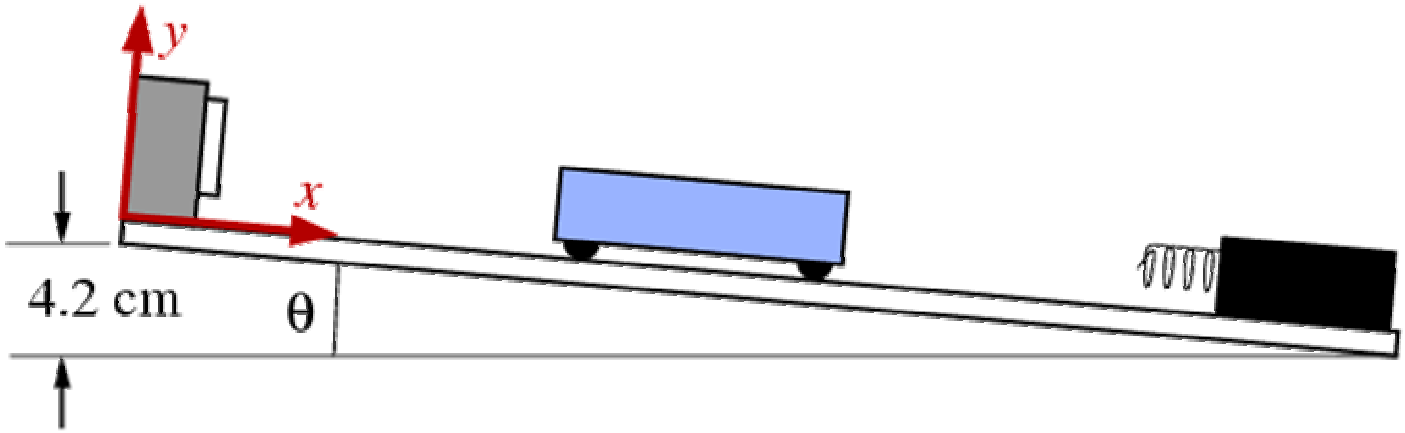
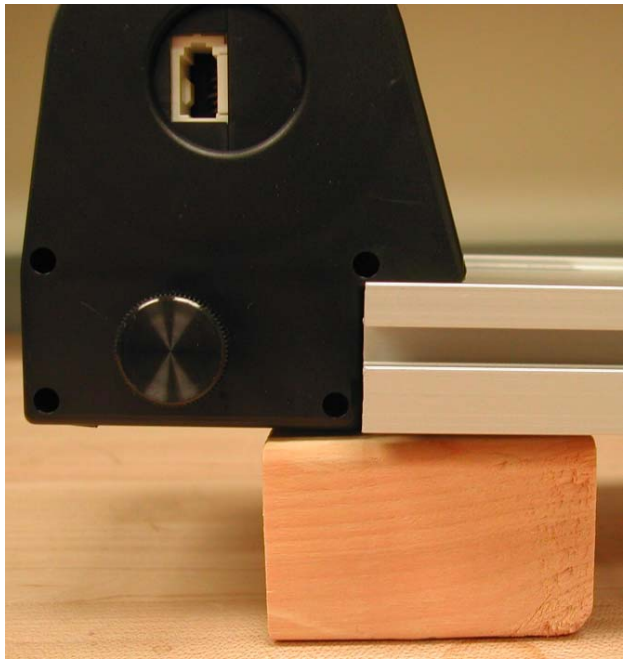
Experiment 06: Work, Energy and the Harmonic Oscillator

Goals

- Investigate the work-mechanical energy theorem.
- Observe how forms of mechanical energy are converted from one to another and lost by non-conservative work.
- Study the behavior of a simple harmonic motion with a high quality low-loss spring.

