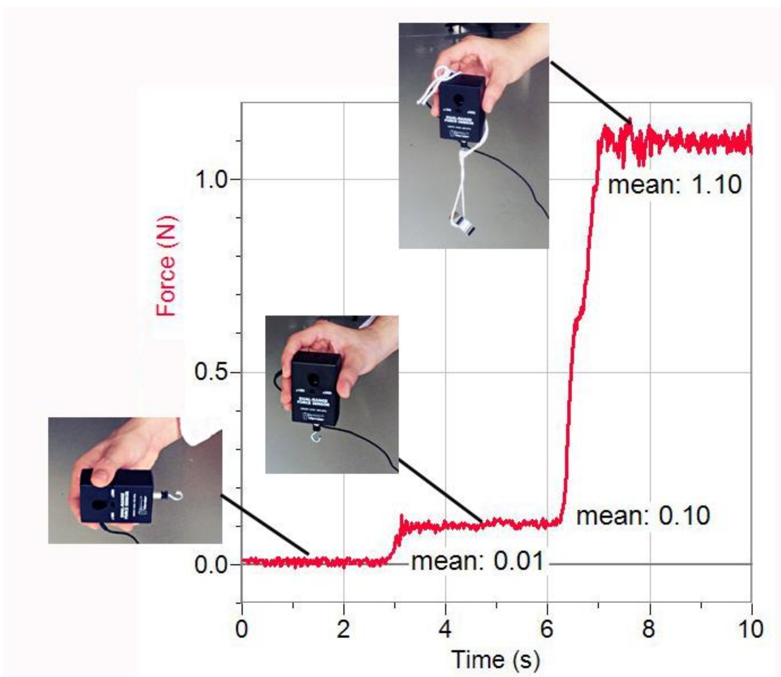
Work (the integral *f.dx*) and Kinetic Energy

A motion detector and a force probe (1-10 N) are connected to a Lab Pro. The Lab Pro is connected to the USB port of a computer running Logger Pro. A glass container of known mass has a 20-30 cm loop of string attached. You have additional masses. Place the motion detector and force probe as shown.

Instructions 1: to set the computer to record data

a Connect the Lab Pro to a USB port of your computer, Open Logger Pro. Go to **Experiment** … **Data collection**. Set the collection time to 5 s and the data rate to 200 points per second (for the force probe only).

b Press control … zero on the keyboard and click OK to zero the force probe.

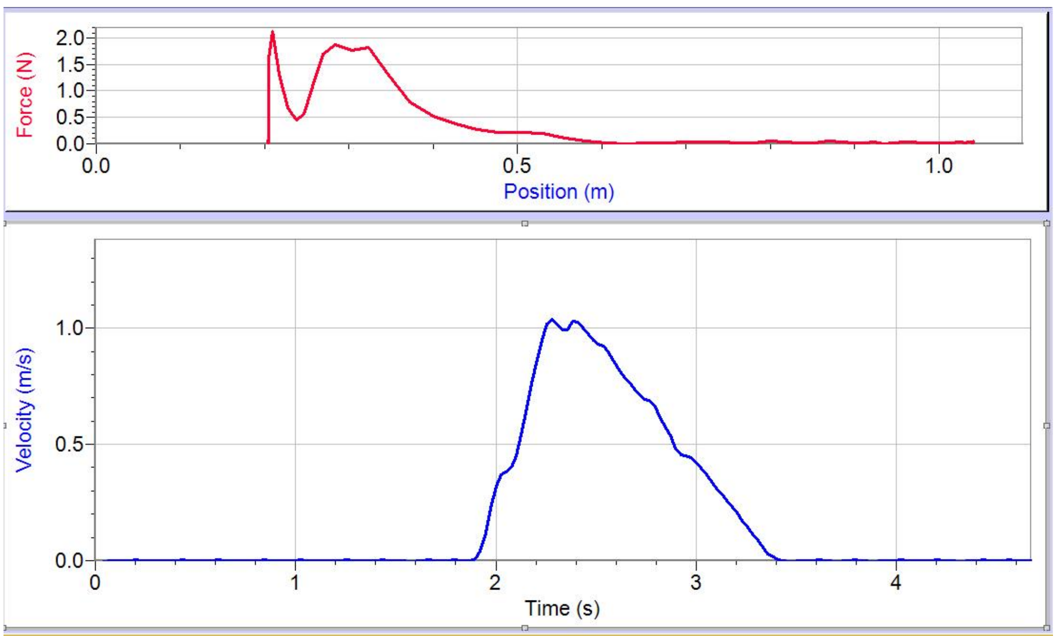


The force probe is horizontal, vertical, and has a hanging 1 newton weight.

