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.

Although you may use additional sheets of paper which should be turned in with your test, please write (neatly) your answers on the pages where the problems are presented.

(1)(a) An open ended organ pipe has a length of $5.00\text{x}10^2$ m (it is a very long organ pipe). Assuming the speed of sound is 343 m/s, find the frequency of oscillation of the lowest lying mode in this organ pipe.

(b) What tension would a string of length $5.00\text{x}10^2\ \text{m}$ with a mass per unit length $\mu = 1.00\text{x}10^{-5}\ \frac{\text{kg}}{\text{m}}$ need to have the same fundamental frequency of oscillation if both ends of the string are fixed?

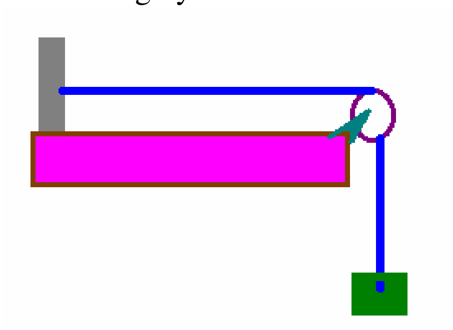
(2) Suppose a simple pendulum has a length of 10.0 m at a temperature of $0.00^0\mathrm{C}$ degrees centigrade and is set into motion. You may assume the acceleration due to gravity is $g = 9.80\,\frac{\mathrm{m}}{\mathrm{s}^2}$.

(a) What mass should be placed on a spring with a spring constant of $k = 0.500\,\frac{\mathrm{N}}{\mathrm{m}}$ in order to produce the same frequency of oscillation at the simple pendulum?

(b) If the coefficient of linear expansion of the thin wire is $\alpha = 1.00\times10^{-3}\,\frac{1}{^0\mathrm{C}}$, find the period of the pendulum when the temperature is at $50.0^0\mathrm{C}$.

(c) Suppose an object with a volume $V_0 = 1.00\,\mathrm{m}^3$ at $0^0\mathrm{C}$ with the same coefficient of linear expansion as in part (b) and a density of $\rho_{\mathrm{obj},0^0\mathrm{C}} = 500\,\frac{\mathrm{kg}}{\mathrm{m}^3}$ at $0^0\mathrm{C}$ is placed in water with a density $\rho_{\mathrm{water}} = 1000\,\frac{\mathrm{kg}}{\mathrm{m}^3}$ which is at a temperature of $50.0^0\mathrm{C}$. When the object heats up to the same temperature as the water, what is the ratio of the volume of the object under the water to the volume of the entire object?

(3) A wire has a mass of 0.05 kg and a total length of 5.00 m with 1 m of the wire hanging over a pulley as shown and is attached to a 10 kg mass while the other end of the wire is attached to a grey block. Find the lowest 3 modes of oscillation in this system. You may assume that the end at the pulley is fixed as is the end at the grey block.



(4) A solid sphere of mass m and radius R has a moment of inertia given by $I_{solid} = \frac{2}{5}mR^2$. A spherical shell of the same mass and radius has a moment of inertia given by $I_{hollow} = \frac{2}{3}mR^2$.

(a) If both are rolled down an inclined plane without slipping (dropping through a height h), what is the value $\frac{v_{hollow}}{v_{solid}}$ at the bottom of the plane?

(b) Suppose now you race two solid spheres down the same inclined plane. Both spheres have the same mass but sphere #2 has twice the radius of sphere 1. If both roll without slipping, what is the value of $\frac{v_{\#1}}{v_{\#2}}$ at the bottom of the plane?

(c) What is the angular momentum of sphere #1 at the bottom as compared to the angular momentum of sphere #2 at the bottom: $\frac{L_{sphere\#1}}{L_{sphere\#2}} = ?$ (Your answer should be numerical here and the two spheres are the same as in part b.)