Equipment setup

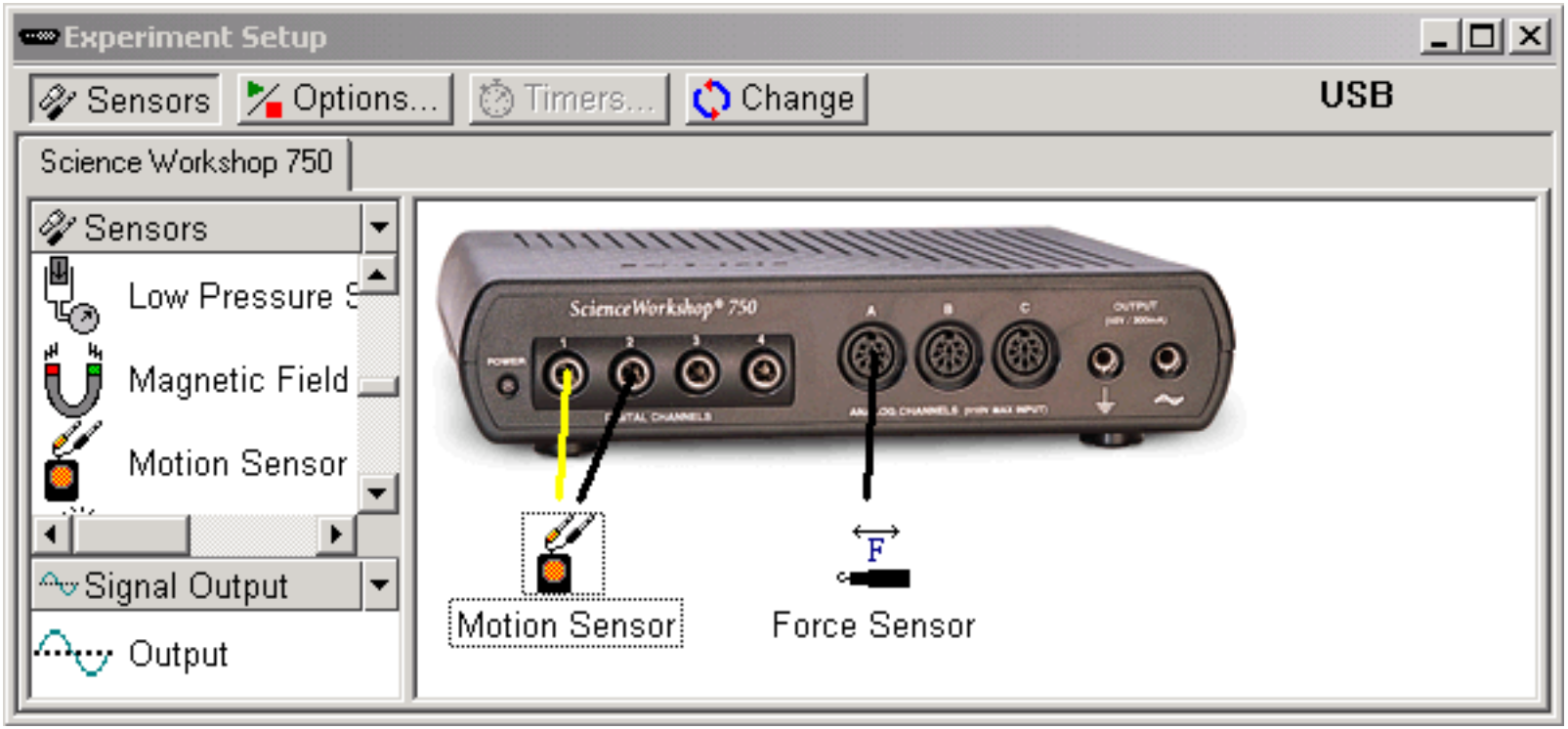




- Use the heavy spring on the force sensor.
- Put two 250g weights in the cart.
- Clip motion sensor to other end of track, and support it on a piece of 2x4.

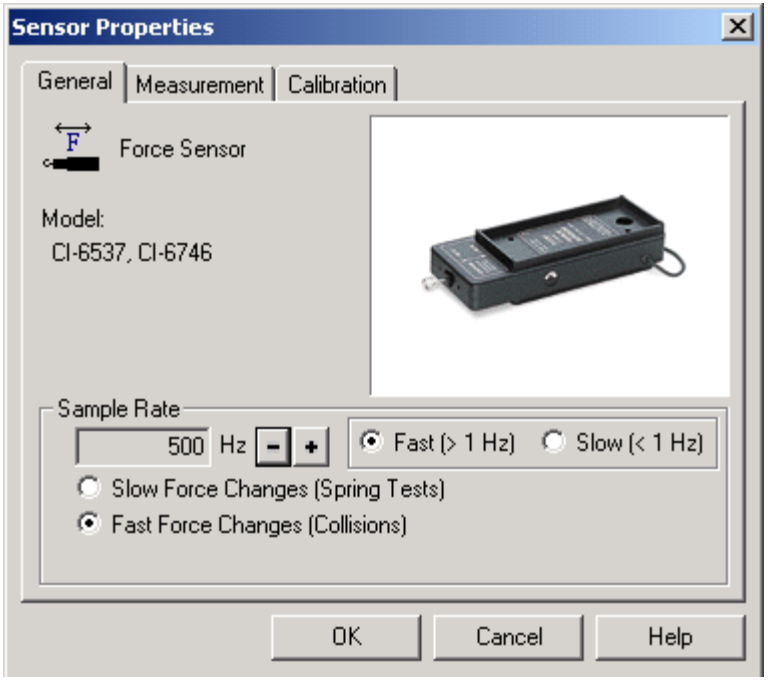
Starting DataStudio

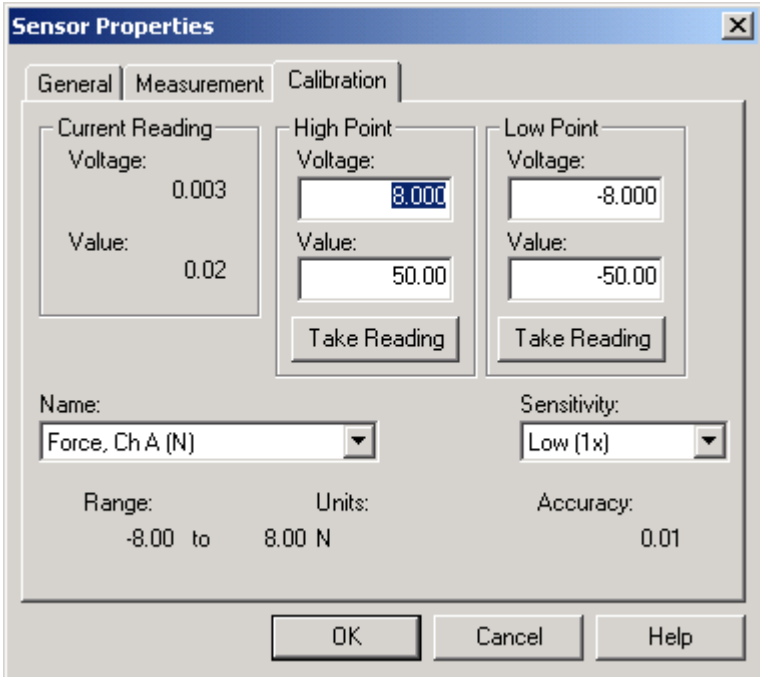
- Create a new experiment.
- Plug force and motion sensors into the 750 and
- drag their icons to inputs in the Setup window.



