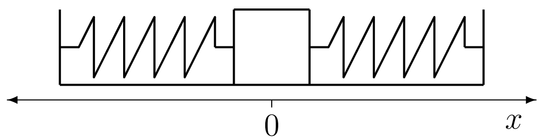
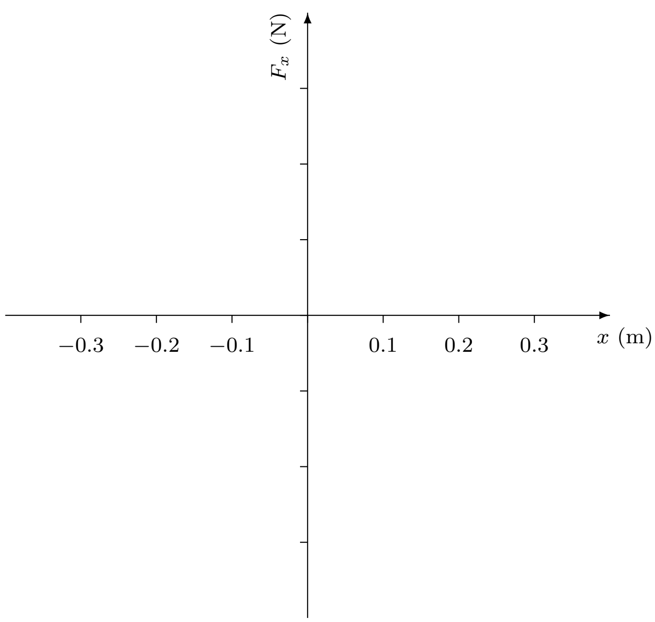
Assignment 1; Phys 186 Name ________________

1. (30 points) You have a 0.32 kg object attached to two identical springs, each with spring constant 10.0 N/m, at each end as shown in the diagram. The mass oscillates back and forth horizontally on a frictionless surface.



(a) Using the axes given, draw a graph of the total force on the mass F_x vs. the displacement from equilibrium x. Take care to indicate the force direction with appropriately positive or negative quantities. Write in the appropriate numbers on the tick marks on the F_x axis on your graph.



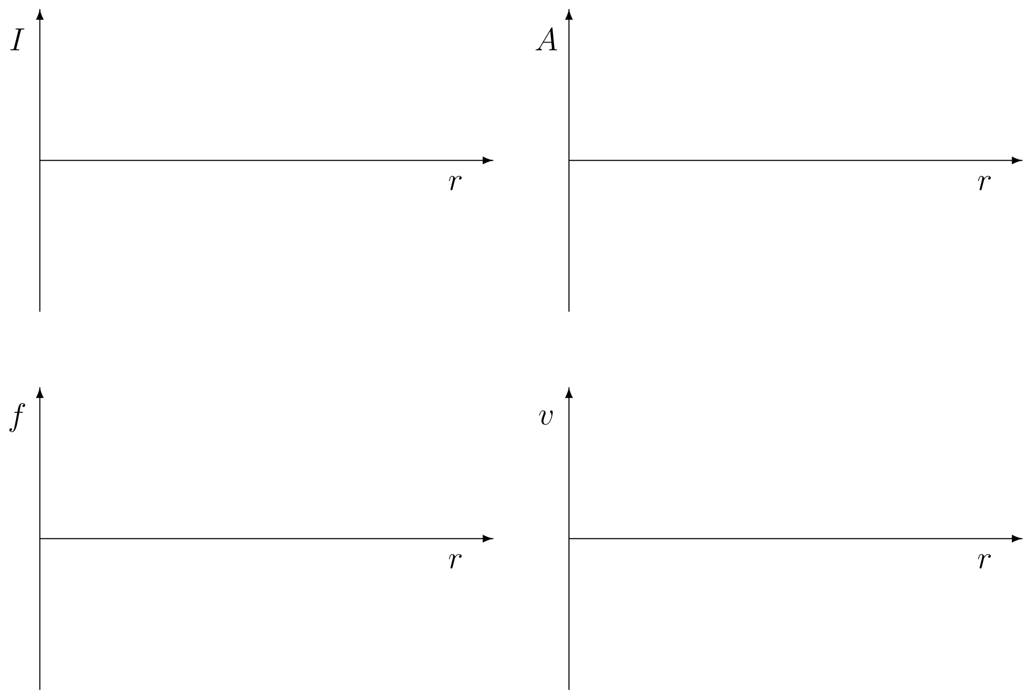
(b) The oscillations of a single spring have an angular frequency $\omega = \sqrt{k/m}$. What is the angular frequency for the oscillations of this double spring setup? Explain.

