To Determine the Mass of two Different Objects Using a Beam Balance

Aim

To determine the mass of two different objects using a beam balance.

Apparatus

Beam balance, weight box, forceps, two objects of different masses.

Theory

A physical balance determine the gravitational mass of a body by making use of principle of moments.

Load x load arm = effort x effort arm

$m_1g \times a_1 : m_2g \times a_2$

$m_1a_1 = m_2a_2$

A body having gravitational mass m_1 is placed in the left pan and a standard weight of gravitational mass m_2 is put in the right pan to keep the beam horizontal for a beam balance, $a_1 = a_2$

Then, $m_1 = m_2$

i.e., gravitational mass of the body in left pan = gravitational mass of the standard weight in right pan.

Diagram

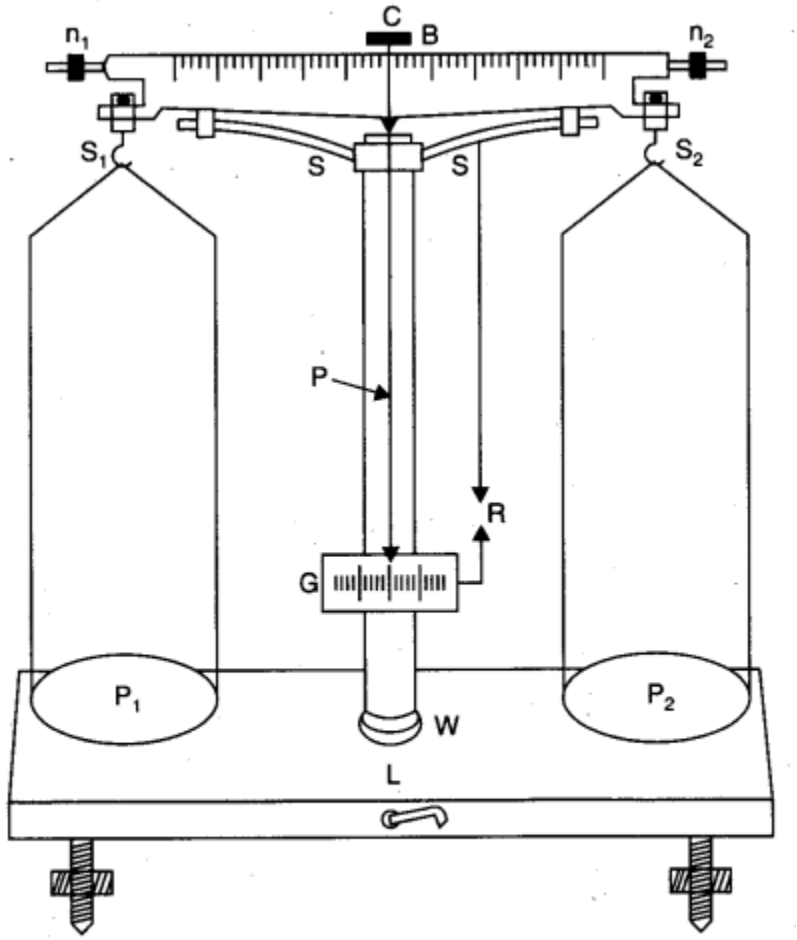

Fig. Physical balance.

Procedure

1. Adjust the physical balance. When the beam is in raised position, the pointer will stay at rest and coincide to the zero division or moves to and fro over the scalp, equally, about the zero division.
2. When the beam is in rest position, put any one of the object in the left pan. Now put some standard weight with the half of forceps from the weight box.
   Shut the front glass door so that air current should not disturb. Raise the beam with the helf of handle and notice that beam is horizontal and pointer is moving to and fro equally both sides of zero division.
   If, not, then put or remove some fractional weights to get the correct horizontal position of beam and pointer. Bring the beam in rest position and collect all the weight and add them which give the gravitational mass of the object. Now the remove the object also from left pan.
3. Repeat the Step-2 for the second object.

Observations

Serial No.	Body	Weight in x (g)	Weight in y (mg)	Total weight (x + y) g
1.	I	.....	.....	.....
2.	II	.....	.....	.....

Result

The gravitational mass of the bodies are:
(i) mass of one body, m_1 =……g
(ii) mass of other body, m_2 = ……g.

Precautions

1. Put the weight and an body in pans gently with the help of forceps.
2. Close the front glass door gently while taking the measurement so that air current should not disturb the weighing.
3. Pointer should coincide to the zero mark or oscillate equally on both side the central mark.

Sources of error

1. Air can disturb the weighing.
2. Pointer can oscillate unequally about the zero mark.

Viva Voce

Question. 1. What do you understand from mass of a body ?
Answer. It is the quantity of matter possessed by the body.

Question. 2. What are units of mass ?
Answer. S.I. unit of mass is kilogram and C.G.S. unit of mass is gram.
1 kg = 10^3 g.

Question. 3. What is one kilogram ?
Answer. It is the mass of a platinum-iridium cylinder, having diameter equal to height, stored in a special vault in the International Bureau of Weight and Measures at Severe, near Paris in France.

Question. 4. Define weight.
Answer. Weight of a body is defined as the force with which the body is attracted by the earth towards its centre. W = mg.