- Double-click the Force Sensor icon.

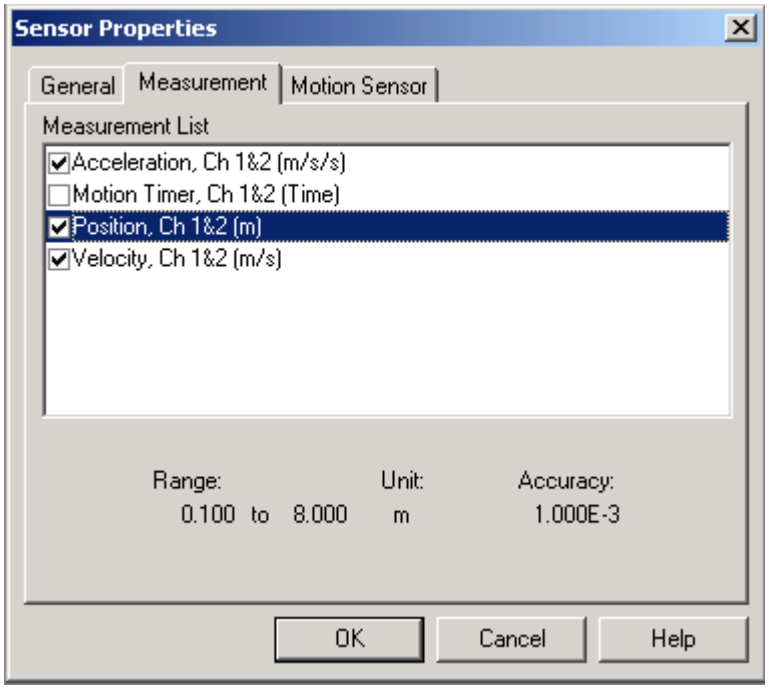
Force Sensor

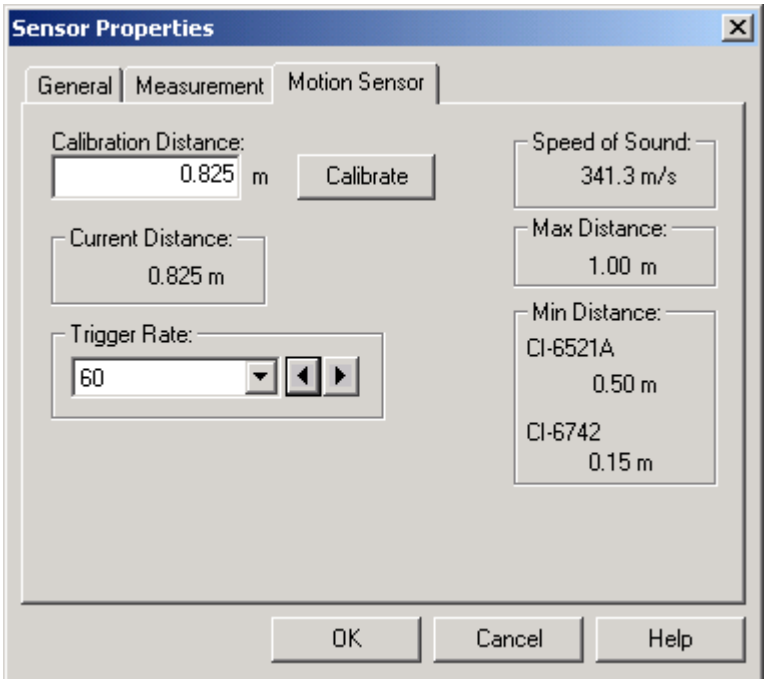




- Set Sample Rate to 500Hz and Sensitivity to Low.
- Double-click the Motion Sensor Icon.

Motion Sensor

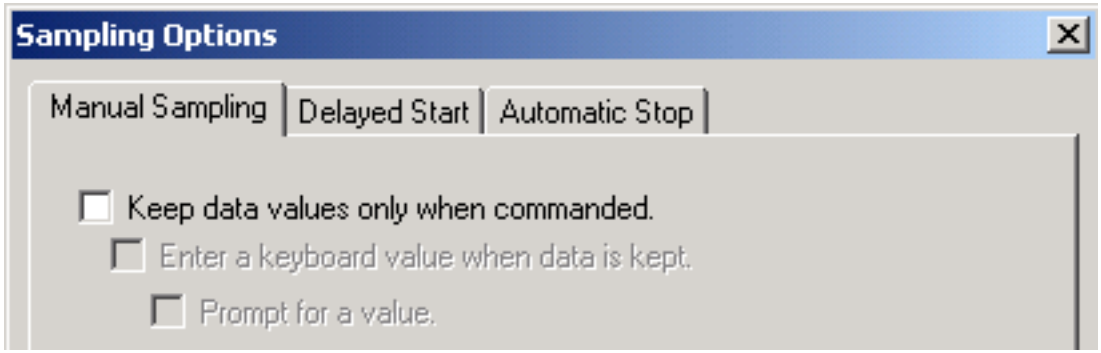




- Ensure to have Acceleration, Position and Velocity checked
- Set Trigger Rate to 60Hz and
- calibrate distance to cart when it is resting against the spring.

