To Determine Mass of a Given Body Using a Metre Scale by Principle of Moments

Aim
To determine mass of a given body using a metre scale by principle of moments.

Apparatus
A metre scale, a broad heavy wedge with sharp edge, a weight box, a body of unknown mass.

Theory
If m and M be the mass of the body and mass of the weight used and a_1 and a_2 be the distances of their loops from wedge. Then, power (mass) arm = a_1, weight arm = a_2
From principle of moments $mg\ a_1 = Mg\ a_2$
or $m=Ma_1/a_1$ which can be calculated.

Two Different Methods

(i) Arm lengths fixed and equal, weight adjustable.
The thread loops are suspended at positions forming both arm of equal length. Weights in the paper pan are adjusted till the metre scale becomes horizontal. (Fig. 3).
In this case $a_1 = a_2 = a$
Hence, $mg\ a_1 = Mg\ a_2$
or $m = M$

A physical balance makes use of this method.

(ii) Masses and power arm fixed, weight arm adjustable.
Mass is suspended at a fixed distance a_1.

Length of power arm is adjusted by moving weight loop thread in and out till the metre scale become horizontal (Fig. 4).

In this case $a_1 = a$, $a_2 = A$

Hence $mg\ a_1 = Mg\ a_2$, becomes $mg\ a = Mg\ A$

or $m= M\ A/a$

Diagram

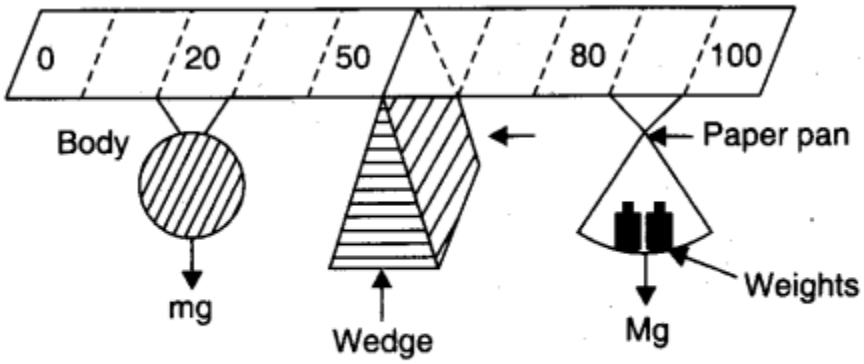

Fig. Metre-scale balance Power and weight arms of equal length.

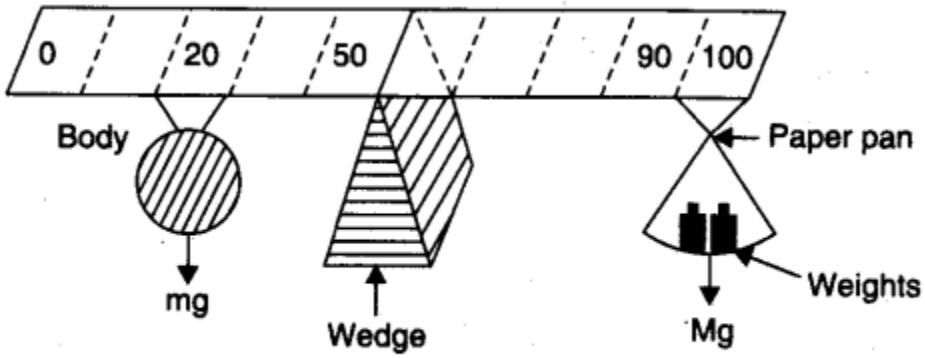

Fig. Metre-scale balance Power and weight arms of unequal length.

Procedure

(i) First method

1. Arrange the metre scale horizontally by supporting it at the sharp edge of the broad heavy wedge at 50 cm mark.
2. Suspended the body of unknown mass by a loop thread at a fixed mark on the left of the wedge.
3. Suspended paper pan at same distance on the right of the wedge with some weights in it.
4. Adjust the weights in the paper pan till the metre scale becomes horizontal.
5. Note the mass of the weights in the pan.
6. Repeat steps 2 to 5, three times by increasing the length of the arms in equal steps keeping the lengths equal.
7. Record the observations as given in the following table.

Observations and calculations

S. No.	Length of weight (or power) arm a (cm)	Mass of Weight in the Paper pan M(g)	Unknown mass m(g)
1. 2. 3.			

(*Observations are as sample*)

Mean mass, $m = \frac{m_1 + m_2 + m_3}{3}$ g = ... g

It will be found that $M_1 = M_2 = M_3 = m$ in all cases.

Result

The unknown mass of the body, m =.....g.

Alternate method

(ii) Second method

1, 2. Step 1 and 2 of first method.

3.Suspend the paper pan on the right of the wedge with some known weight in it.

4. Adjust the distance of the paper pan till the metre scale becomes horizontal.

5. Note the position of the paper pan and thus length of the weight arm.

6. Repeat steps 2 to 5, three times by increasing the mass of the weights by equal amount.

7. Record the observations as given below in table.

Observations and calculations

Fixed length of power arm, a = ... cm

S. No.	Mass of weight in the Paper Pan M (g)	Length of the Weight arm A(cm)	Unknown mass $m = \frac{MA}{a}$ m(g)
1. 2. 3.			

(*Observations are as sample*)

Mean mass, $m = \frac{m_1 + m_2 + m_3}{3}$ g = ... g

It will be found that $m_1 = m_2 = m_3 = m$ in all cases.

Result

The unknown mass of the body, m =……..g.

Precautions

1. The wedge should be broad and heavy with sharp edge.
2. Metre scale should have uniform mass distribution.
3. Threads used for loops should be thin, light and strong,

Sources of error

1. The wedge may not be sharp.
2. Metre scale may have faulty calibration.
3. The threads used for loops may be thick and heavy.