EXPERIMENT NO. 1 A

Object

To determine the mass of a metre rule using it as a lever.

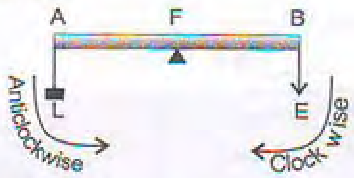
Apparatus Required

A metre rule of uniform thickness graduated in centimetre or millimetre, a wooden wedge, thin thread of negligible mass, a set of weights (10 g f and 20 g f), a half metre rule and a spring balance.

Principle

The Law of Lever

In equilibrium position, the clockwise moment of the load about the fulcrum is equal to anticlockwise moment of the effort about the fulcrum.



$$\text{Load} \times \text{Load arm} = \text{Effort} \times \text{Effort arm}$$

$$L \times AF = E \times BF$$

Mechanical Advantage of a lever is equal to the ratio of length of effort arm to the length of load arm.

$$\text{Mechanical Advantage } (M.A.) = \frac{\text{Load } (L)}{\text{Effort } (E)} = \frac{\text{Effort arm } (BF)}{\text{Load arm } (AF)}$$

Velocity Ratio is the ratio of velocity of effort to the velocity of the load.

$$\text{Velocity Ratio } (V.R.) = \frac{\text{Velocity of effort } (v_K)}{\text{Velocity of load } (v_L)}$$

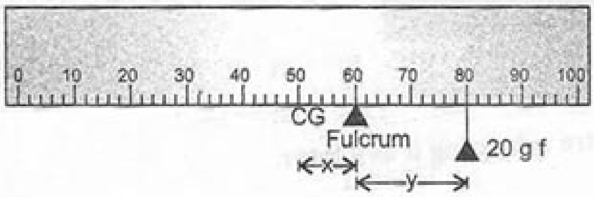
$$= \frac{\text{Displacement of effort } (d_E)}{\text{Displacement of load } (d_L)}$$

$$= \frac{\text{Effort arm } (BF)}{\text{Load arm } (AF)}$$

Procedure

1. Make a loose thread loop and put metre rule in the loop in such a way that its graduated flat portion remains vertical. Suspend the metre rule by adjusting the position of loop till the metre rule rests in horizontal position. Mark this point on metre rule as centre of gravity of metre rule. It will lie almost nearly on 50 cm mark.

2. Take a 20 g f weight. Suspend it on the scale with the help of thread on the right side of *CG* of metre rule. Put the scale on wooden wedge placing in between the *CG* and the weight as shown in the figure given below.



Now hold the metre rule with left hand and adjust the position of loop on the metre rule with right hand till it balances in horizontal equilibrium position.

3. Note down the distance between *CG* and fulcrum of metre rule i.e. x ; also note down the distance between fulcrum and weight i.e. y. Record these measurements in observation table.
4. Repeat the observation by changing the weight i.e. 30 g f and 40 g f. Note down the distances x and y separately for each. Record the values in observation table.

Observations

Least count of the metre rule = ____________ cm

Least count of given spring balance = ____________ g f

S. No.	Weight suspended, w (in g f)	Distance, x (in cm)	Distance, y (in cm)	Mass of metre rule, m $m = \frac{wy}{x}$ (in g)
1.	20			
2.	30			
3.	40			
				Mean mass of metre rule, m = ____ g

Calculations

Calculate the mass of a metre rule by using given relation

i.e.
$$m = \frac{wy}{x}$$

where m = mass of the metre rule, w = mass of suspended weights

Result

The mass of given metre rule = ____________ g

Precautions

1. Ensure that position of fulcrum is not changed while shifting the position of weight.
2. While taking observations, metre rule should be in horizontal equilibrium position.
3. Metre rule should be clearly graduated and marked so that the distances are clearly/ correctly observed.

EXPERIMENT NO. 1 B

Object

To prove that $MA < VR$, $MA = VR$ and $MA > VR$ using metre rule as a lever where MA is Mechanical Advantage and VR is Velocity Ratio of the lever.

Apparatus Required

A metre rule of uniform thickness calibrated in centimetre and millimetre, a wooden wedge, thin thread (~1 m) of negligible weight and a set of weights (10 g f and 20 g f).

Principle

According to the principle of moments,

the sum of clockwise moment is equal to the sum of anticlockwise moment about the fulcrum in equilibrium,

i.e. $$\text{Load} \times \text{Load arm} = \text{Effort} \times \text{Effort arm}$$

Procedure

1. Put the metre rule with fulcrum at 40 cm mark as shown in the figure (*a*). Suspend a known weight w g f (load L) at 10 cm mark (A). Suspend another load w_1 g f (effort E) on right side of fulcrum of the metre rule by adjusting the position of metre rule such that metre rule balances in horizontal equilibrium position say at B 60 cm mark.

Figure (*a*) Case I

2. Now shift the fulcrum at 50 cm mark and suspend the load on left side and the effort on right side of the fulcrum as shown in figure (*b*).

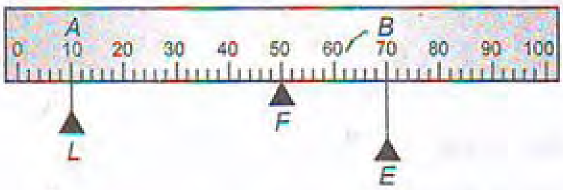


Figure (*b*) Case II

3. Now shift the fulcrum at 60 cm mark and suspend the load and the effort on left side and right side of the fulcrum respectively as shown in figure (*c*).

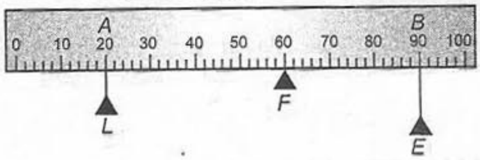


Figure (*c*) Case III

4. In each of the above three cases, calculate *MA* and *VR* using the relations

$$MA = \frac{\text{Load } (L)}{\text{Effort } (E)} = \frac{\text{Effort arm } (BF)}{\text{Load arm } (AF)}$$

$$VR = \frac{\text{Distance of effort from fulcrum } (BF)}{\text{Distance of load from fulcrum } (AF)}$$

Observations

Least count of the metre rule = ______________ mm

Mass of the metre rule; m = ______________ g

S.No.	*Load, L (in gf)*	*Effort, E (in gf)*	*Position of fulcrum, F (in cm)*	*Position of load, A (in cm)*	*Position of effort, B (in cm)*	*Load arm AF (in cm)*	*Effort arm BF (in cm)*	$MA = \frac{L}{E}$	$VR = \frac{BF}{AF}$
1.			40						
2.			50						
3.			60						

Result

Case I

Fulcrum at 40 cm mark, $MA > VR$

In equilibrium position of metre rule

Clockwise moments = Anticlockwise moments

Load × Load arm = Wt. of metre rule × 10 + Effort × Effort arm

$$L \times AF = m \times 10 + E \times BF$$

Case II

Fulcrum at 50 cm mark (i.e. on *CG*), $MA = VR$

$$L \times AF = E \times BF$$

Case III

Fulcrum at 60 cm mark, $MA < VR$

$$L \times AF + m \times 10 = E \times BF$$

Here, weight of metre rule acting at centre of gravity in the downward direction acts like load.