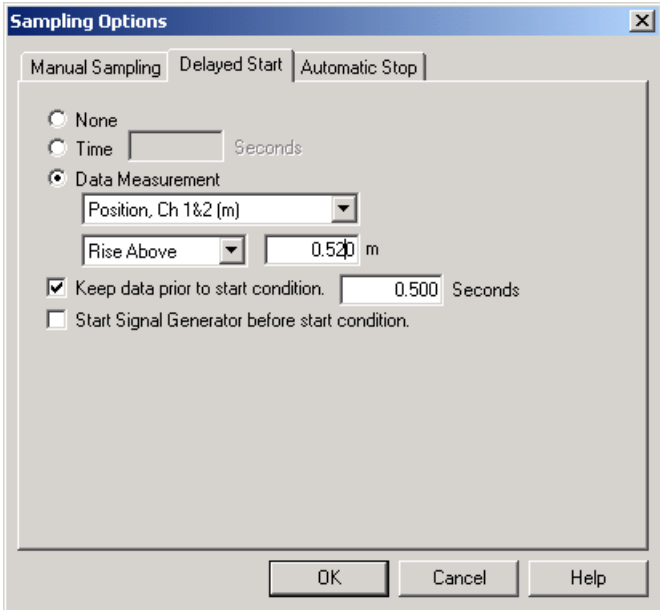
Click 

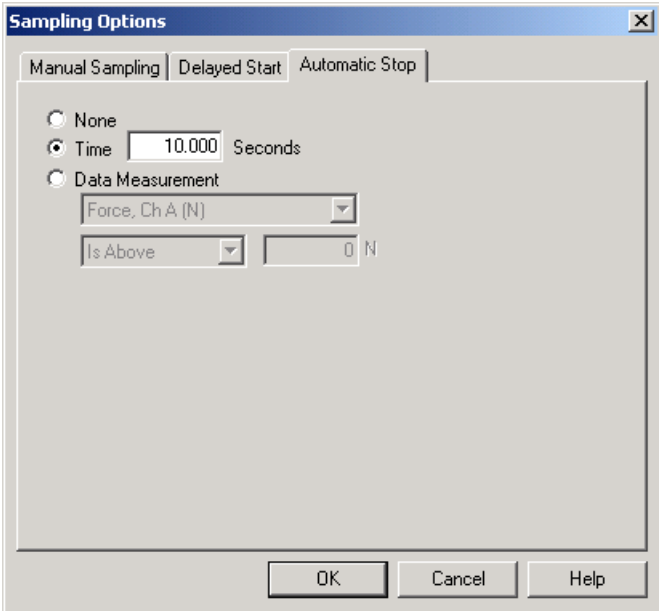
Sampling Options



No boxes checked!

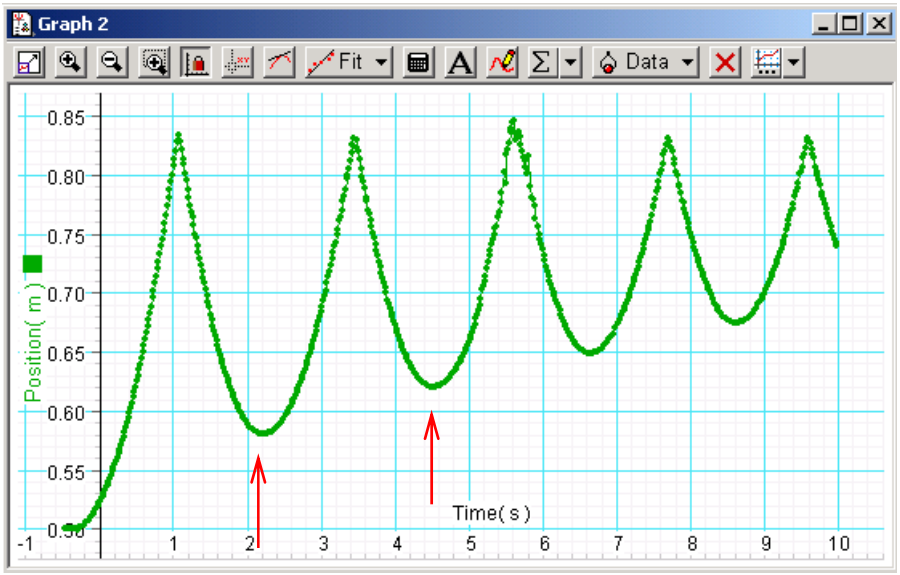
Delayed start on position measurement!



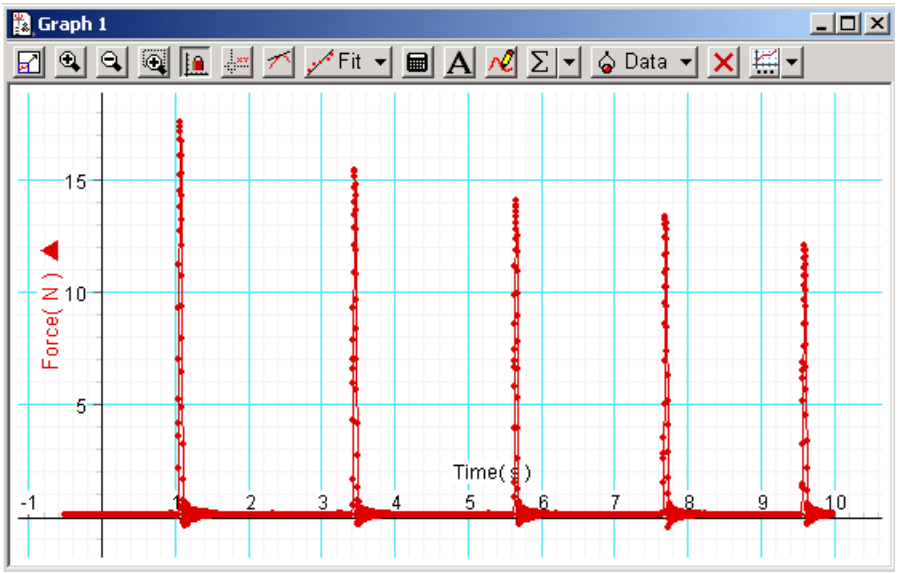


Stop after 10s!

