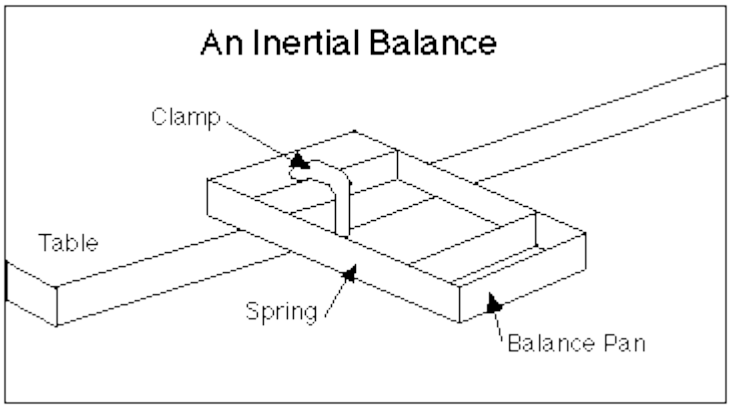
Inertia Balance

"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"

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 displays the relationship between how quickly an unknown mass vibrates.

Equipment:

inertial balance
C-clamp
set of standard masses
"unknown" masses
stopwatch

Procedure:

1. The instructor will demonstrate how to 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.
2. You will use a wide a range of masses. Be sure to be accurate as you complete the data tables below.

- It might be wise to time each mass more than once to catch timing or counting mistakes.
- Hold a piece of paper off to one side, close enough so the pan will hit the paper during its motion. Use the sound hits as your count of the number of cycles completed.
- Record the time for 20 cycles (hits). Start your timer once the pan hits the paper for the 1st time and stop your timer after the cycle is completed.
- Repeat for each of the different masses.

3. 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 a small (mass) unknown and a big (mass) unknown using the same steps as above.

Trial	Mass (g)	Time for 20 vibrations (s)					
		Trial 1	Trial 2	Trial 3	Average	Period (T)	T^2
1							
2							
3							
4							
5							
Small Unknown	? (this is what you will find out)						
Large Unknown	? (this is what you will find out)						

- Use your data and Logger Pro to fill-in the table below with units (if needed).
- Label the **T^2 vs. Mass** graph with the appropriate axes
- sketch a line of best fit for the variables
- Solve for unknown masses & calculate percent %

Period (T) is the time to complete one cycle.

T= Average Time

# of cycles

Relationship between variables	
Your Slope with units	
Y intercept	
Equation for your line	
Equation with graph info added	
Mass of the small unknown	
Percent error for small unknown	
Mass of the large unknown	
Percent error for large unknown	

Conclusion Questions

1. Explain the Y intercept, and can you give a reason for this?

_____

2. When comparing Object A and Object B, it is observed that Object A has a greater tendency to resist changes in its state of motion. What does this observation indicate about Object A and Object B?
    a. Object A is acted upon by more force than Object B.
    b. Object A is a solid and Object B is either a liquid or a gas.
    c. Object A has more inertia than Object B.
    d. Object A experiences a lot more friction than Object B.

3. When compared to a less massive object, a more massive object will always _____.
    a. experience a greater unbalanced force
    b. experience a smaller unbalanced force
    c. have a greater tendency to resist changes in its state of motion
    d. have a smaller tendency to resist changes in its state of motion

4. Which of the following statements are true of **inertia**? Circle all that apply.
    a. Inertia is a force.
    b. Inertia is a force that keeps stationary objects at rest and moving objects in motion at constant velocity.
    c. Inertia is a force that brings all objects to a rest position.
    d. All objects have inertia.
    e. A more massive object has more inertia than a less massive object.
    f. Fast-moving objects have more inertia than slow-moving objects.
    g. An object would not have any inertia in a gravity-free environment (if there is such a place).
    h. Inertia is the tendency of all objects to resist motion and ultimately stop.
    i. In a gravity-free environment (should there be one), a person with a lot of inertia would have the same ability to make a turn as a person with a small amount of inertia.

5. Which of the following statements are true of the quantity **mass**? Circle all that apply.
    a. The mass of an object is dependent upon the value of the acceleration of gravity.
    b. The standard metric unit of mass is the kilogram.
    c. Mass depends on how much *stuff* is present in an object.
    d. The mass of an object is variable and dependent upon its location.
    e. An object would have more mass on Mount Everest than the same object in the middle of Lake Michigan.
    f. People in Weight Watcher's are really concerned about their mass (they're mass watchers).
    g. The mass of an object can be measured in pounds.
    h. If all other variables are equal, then an object with a greater mass would have a more difficult time accelerating.
    i. If all other variables are equal, then it would require less exerted force to stop a less massive object than to stop a more massive object.
    j. The mass of an object is mathematically related to the weight of the object.

6. Which of the following statements are true of the quantity **weight**? Circle all that apply.
    a. The weight of an object is dependent upon the value of the acceleration of gravity.
    b. Weight refers to a force experienced by an object.
    c. The weight of an object would be less on the Moon than on the Earth.
    d. A person could reduce their weight significantly by taking an airplane ride to the top of Mount Everest.
    e. Two objects of the same mass can weigh differently.
    f. To gain weight, one must put on more mass.
    g. The weight of an object can be measured in kilograms.
    h. The weight of an object is equal to the force of gravity acting upon the object.
    i. When a chemistry student places a beaker on a balance and determines it to be 84.3 grams, they have weighed the beaker.