KATER'S PENDULUM

Experiment No.- **Date-**

Aim: To determine the value of acceleration due to gravity by Kater's pendulum.

Apparatus: 1) Kater's pendulum 2) Stop watch, 3) Telescope & 4) Meter scale.

Theory:

Kater's pendulum is a **compound pendulum** constructed on the principle that *the centre of oscillation and centre of suspension are interchangeable*. It consists of a brass or steel bar capable of vibrating about two adjustable knife edges K_1 & K_2 facing each other. Two metal weights **W** and **w** can be made to slide, along the length of bar & can be clamped at any position. A wooden weight '**W**' exactly similar to metal weight **W** can also slide along the bar. The smaller weight **w** is exactly placed between the two knife edges and the larger weight **W** is fixed at one end, while the wooden weight '**W**' was kept symmetrically at the other end of the bar. In this position, the centre of gravity lies between small weight and near one the knife edges.

The position of the two knife edges & the weight **w** are so adjusted that the time period of the pendulum about the two knife edges are equal. In such a case, one knife edge is at the centre of oscillation w.r.t the other and the distance between the two knife edges is equal to the length of an equivalent simple pendulum **L**. If't' the time period, then the acceleration due to gravity **g** can be found out from the relation.

$$t = 2\pi\sqrt{\frac{L}{g}}$$

If t_1 and t_2 are time periods about the two knife edges K_1 & K_2 respectively. Also, 'l_1' the distance the knife edge K_1 & 'l_2' that of the knife edge K_2 from the C.G, then

$$t_1 = 2\pi\sqrt{\frac{l_1^2 + k^2}{l_1 g}} \qquad (1)$$

$$t_2 = 2\pi\sqrt{\frac{l_2^2 + k^2}{l_2 g}} \qquad (2)$$

From eq. (1) and (2),

$$g = \frac{8\pi^2}{\frac{t_1^2 + t_2^2}{l_1 + l_2} + \frac{t_1^2 - t_2^2}{l_1 - l_2}}$$

Procedure:

1) Shift the weight **W** to one end of the Kater's pendulum (say A) of and fix it. The knife edge (**K_1**) is fixed just below it. **'W'** is kept at one end of the rod to shift the centre of gravity (CG) of the pendulum.. The two points about which the time period is same will now lie unequal distances from the **CG** on either side of it.

2) **K_2** is kept at the other end of the pendulum (say B) and the smaller weight **w** is placed nearly in the centre. 'W' is fixed near the end **B** in such way that it is , symmetrical to **W**.

3) Suspend the pendulum about **K_1** & set into vibration with a very small amplitude. Start the stop watch when the pendulum is just passing through the equilibrium position. Note the time taken for 20 oscillations.

4) Pendulum is then suspended about **K_2** and again the note the time for 20 oscillations.

5) Adjust **K_2** to obtain nearly the same time period as that of **K_1**.

6) Again suspend the pendulum about **K_1** & note the time for 20 oscillations (this time period may differs from the time period taken in step **3**, as the **CG** has been shifted).

7) Again suspend the pendulum about **K_2** & adjust the position very slightly such that the time period about **K_2** is nearly equal to the time period about **K_1**..

8) Adjust the telescope such that the cross wires are clearly visible and focus the telescope on the Kater's pendulum. Find the time period for 50 vibrations about K_1 and K_2 for three times.

9) Balance the pendulum on a sharp wedge and mark the position of CG. Measure the distance (l_1 & l_2) of the knife edges K_1 & K_2 from the CG.

Table 1

Knife edge	Time for 20 oscillations	
K_1		
K_2		

Table 2

Knife edge	Time for 50 oscillation				**Time Period**
	$\mathbf{T_1}$	$\mathbf{T_2}$	$\mathbf{T_3}$	**Mean**	
$\mathbf{K_1}$					$\mathbf{t_1}$
$\mathbf{K_2}$					$\mathbf{t_2}$

Observation: $l_1 =$ Distance between K_1 & CG = ... cm

$l_2 =$ Distance between K_2 & CG = ... cm

So, $l_1 + l_2 =$ .... cm, and $l_1 - l_2 =$ .... cm.

Calculation:

$$g = \frac{8\pi^2}{\dfrac{t_1^2 + t_2^2}{l_1 + l_2} + \dfrac{t_1^2 - t_2^2}{l_1 - l_2}} = \text{........................ m/s}^2$$

% error:

Conclusion: The acceleration due to gravity "g" was found to be ....with % error........

Precaution:

1) *W should be placed at one end, so that the CG lies near one of the knife edges and wooden weight W' is symmetrically at the other end to avoid error due to air drag.*
2) *The two knife edges should be parallel to each other.*
3) *The amplitude of vibration should be small, so that the motion of the pendulum satisfies the condition sin θ = θ.*
4) *The readings should be taken only after the vibrations are regular.*

Mark s awarded

Planning and execution (2)	Result & Report (6)	Viva (2)	Total (10)

Signature of the Student

Regd. No...................................

Branch & Group ....

Signature of the faculty