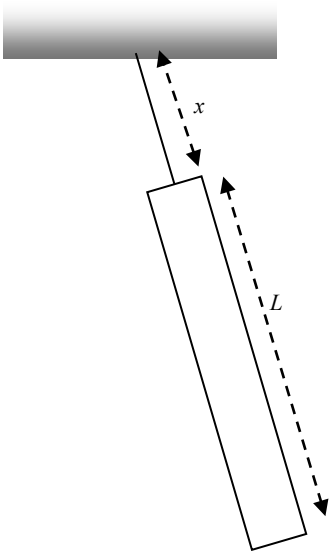
**Physics 162 Oscillations and Waves Discussion Questions**

**Apparatus:** rods, bases, stands, right angle clamps, meter sticks, string, tape, scissors, set-up for running the longitudinal standing wave demo (spring from Chladni plates, oscillator, function generator, some rods, right angle clamp, and base)

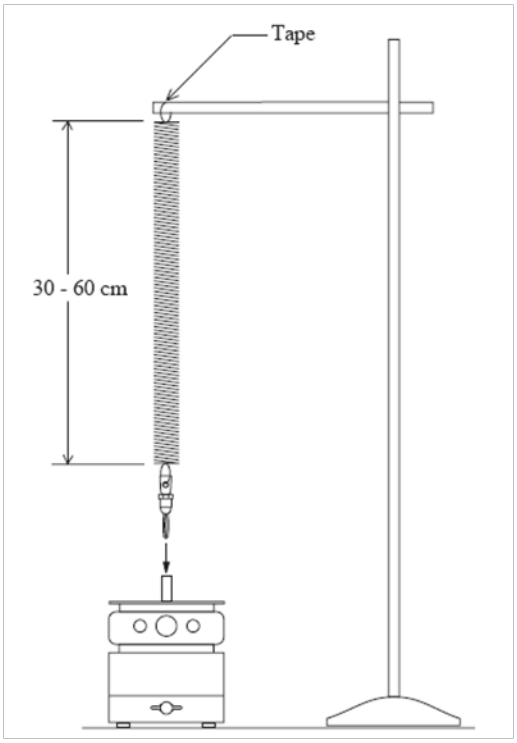
1) Suppose you are told that the pistons in one particular NASCAR engine execute simple harmonic motion with an amplitude of 1.625". The piston oscillates at about 10000 RPMs. To make this problem slightly more challenging, let's assume we are considering a piston that reaches its max position $T/3$ after the first piston reaches its maximum (here $T$ is the period of the oscillation).

a) *Determine the amplitude in cm.
b) *Determine the period of motion.
c) *Write down the equations for position as a function of time using the standard method described in class…$x(t) = A\cos(\omega t + \phi)$.
d) *****Do the same for $v(t)$ and $a(t)$ then graph all three. Include units and axis labels. Use engineering paper and make each graph about 1/3 of a page. Clearly indicate the intercept, max, and min on the y-axis of each graph.




2a) *****Determine the period of small oscillations of a meterstick length $L$ attached to a frictionless pivot point with a small length of massless string length $x$.
2b) *Verify your answer is correct by setting x equal to zero and comparing it to the answer obtained for a rod with the pivot at its end.
2c) **Set up the experiment and experimentally obtain a result. Compare to the theory with a % difference. You should probably be within 10%. Be sure that when the pendulum and string are swinging they are collinear or your results will be off!

**3) Longitudinal Standing Waves on a Spring**




a) Predict the boundary conditions for standing waves in the apparatus shown at right (node-node, node-antinode, or antinode-antinode).
b) Derive a formula for the resonant frequencies of the spring in terms of $L$, $v$, and some integer $n$. Be clear to specify if $n$ takes on all values, even values only, or odd values only.
c) Hook one end of the spring through the hole in the banana plug assembly.
d) Insert the banana plug on one end of the spring into the drive shaft of the Mechanical Driver.
e) Suspend the other end of the spring from a ring stand or other support such that the length of the spring is between 30 and 60 cm. (It may be desirable to tape the loop on the end of the spring to the support so that it does not move once resonance is attained.)
f) Connect the Mechanical Driver to a function generator capable of driving a speaker.
g) Start driving the Mechanical Driver at about 10 Hz with approximately 1 mm of amplitude and slowly increase the frequency. **NOTE:** It may be necessary to decrease the driving amplitude when resonant points are attained. **NOTE:** A light background is best for viewing the nodes and anti-nodes.
h) Graph the relation between the number of nodes and the driving frequency. Determine the velocity of waves on the spring.
i) As you stretch the spring, speculate what should happen to the wave speed. Speculate how this will affect the frequencies used to obtain standing waves.
j) Change the length (thus the tension) of the spring and see if different frequencies are required for the same number of nodes. Does it match your reasoning from part i?