

Instructions: You have a total of 50 minutes to complete this test.

Answer each of the following questions completely.

Time Start _____ Time finish _____ Pledged _____

[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 5.00×10^1 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 $g = 9.8 \text{ m/s}^2$.

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

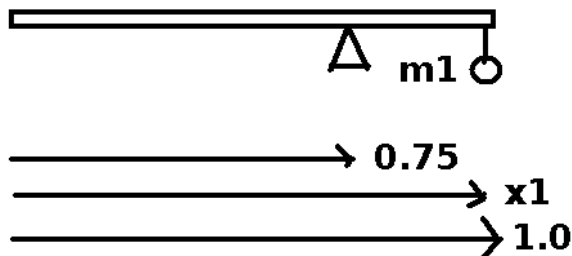
[2](b) What mass should be placed on a spring with a spring constant of $k=2.0 \text{ N/m}$ in order to produce the same frequency as the pendulum has?

$m=$ _____

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

$E=$ _____

[3] A meterstick of mass $m=0.5\text{kg}$ and length $L=1\text{m}$ is on a pivot at $x=0.75\text{m}$. Find the position that a mass $m_1=4\text{ kg}$ 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 F_p .

[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.

$\Sigma \tau$ _____.

[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 $F = bt^5$ (b has SI units of N/s^5) 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) At a time t , what is the angular velocity of the wheel (b, t, m, R)?

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

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

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

(e) A wheel with a moment of inertia $I_1 = \frac{1}{3} m R^2$ and another wheel with $I_2 = \frac{3}{5} m R^2$ are rolled without slip down a plane, falling through a height h . The two wheels then roll on a flat surface. What is the ratio of the kinetic energies (I_1/I_2) at the bottom of the plane? What is the ratio of velocities (v_1/v_2) at the bottom of the plane?