ACTIVITY 2

AIM

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

APPARATUS AND MATERIAL REQUIRED

A wooden metre scale of uniform thickness (a wooden strip of one metre length having uniform thickness and width can also be used); load of unknown mass, wooden or metal wedge with sharp edge, weight box, thread (nearly 30 cm long), a spirit level, and a raised platform of about 20 cm height (such as a wooden or metal block).

PRINCIPLE

For a body free to rotate about a fixed axis, in equilibrium, the sum of the clockwise moments is equal to the sum of the anticlockwise moments.

If M_1 is the known mass, suspended at a distance l_1 on one side from the centre of gravity of a beam and M_2 is the unknown mass, suspended at a distance l_2 on the other side from the centre of gravity, and the beam is in equilibrium, then $M_2\, l_2 = M_1\, l_1$.

PROCEDURE

1. Make a raised platform on a table. One can use a wooden or a metal block to do so. However, the platform should be a sturdy, place a wedge having a sharp edge on it. Alternately one can fix the wedge to a laboratory stand at about 20 cm above the table top. With the help of a spirit level set the level of the wedge horizontal.
2. Make two loops of thread to be used for suspending the unknown mass and the weights from the metre scale (beam). Insert the loops at about 10 cm from the edge of the metre scale from both sides.
3. Place the metre scale with thread loops on the wedge and adjust it till it is balanced. Mark two points on the scale above the wedge where the scale is balanced. Join these two points with a straight line which would facilitate to pin point the location of balance

position even if the scale topples over from the wedge due to some reason. This line is passing through the centre of gravity of scale.

4. Take the unknown mass in one hand. Select a weight from the weight box which feels nearly equal to the unknown mass when it is kept on the other hand.

5. Suspend the unknown mass from either of the two loops of thread attached to the metre scale. Suspend the known weight from the other loop (Fig. A 2.1).

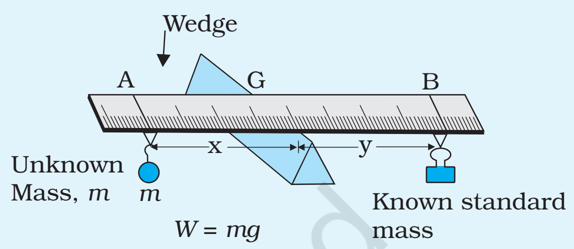

Fig. A 2.1: *Experimental set up for determination of mass of a given body*

6. Adjust the position of the known weight by moving the loop till the metre scale gets balanced on the sharp wedge. Make sure that in balanced position the line drawn in Step 3 is exactly above the wedge and also that the thread of two loops passing over the scale is parallel to this line.

7. Measure the distance of the position of the loops from the line drawn in Step 3. Record your observations.

8. Repeat the activity atleast two times with a slightly lighter and a heavier weight. Note the distances of unknown mass and weight from line drawn in Step 3 in each case.

OBSERVATIONS

Position of centre of gravity = ... cm

Table A 2.1: Determination of mass of unknown object

S. No.	Mass M_1 suspended from the thread loop to balance the metre scale (g)	Distance of the mass from the wedge l_1 (cm)	Distance of solid of unknown mass from the wedge l_2 (cm)	Mass of unknown load M_2 (g) $= \frac{M_1 l_1}{l_2}$	Average mass of unknown load (g)
1					
2					
3					
4					
5					

CALCULATIONS

In balanced position of the metre scale, moment of the force on one side of the wedge will be equal to the moment of the force on the other side.

Moment of the force due to known weight = $(M_1 l_1)\, g$

Moment of the force due to unknown weight = $(M_2 l_2)\, g$

In balanced position

$$M_1 l_1 = M_2 l_2$$

or

$$M_2 = \frac{M_1 l_1}{l_2}$$

Average mass of unknown load = ... g

RESULT

Mass of given body = ... g (within experimental)

PRECAUTIONS

1. Wedge should be sharp and always perpendicular to the length of the scale.
2. Thread loops should be perpendicular to the length of the scale.
3. Thread used for loops should be thin, light and strong.
4. Air currents should be minimised.

SOURCES OF ERROR

1. Mass per unit length may not be uniform along the length of the metre scale due to variation in its thickness and width.
2. The line marked on the scale may not be exactly over the wedge while balancing the weights in subsequent settings.
3. The thread of the loops may not be parallel to the wedge when the weights are balanced, which in turn would introduce some error in measurement of weight-arm.
4. It may be difficult to adjudge balance position of the scale exactly. A tilt of even of the order of 1° may affect the measurement of mass of the load.

DISCUSSION

1. What is the name given to the point on the scale at which it is balanced horizontally on the wedge?
2. How does the least count of the metre scale limit the accuracy in the measurement of mass?
3. What is the resultant torque on the metre scale, due to gravitational force, when the scale is perfectly horizontal?
4. Explain, how a physical balance works on the principle of moments.
5. What problems would air currents cause in this activity?

SUGGESTED ADDITIONAL EXPERIMENTS/ACTIVITIES

1. We can determine the accuracy of various weights available in the laboratory, by finding out their mass by the above method and comparing with their marked values.
2. Verify the principle of moments using a metre scale. After balancing the metre scale at its centre of gravity, suspend masses M_1 and M_2 at distances l_1 and l_2 respectively, from the centre of gravity, on either side. Adjust the distances l_1 and l_2 so that the metre scale is horizontal. Calculate and compare M_1l_1 and M_2l_2. Repeat with other combinations of masses M_1 and M_2.