**Instructions: You have a total of 55 minutes to complete this test.**
**Answer each of the following questions completely.**

Time Start_____ Time finish_____ Pledged_____

**You must supply all details that led to your answer.**
**You must provide correct SI units where required.**
**Do not discuss any aspect of this test with anyone until I return the test.**

[1](a) An closed organ (1 end closed) pipe has a length of 2.50 m. Assuming that the speed of sound is 343 m/s, find the frequency of oscillation of the **next to lowest lying mode** in this organ pipe. Hint: Be careful here!

[1](b) How long would an organ pipe with both ends open need to be so that the lowest lying mode has the same frequency?

[1](c) What tension would a string of length $5.00 \times 10^{1}$m with a mass per unit length $\mu = 1.00 \times 10^{-3}$ kg/m need to have so it would have a frequency of oscillation of 35 Hz when both ends of the string are fixed?

[2] Suppose a simple pendulum has a length of 20.0 m. You may assume the acceleration due to gravity is g=9.8 m/s$^2$.

[2](a) What is the period of small oscillations about the equilibrium position?

T=_____

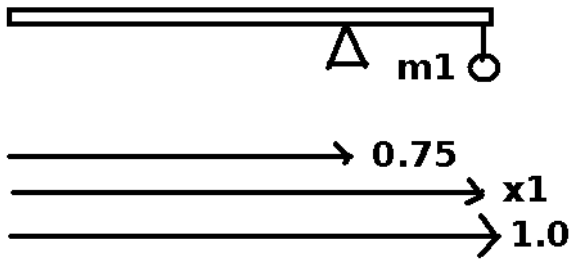
[2](b) What mass should be placed on a spring with a spring constant of k=2.0 N/m in order to produce the same frequency as the pendulum has?

m=_____

[2](c) If a spring mass system in problem (2b) is displaced through a maximum displacement of $x_{max}$=0.5 m, what is the total energy of the system?

E=_____

[3] A meterstick of mass m=0.5kg and length L=1m is on a pivot at x=0.75m. Find the position that a mass $m_1$=4 kg would need to be placed so that the system would be in static equilibrium by answering the following questions.




[3a] Sketch in and properly **label all forces** on the diagram above. Do not neglect the weight of the meterstick. Indicate the force from the pivot as Fp.

[3b] Apply Newton's law to find the force exerted by the pivot.

F=_____

[3c] Now, consider the axis to be located at x=0. Write the torque equation required to achieve static equilibrium. In writing this equation, your final result should have the actual numbers in it (as much as possible) with correct signs.

$\sum \Gamma$=_____ .

[3d] Solve for the position $x_1$ where the mass $m_1$ would be placed for static equilibrium to result. Your answer here is numerical with correct SI units.

$x_1$=_____

[4] A wheel initially at rest of radius R and moment of inertia $I=mR^2$ has a force $F=F_0$ ($F_0$ has SI units of N) applied tangent to the edge of the wheel so that the wheel starts spinning. At time t, the force is removed from the wheel. Your answers must be in terms of the variables indicated in parenthesis.

(a) After a time t, what is the angular velocity of the wheel ($F_0$, t, m, R)?

(b) What is the kinetic energy of the wheel at time t ($F_0$, t, m)?

(c) What is the angular momentum of the wheel at time t ($F_0$, R, t)?

(d) Suppose that at time t, the radius of the wheel suddenly expands by a factor of 2 so that $R_{after}=4R$. What is the angular velocity of the wheel after this expansion has occurred ($F_0$, R, t)?