Physics Lab # **Name:** ________________________________

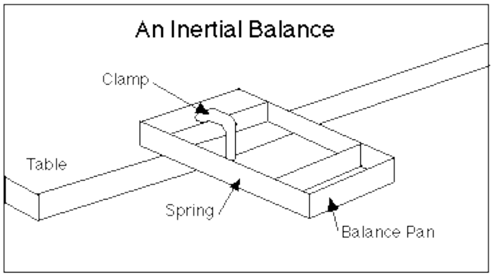
Lab Title: Inertial balance **Date Performed:** ________________________

PURPOSE: The purpose of this lab is to:

1) utilize the physical property of Inertia to measure the inertial mass of an object.
2) demonstrate how the measurement of inertia is done independent of gravitational forces.
3) confirm that the inertial mass and gravitational mass are essentially the same.

INTRODUCTION: Scientists measure things. A scientific question to ask is "This definition of mass is very nice, but how can mass be measured?" A good general definition of mass is anything that has mass and takes up space. There are several ways to measure mass - a triple-beam balance measures mass. 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" (inertia) 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.

MATERIALS: C-clamp, inertial balance, mass set, stopwatch

PROCEDURE: **Part 1: Calibrating the balance**

1) The object of calibrating the inertial balance is to come up with a relationship that shows the response of the balance when a range of masses is placed in it.
2) 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. I recommend changing the mass by about 50-100 grams per trial.
3) You can determine the response of the inertial balance by measuring its period - the time it takes for one complete vibration (over and back). Time 20 oscillations and divide by 20 to get the time for one period.
4) Graph your known masses to the time it takes for one period of vibration.

Part 2: Measuring "Unknown" Masses

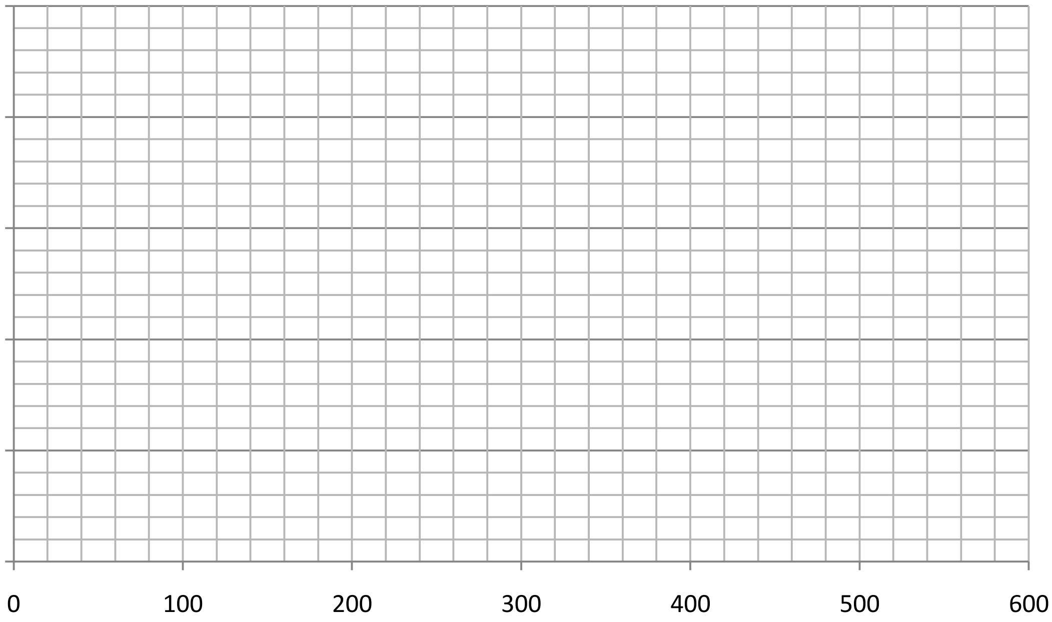
5) You need to demonstrate that you can measure the mass of an object using the inertial balance. Your instructor will place an object of "unknown mass" where you have access to it. Determine its mass using your inertial balance.
6) Check its actual mass with the digital scale and calculate the percent error.

DATA COLLECTION:

Mass (grams)	Time for 20 oscillations (sec)				Period (1 oscillation) (sec)
	1	2	3	avg.	
±				±	±
±				±	±
±				±	±
±				±	±
±				±	±
±				±	±

Actual mass of unknown: __________ Mass of unknown from graph: __________ % error: _______

Data Analysis:



On your own paper, answer the following questions

ASSIGNED QUESTIONS:

1. What are some advantages of timing many vibrations of the inertial balance instead of just one?
2. How accurately does the inertial balance measure the masses of your unknowns? What limits its accuracy? (Be specific, and support your answer.)
3. Would the inertial balance successfully measure mass in the Space Shuttle when it is in orbit around the Earth? Why do you think so? What about a triple-beam balance, which is the more-common way of measuring mass on Earth?
4. Astronauts making extended space flights tend to lose muscle and bone mass due to the "zero-g" conditions in space. This means that it is critical to monitor an astronaut's weight or mass during their stay in space - but the astronaut is "weightless"! How do you think this is done?