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Senior Physics Labs

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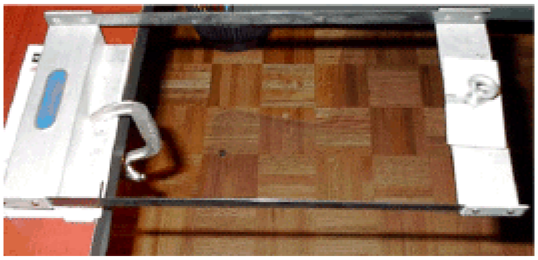
The Inertial Balance



Inertial Mass & Gravitational Mass - Definition

Mass is the amount of matter in an object. Mass is the measure of the inertia of an object. The ***inertial*** mass of an object is the property of an object that resists any changes in the state of rest (or motion) of the object. This is the mass defined in Newton's Second Law: **Fnet = m x a.** This type of mass is measured with an **inertial** balance.

The gravitational mass of an object is the property of the object that pertains to the effect of the gravitational field strength acting on the object. This is the mass found in the equation **Fg = m x g.** This type of mass is measured with an **equal arm or a** **beam** balance.

Adjustment and Use of the Inertial Balance

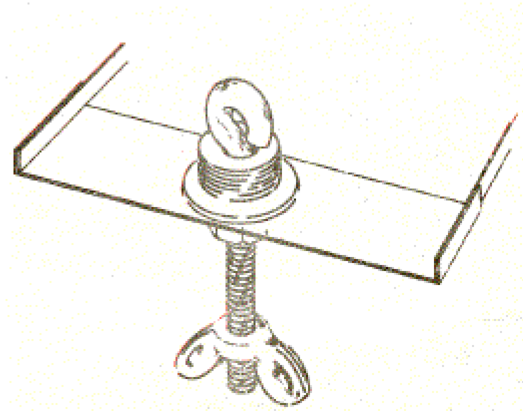
1. Clamping the Balance

Tighten the C-clamp enough to prevent any friction between the inertial balance and the table.

2. Fastening the Masses to the Balance Tray

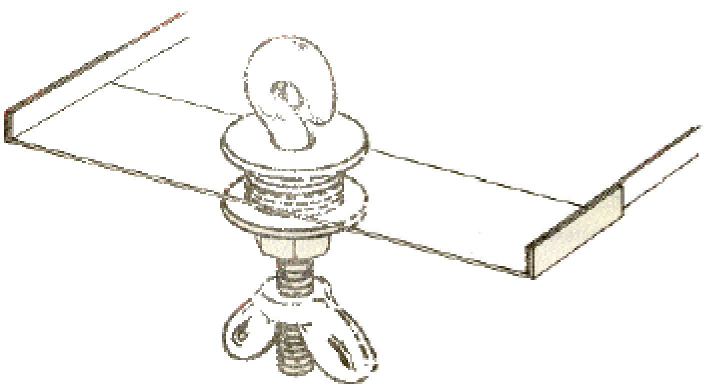
The combination of the eyebolt, hex nut, wing nut, the six small washers and the two large washers totals one unit mass,

Fasten this unit mass to the balance as shown:



3. Suspended Masses

Set the suspended masses in the hole of the Inertial balance as shown:



When adjusting the suspended masses to swing with the tray, it is critical that they do not rub. Any rubbing will cause the swings to decrease too rapidly for proper determination of the frequency

4. Straightening the Blades

The blades of the balance must at all times be parallel for uniform results. Should they become slightly misaligned due to rough handling they may be straightened with pliers by carefully squaring the rivet tabs on the base and on the balance tray while the base is secured to the table.

Equipment:

- inertial balance
- stopwatch
- C-clamp
- given masses (flat blacks with semicircular hole)
- string
- equal arm balance
  (or triple beam balance)
- graph paper
- masking tape

Planning Procedure:

1. Take the mass of the given masses using the equal arm balance.

2. Calibrate the balance using the given masses first.
3. To calibrate the balance set the balance in motion and record the time it takes for 40 vibrations. Record the period of the balance (the time for one full vibration).
4. Add a known mass to the balance and repeat step 3.
5. Repeat step 4several times by increasing the mass by one unit at a time.
6. Record your data in a table similar to the one below

Trial	Number of Mass Units	Mass (kg)	Time for 40 Vibrations (s)	Period (s)

7. Have your partner(s) repeat the procedure. More data points will lower the average error factors.
8. Plot a graph of Mass as a function of Period.
9. Use your balance to determine the inertial mass of an unknown provided by your instructor.
10. Compare this value to the one obtained by interpolation of your graph.
11. Draw your conclusions about the differences and similarities of the inertial mass as compared to the gravitational mass.
12. Account for sources of error.
13. Calculate errors by any methods (i.e. %error, standard deviation, error bars on graphs, + or - % difference, etc..)
14. Account for error propagation in your calculations and be extremely careful about significant digits.

Extension:

a. How does the principle of Torques apply to the equal arm balance?

b. Does Torque apply to the inertial balance? Explain.

c. Suggest and carry out a procedure to determine the spring constant for the inertial balance provided in this laboratory experiment.

d. Is gravity a necessary "ingredient" to make an equal arm balance operate? Why (why not?)

e. Is gravity a necessary "ingredient" to make an inertial balance operate? Why (why not?)

f. Suggest and carry out a procedure to test your hypothesis in (e.)
Hint: Note that the eye bolt provided can be made to move up and down in the central hole of the inertial balance. You are given a string. You may want to raise the eye bolt in the hole by attaching the string to it

and suspending it from a ring on a ring stand. You may want to measure the periods of the inertial balance with the eyebolt when it rests on the pan of then balance and again when it is suspended by the string so that it no longer touches the pan and compare these periods. Does gravity affect the operation of the inertial balance?

g. Sources of error and explanations thereof are an invaluable source of insight (and marks)-- as always... have fun!