Measurement Results

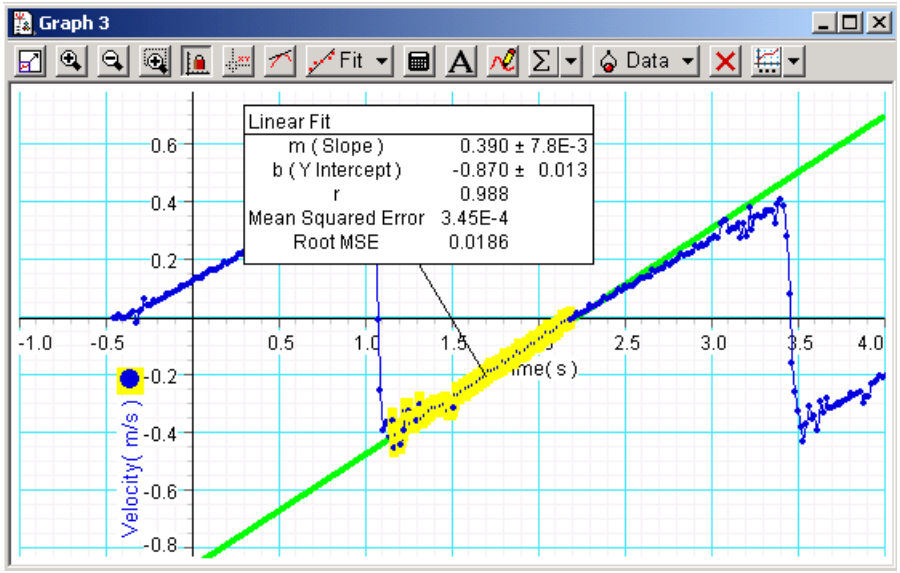


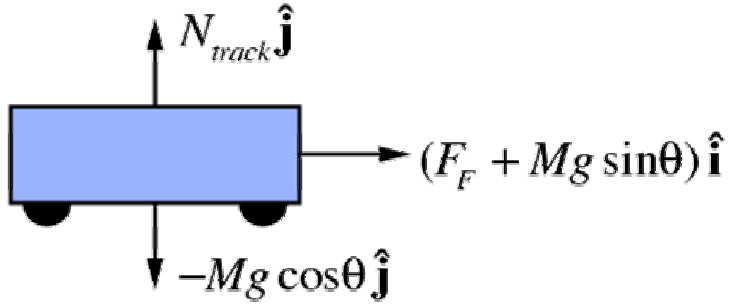
- Position vs. Time: Measure maximum heights either side of 2nd bounce, calculate loss of potential energy, and friction force. Enter in table!



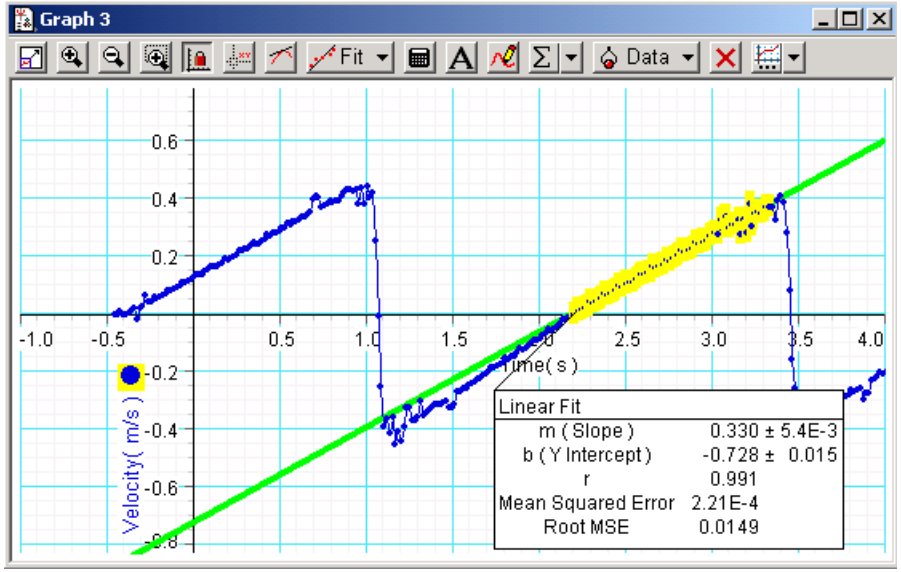
- Force vs. Time: Expand force peak around 2nd bounce.

