Applied Force $\|F\|$ ( )
0.05	
0.10	
0.15	
0.20	
0.25	

For the five trial runs, plot the absolute value of the force $|F|$ versus the absolute value of the displacement $|\Delta x|$. Use a computer to prepare and print this graph. Label your axes, include the units with your axis labels and title your graph "Force vs. Displacement". Then, draw a best-fit line (do **not** just connect the points!) that approximates the behavior of your points.

Find the **slope** of the best-fit line, which represents the system spring constant *k*. Be sure to include the units. <u>It is required that you use a computer-graphing program</u> (e.g., MS Excel, which is available in all ITaP labs). Use the “Trendline” option to obtain the value of the slope of the best-fit line.

Write the equation with numerical values of the slope and y-intercept on the graph! Please **print** and attach your plot to your lab report and fill in the value of the slope below.

Spring constant k = ______________ (   )

Activity 5: Elastic Potential Energy vs. Kinetic Energy *(1 p.)*

Potential energy of a spring and kinetic energy of the collision cart.

Object	Mass m ( )	Initial Displacement $\lvert\Delta x\rvert$ ( )	Potential Energy Change $\lvert\Delta PE\rvert$ ( )	Maximum Speed $\lvert v\rvert$ ( )	Kinetic Energy KE ( )
cart + force sensor					

Percent of energy lost for the first (cart + force sensor) run:

1st Run $\left(100\% * \frac{\left|\lvert\Delta PE\rvert - KE\right|}{\lvert\Delta PE\rvert}\right) =$ ____________ (%)

Remove the collision cart from the track. Put both springs back in the blue box.

Complete the lab report and return it to the lab TA.