Question. 5. What is difference between mass and weight ?
Answer. 1. Mass m is constant at all places.
Weight W = mg varies from place to place, because g varies.
2. Mass m is never zero.
Weight W = mg becomes zero at the centre of the earth, where g = 0.

Question. 6. Define inertial mass of a body.
Answer. The mass which offers inertia, is called inertial mass.

Question. 7. How can we measure inertial mass ?
Answer. Inertial mass can be measured by using relation m_1 = F/a. Hence, for measuring inertial mass, a known force F is applied on the body and acceleration (a) produced is measured.

Question. 8. Define gravitational mass of a body.
Answer. The mass which offers gravitational attraction, is called gravitational mass.

Question. 9. How can we measure gravitational mass ?
Answer. Gravitational mass can be measured by using relation m_G= W/g.
Hence, for measuring gravitational mass, weight W of a body is measured at a place of known value of g.

Question. 10. What is relation between inertial mass and gravitational mass of a body ?
Answer. The two masses are found to be equal.

Question. 11. Describe a phenomena in which both the inertial and the gravitational masses of a body take part.
Answer. In simple harmonic motion of the bob of simple pendulum, both the inertial and the graviational masses of the bob play their part.
Gravitational mass m_G provides the restoring force. Inertial mass ml controls the acceleration of the bob.

Question. 12. Which instrument determines the inertial mass ?
Answer. An inertial balance determines the inertial mass.

Question. 13. Define inertia.
Answer. It is the property of a body, due to which the body continues in its state of rest or of uniform motion in a straight line.

Question. 14. How is inertial mass related to inertia ?
Answer. The inertial mass is a measure of amount of inertia present in a body. A body of more mass, has more Inertia and vice-versa.

Question. 15. Which instrument determines the gravitational mass ?
Answer. A spring balance and a physical (beam) balance determine the gravitational mass.

Question. 16. Does the spring balance measure mass or the weight ?
Answer. The spring balance measures weight.

Question. 17. What is the principle of working of a spring balance ?
Answer. It works on Hook's law. It works on the fact that when a body is suspended from a vertical spring, the body produces extension in the length of the spring proportional to its weight.

Question. 18. What is principle of working of a physical balance ?
Answer. It works on the principle of moments.

Question. 19. What is principle of moments ?
Answer. It tells that bodies of equal weight suspended at equal distances from the fulcrum on the two sides of the beam, keep the beam horizontal.

Question. 20. What is a true balance ?
Answer. A balance which has arms of equal length and pans of equal weight, is called a true balance. Its beam is horizontal with empty pans and also when equal weights are put on the pans.

Question. 21. What is a sensitive balance ?
Answer. When a small difference in weights of two bodies in the two pans of the balance, makes the beam pointer to turn through sufficient angle, the balance is said to be sensitive.

Question.22. Define resting point of a balance.
Answer. Resting point (R.R) of a balance is the point (position) on the scale at which the pointer will come to rest when the beam stops oscillating.

Question. 23. What is atomic unit of mass ?
Answer. Atomic unit of mass is atomic mass unit (a.m.u.). It is 1/12th of mass of an atom of the carbon isotope ^{12}C. Its value is 1.66×10^{-27} kg.

Question. 24. What is astronomical unit of mass ?
Answer. Astronomical unit of mass is solar mass. Its value is 2×10^{30} kg which is the mass of the Sun.

Question. 25. Define density of a substance.
Answer. The density of a substance is defined as its mass per unit volume.

Question. 26. Is densities for different materials are same ?
Answer. No. It is different for different materials.

Question. 27. What is unit of density ?
Answer. In C.G.S. system, unit of density is gram per cm^3 ($g\text{-}cm^{-3}$).
In S.I., unit of density is kilogram per $metre^3$ ($kg\text{-}m^{-3}$).

Question. 28. How does density change with temperature ?
Answer. Density of substance decreases with rises in temperature because for same mass volume of the body increases due to thermal expansion.

Question. 29. Define specific gravity or relative density.
Answer. Specific gravity (S.G.) or relative density (R.D.) of a substance is defined as the ratio of mass of a given volume of the substance to the mass of same volume of water at 4°C.

Question. 30. What is density of water at 4°C ?
Answer. Density of water at 4°C is 1 g cm^{-3} or 103 kg m^{-3}.

Question. 31. What is density of ice at 0°C ?
Answer. Density of ice at 0°C is 0.930 g cm^{-3} or 930 kg m^{-3}.

Question. 32. What is unit of specific gravity or relative density ?
Answer. It has no unit, because it is simply a ratio of two similar quantities.

Question. 33. What is the temperature, at which density of water is maximum and why ?
Answer. The density of water is maximum at 4°C. Because the volume of water is minimum at this temperature. The volume of water decreases from 0°C to 4°C then increases with increases in temperature till 100°C.

Question. 34. What is the density of heaviest liquid ?
Answer. Mercury has highest density. Its density is 13.6 times the density of water
$\rho = 13.6 \times 10^3$ kg m^{-3}

Question. 35. Is density of a body change with places on earth ?
Answer. No, because it does vary with g.