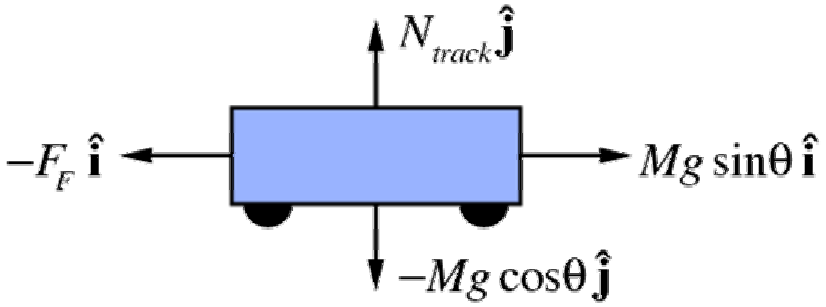
Finding Acceleration Up & Down





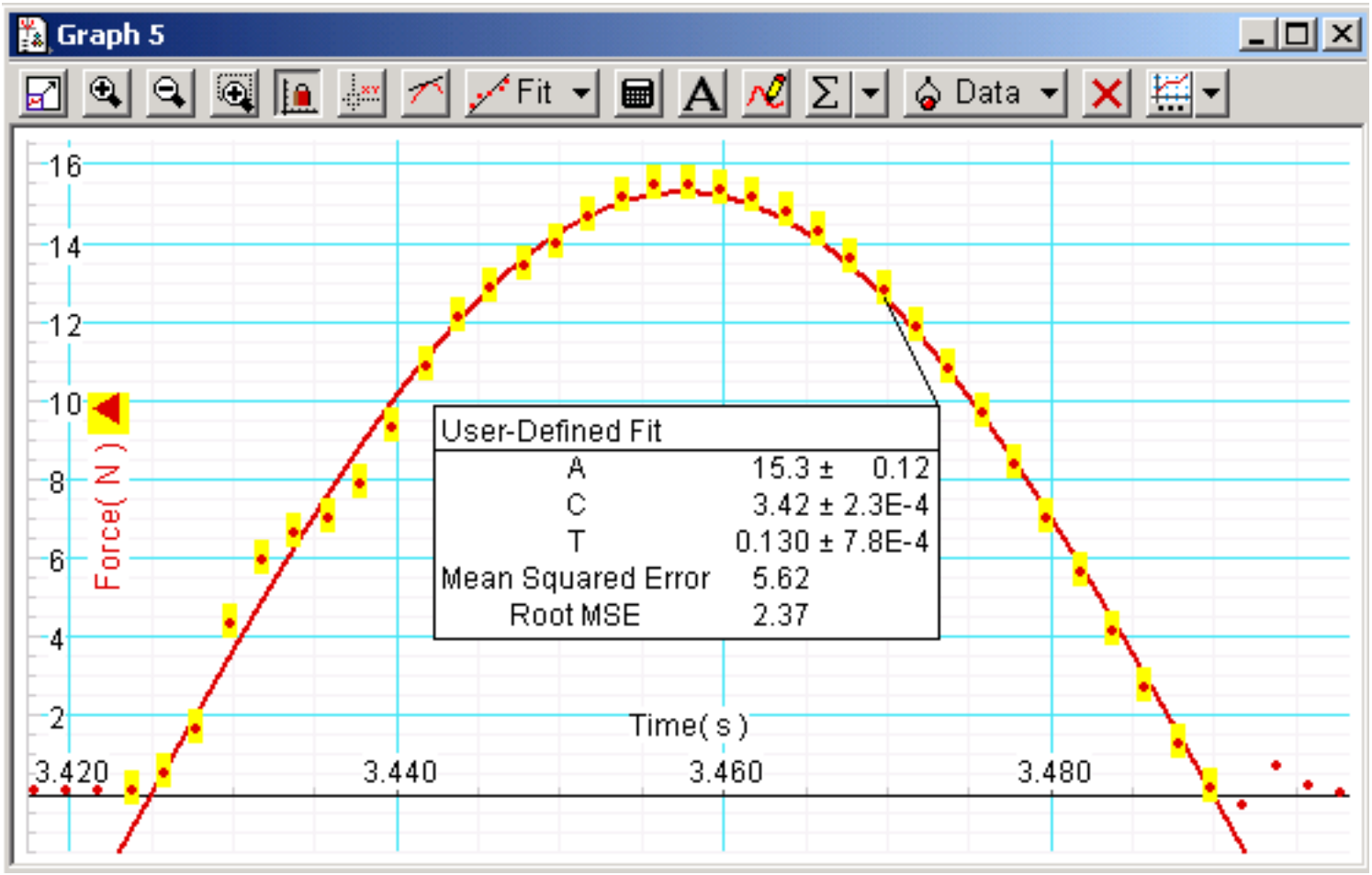
Linear fit to find a_{up}





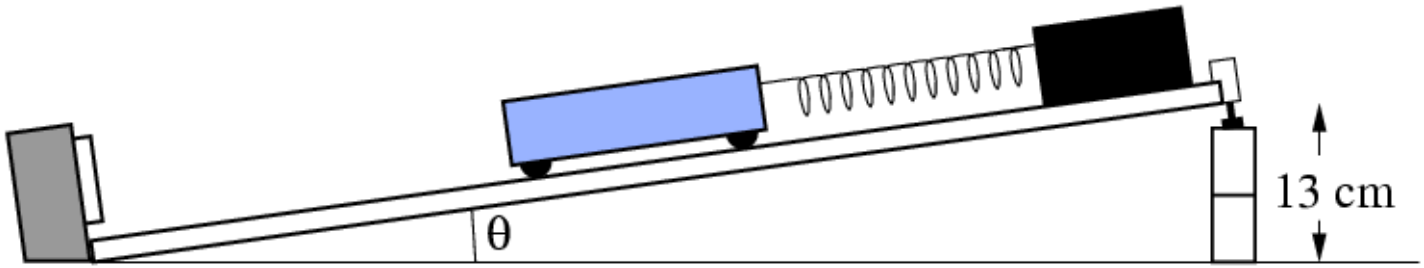
Linear fit to find a_{down}

Analysis Force Peak



User-Defined Fit to A*sin(2*pi(x-C)/T)