2. (30 points) You're given a spring, a known mass m_0, and an unknown mass m_1. The only measuring device you have is a stopwatch. Describe an experiment you would design in order to determine m_1. Provide an equation that expresses m_1 in terms of m_0 and quantities you can measure with your stopwatch.

3. (20 points) We characterize waves by their frequency, wavelength, and amplitude. Audible sound has a frequency range of 20 Hz to 20 kHz, wavelengths between 1.7 cm and 17 m, and a minimum intensity of 10^{-12} W/m^2. *Ultrasound* can be used for medical imaging, where it can resolve structures with sizes considerably less than 1 cm. The "ultra" in ultrasound must therefore refer to higher than audible frequency, wavelength, or amplitude—which one? Explain. For the range of values in question, you can take the speed of sound to be constant.

4. (20 points) You have a radio beacon set up in outer space, broadcasting with equal and constant power in all directions.

(a) *Qualitatively* sketch the following graphs of the broadcast waves' intensity, amplitude, frequency, and wave speed vs. the distance r from the beacon.



(b) Give the r-dependence of all four variables. The answer for each should be one of r^2, r^1, r^0 (constant), r^{-1}, or r^{-2}. (*Note:* the symbol "$\propto$" means "proportional to.")

$I \propto$

$A \propto$

$f \propto$

$v \propto$

Extra Problems (not graded)

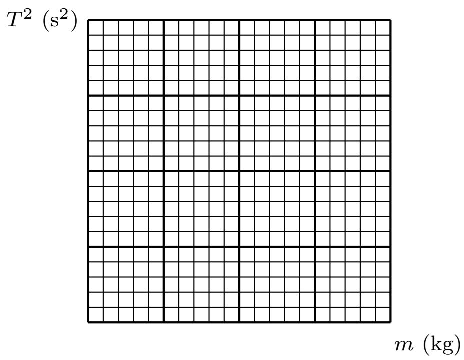
5. (0 points) You have a mass m attached to a frictionless spring with spring constant k, and you set the mass oscillating. In the following list of variables that might describe the resulting motion, draw a circle around those that depend on the mass m:

amplitude, wavelength, period, phase, diffraction

Sketch a graph of this dependence (with m on the horizontal axis) for each variable you circle.

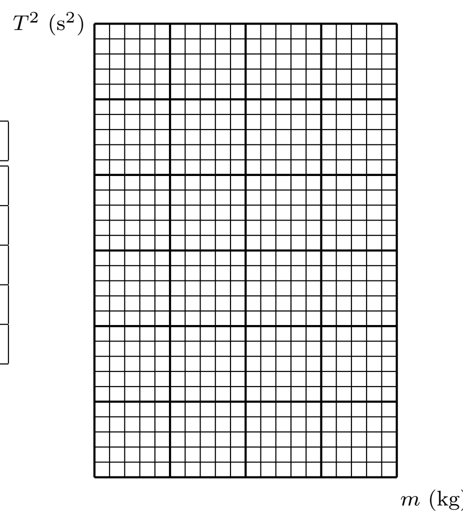
6. (0 points) Tell me if you want to play with an actual spring and masses while thinking about this.

(a) Imagine you hung masses from the end of an ideal spring, with zero mass and no limits on extension or compression without deformation. The spring constant is $k = 10.0$ N/m. You use masses m varying between 0.00 kg and 1.00 kg, and set each mass oscillating, measuring the period T of the resulting motion. What would your predicted graph for the square of the period (T^2) versus mass (m) look like? Put in appropriate numbers on the axes.



(b) You now get a real spring, and make the following measurements of period for different masses. Make the graph and find k. (*Hint:* Use the slope.)

m (kg)	T (s)	T^2 (s^2)
0.00	0.99	
0.25	1.49	
0.50	1.86	
0.75	2.17	
1.00	2.43	



(c) From your graphs, what is the difference between the behavior of the real and ideal springs? Which of the following equations, with an extra parameter ξ, do you think best describes the real spring's period? (*Hint:* $\xi = 0$ for an ideal spring, $\xi \neq 0$ for a real spring.)

$$T = (2\pi + \xi)\sqrt{\frac{m}{k}} \qquad T = 2\pi\sqrt{\frac{m+\xi}{k}} \qquad T = 2\pi\sqrt{\frac{m}{k+\xi}}$$

Explain:

(d) What property of the real spring, ignored in an ideal spring, do you think gives rise to the parameter $\xi \neq 0$? Explain your reasoning.