c Left-click the Time label on the Force-time graph and select Position.

d Click and drag the small square centre-top of the velocity-time graph upwards to fill the space with the lower graph.

e Mass the cup and add masses wrapped in tissue paper. Accelerate the cup with the force probe (keeping the string horizontal) then let it slide freely to a stop. **Autoscale both graphs and adjust the scales.** Practice until you get graphs like the example below. **Pull the cup gently over a few cm so that the force-position graph has enough data points to calculate the integral.**



Typical force-**position** and velocity-time graphs.

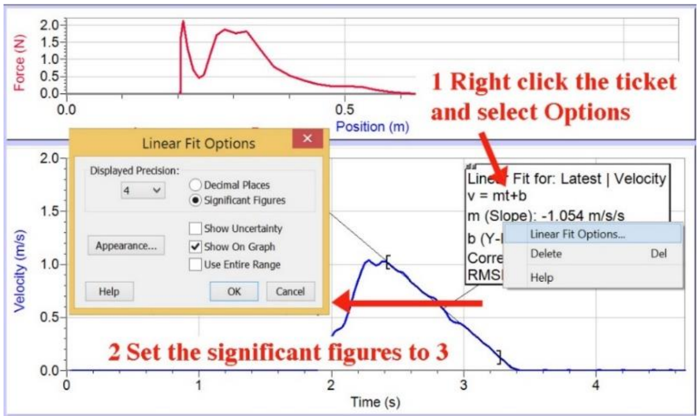
2 Data collection: *each person is to save the Logger Pro file four times with different names (1, 2, 3, 4) to a folder on their own computer.*

a Make four data sets with *the same mass*. Record the mass and save the Logger pro file four times to a folder.

b For the next person change the mass. Either, connect their computer to the Lab Pro and repeat, or use the same computer and email the new saved files as attachments to the next group member. *Each person is to have four files of their own with the same mass each time.*

3 Analysis: find the acceleration when sliding and the friction force

a Fit a straight line to the velocity-time graph. Right-click on the ticket that appears on the graph to open a menu panel. Go to **Linear Fit Options** and set the significant figures to 3.

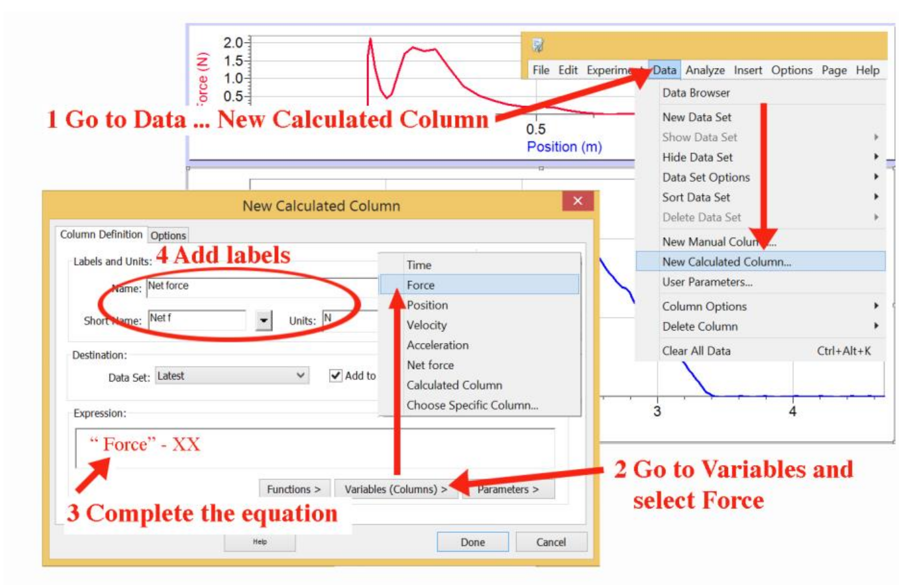


b Find the constant sliding friction force f_o using $f = ma$.