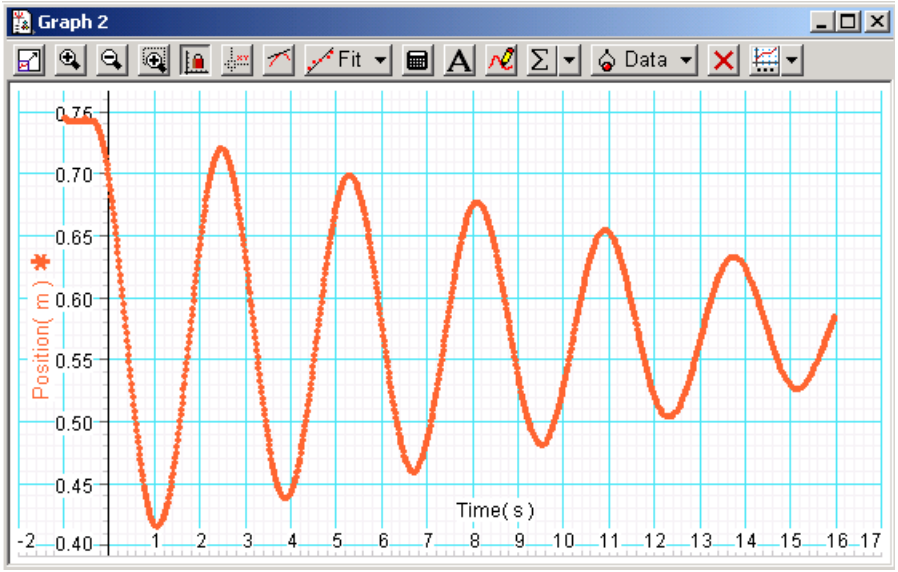
Harmonic Oscillator



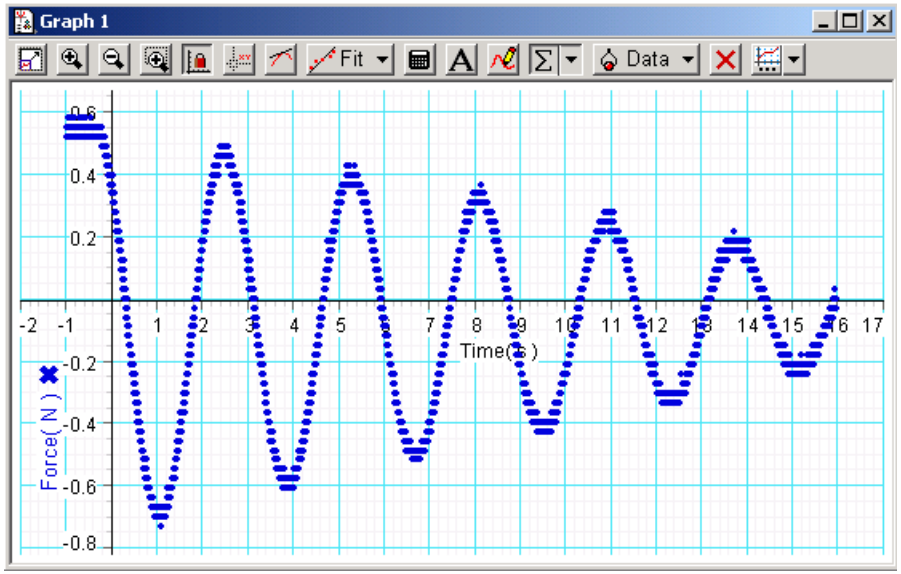
Unclip motion sensor, raise the force sensor end of track

Attach spring to plunger on cart with a binder clip and to the hook on force sensor.
Add two 250g weights in the cart.
Place motion sensor on table touching other end of track.
Set Delayed Start and Auto Stop.

Harmonic Oscillator Results



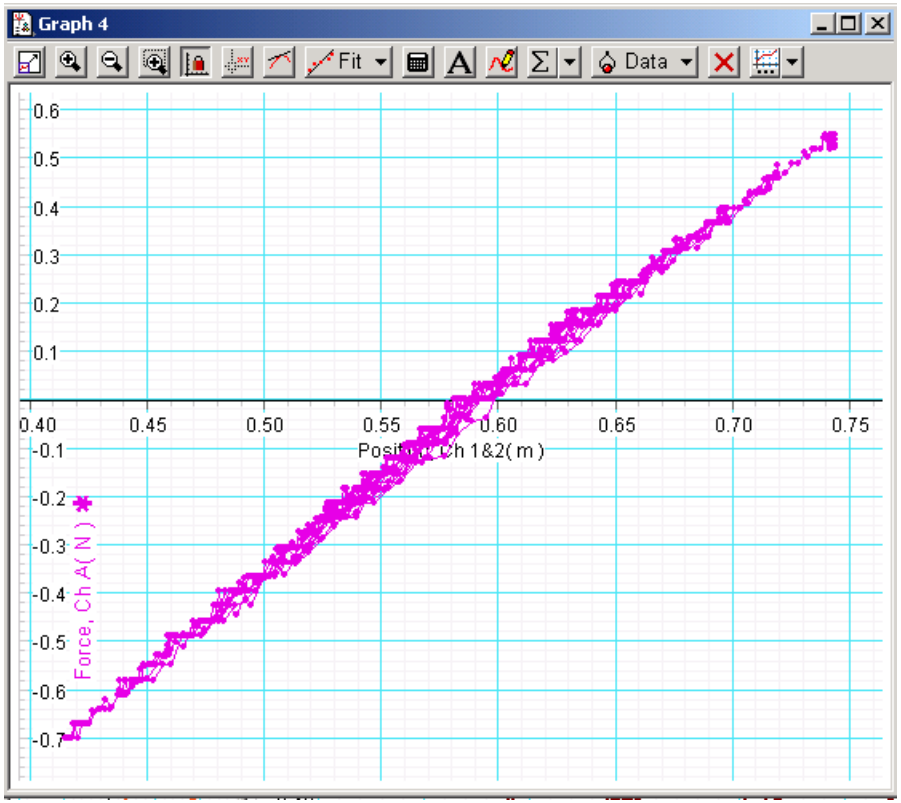
Position vs. Time:
Measure the period, and calculate spring constant k from M = 0.75 kg.



