Name: _____ Date: _____

Objective:
To use an inertial balance to measure the masses of objects.

Abstract:
"Mass: The quantity of matter in a body. More specifically, it is a measure of the inertia or "laziness" that a body exhibits in response to any effort made to start it, stop it, or change in any way its state of motion.
Scientists measure things. A scientific question to ask is "This definition of mass is very nice, but how can mass be measured?" There are several ways to measure mass - a triple-beam balance measures mass, for instance. The triple-beam balance has a couple of disadvantages, however. First, it is difficult to see how the measurement you make on a balance correlates to the definition of mass given above, and the triple-beam balance won't work where there is no gravity.
If mass measures the "laziness" of an object in response to efforts made to change its velocity, it makes sense that you should be able to measure mass by making an effort to change the velocity of an object and recording its "laziness". This is what an inertial balance does. It uses two strips of spring steel to apply the same "effort" in order to vibrate it back and forth. (A vibration involves speeding up, slowing down, and changing direction, so the state of motion of the object is certainly changed.) If the object vibrates quickly it is not "lazy" - it does not have much mass. Objects that vibrate slowly have a large mass.
By measuring how fast known masses vibrate on the inertial balance, you can construct a graph that "calibrates" the balance - that is, if you know how quickly an unknown mass vibrates you can use the graph to determine its mass.

Equipment:
Inertia balance stopwatch masses C-clamps masking tape

Procedure:
Set up the inertial balance. Be sure to clamp one end of the balance to the table so that the other end is free to vibrate freely in the air beside the table. When you place objects in the balance pan, you will need to use masking tape to keep them from sliding about in the pan. The pan with the hole in it should be the side that is swinging.
The point of calibrating the inertial balance is to come up with a graph that shows the response of the balance when a range of masses is placed in it. To do this, you will need to do some careful planning. Here are some hints and pointers:
You will need to use as wide a range of masses as practical - from 0 grams up to as much mass as the inertial balance will hold without buckling. You will need to determine how much mass to add for each trial - you want to be able to tell the difference in the vibration of the inertial balance, but you need to collect several sets of data, too. A little "trial and error" might be helpful here. You don't have to take the masses in strict order - you can come back and fill in "gaps" in your data.
You can determine the response of the inertial balance by measuring its period - the time it takes for one complete vibration (over and back), or by measuring its frequency - the

number of vibrations of the balance pan in a unit of time. Either period or frequency will produce a usable graph (although the graphs will be differently shaped) - it just depends on which measurement you find most convenient.
Don't try to time one period, or determine the number of vibrations in one second! Record the time for 25 vibrations and construct a data table to record your data.
The point of the lab is to demonstrate that you can measure the mass of an object using the inertial balance. Your instructor will place several objects of "unknown mass" where you have access to them. Determine the mass of two of them using your inertial balance.

Data:

Object	Time Trial 1 (s)	Time Trial 2 (s)	Time Trial 3 (s)	Avg Time (s)	Period (vib/s)	Mass object (g)
Unknown A						??????????
Unknown B						??????????

Results:
Draw a graph of period vs. mass. Draw the best smooth curve through your data points. Use your graph to determine the masses of your unknowns.

Mass of Unknown A is _____

Mass of Unknown B is _____

Analysis/Conclusion:
1. What are some advantages of timing 20 (or so) vibrations of the inertial balance instead of just one?
2. How accurately do you think the inertial balance measured the masses of your unknowns? Use your results as support.
3. What limits its accuracy? (Be specific, and support your answer.)
4. Mass the unknowns and calculate % error.