Find the net force and the integral w.r.t. position

a Click the Force-position graph: go to **Data** … **New Calculated Column**.

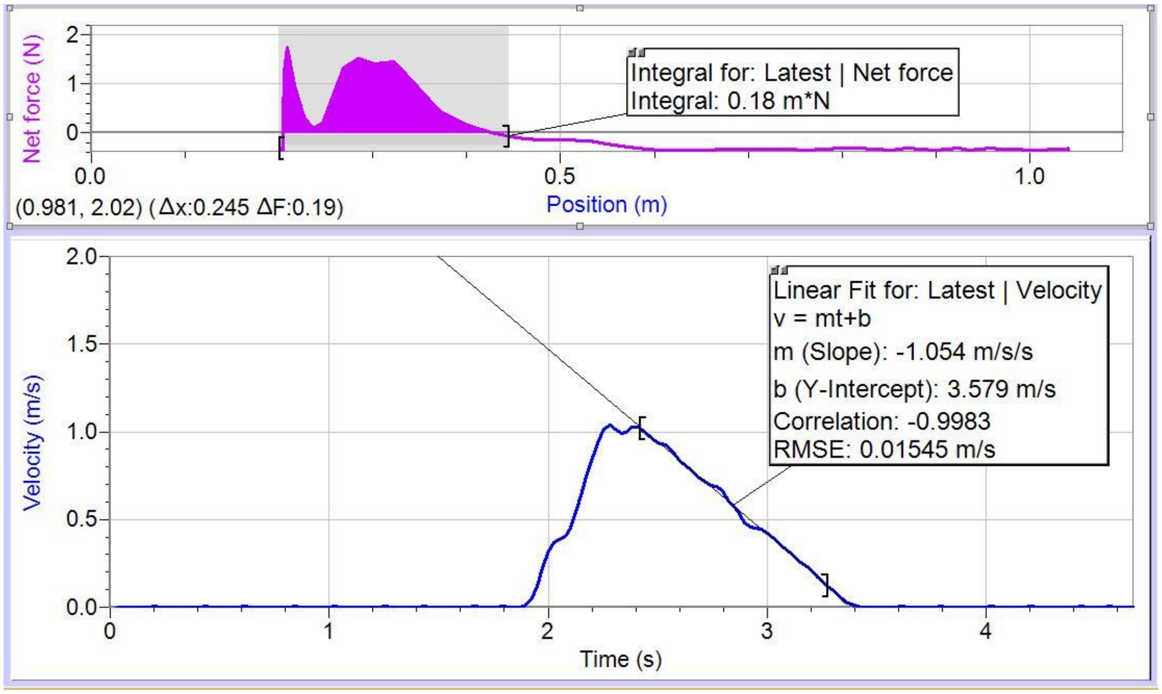
b Call the new column Net-force and enter the relationship [“Force” **-** f_o] using the **Variables** menu to enter the Force values.



c Click on the Force label on the graph axis and change it to Net Force.

d Drag across the Net-force graph. Go to Analyze and find the Integral in Newton metres.

e Right click on the ticket to set the significant figures for the integral to 2 as above.



Compare the value of the force-position integral with the maximum KE

a Find the maximum velocity from the lower graph and calculate the maximum kinetic energy … $\frac{1}{2}mv^2$.

b Are the two values the same each time within errors?

> **Note: you will not be sure what the random errors are because you only have four data sets.** We need more data to find the random errors in this situation.

c Write down the values of the integral (work done) and maximum KE for each data set **to two significant figures** and email them to your instructor.

A question:

Why might the force-position graph in the example above have a large spike on the left hand side of the force/position integral?