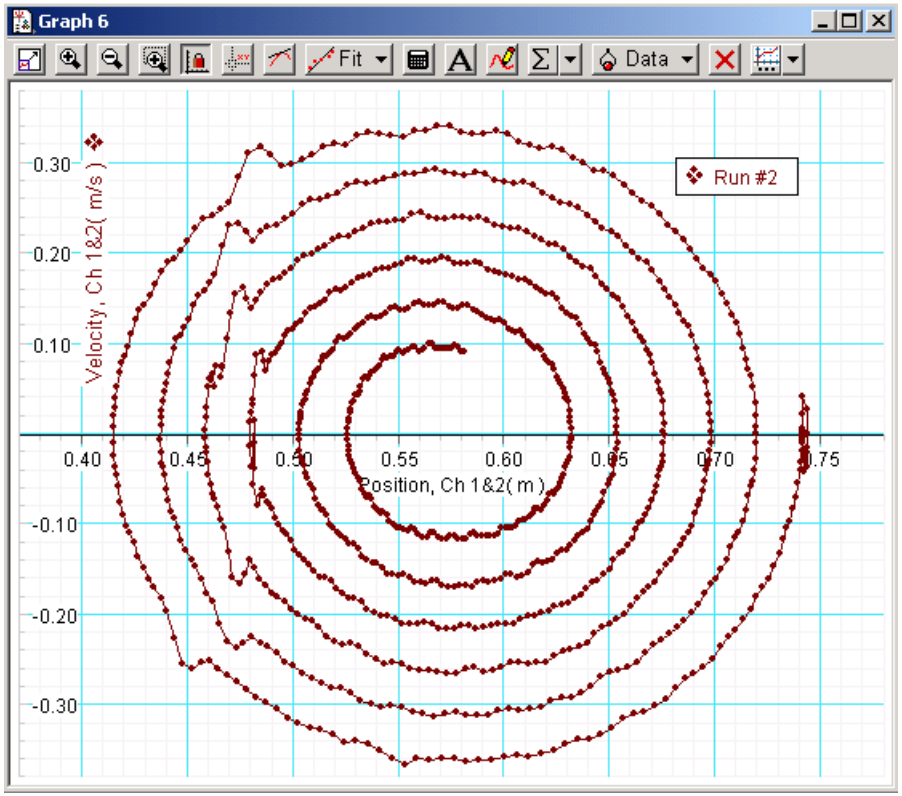
Force vs. Time.

Make a plot of force vs. position.

Lissajous Patterns



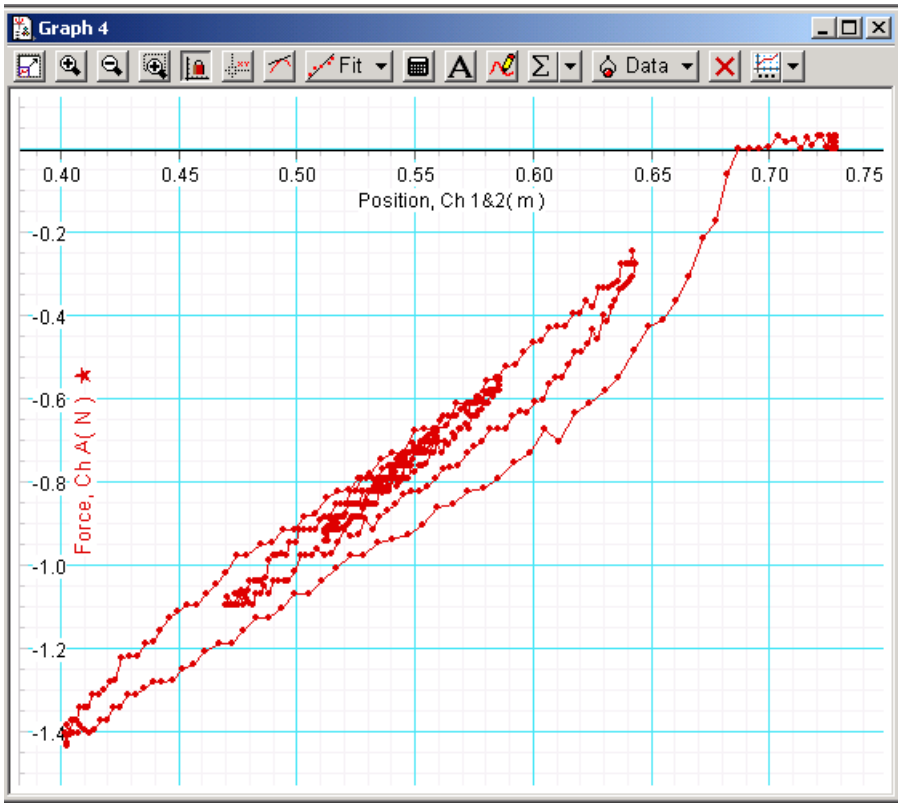
Force vs. Position: Find k from a Linear Fit.



Velocity vs. Position.

Rubber Band Spring - Optional

Position vs. Time:
Note increased damping.



Force vs. Position.
Not linear.