DEPARTMENT OF PHYSICS

MAR THOMA COLLEGE FOR WOMEN, PERUMBAVOOR

ASYMMETRIC COMPOUND PENDULUM

An asymmetric compound pendulum is a complex pendulum consisting of a rigid body that can rotate freely about a horizontal axis. Unlike a simple pendulum, it has an uneven distribution of mass around the axis of rotation. This uneven distribution affects its motion, making it more complicated than a simple pendulum.

The pendulum's behaviour is influenced by factors such as the centre of mass, moments of inertia, and gravitational forces. When displaced from its equilibrium position, it oscillates back and forth, but with a different period compared to a simple pendulum.

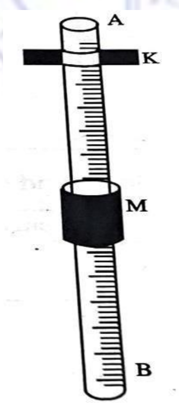
Aim

To determine the acceleration due to gravity at a place, radius of gyration and moment of inertia of the compound pendulum given (asymmetric).

Apparatus

Asymmetric compound pendulum, a stopwatch /clock and a metre scale.

The symmetric pendulum consists of a uniform cylindrical rod AB, one metre long. It is provided with a movable knife edge K. Markings are made at equal distances of 5 cm along the length of the rod. A heavy mass M is attached slightly below the centre of gravity of the rod. This makes the pendulum asymmetrical.



Theory

The acceleration due to gravity is given by g = $4\pi^2 \frac{l_{eq}}{T^2}$. where l_{eq} is the length of the equivalent simple pendulum and T is the time period of the pendulum.

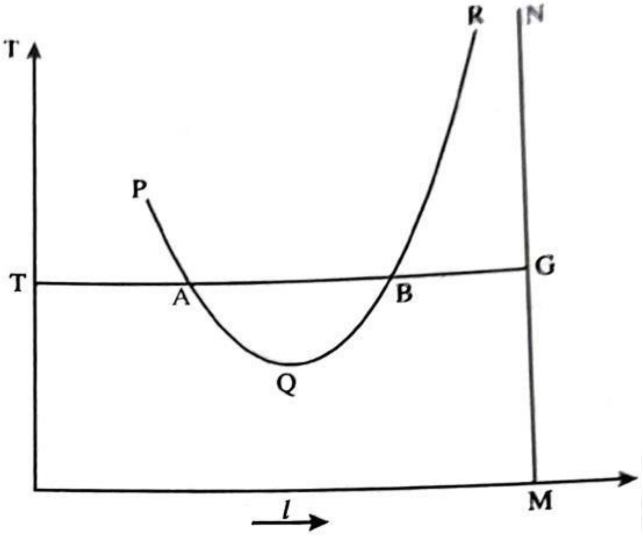
Using the above formula g can be calculated. From the length of the equivalent pendulum we can calculate the radius of gyration k. Using the formula $I = mk^2$, the moment of inertia of the pendulum can be found out.

Procedure

The knife edge K is fixed at 5 cm marking from the lighter end A. The time (t) for 20 oscillations is determined. From this the time period [T= $\frac{t}{20}$] is calculated. This is repeated by fixing the knife edge at different equidistant markings on the rod. A graph is plotted taking distance (l) of knife edge from the lighter end A along the horizontal axis and period along the vertical axis. We obtained a graph PQR (asymmetric) as shown in figure below.

The centre of gravity of the pendulum is determined by balancing it on a knife edge. The distance of centre of gravity from the lighter end A of the bar is measured. Corresponding to this distance on the horizontal axis the line MN is drawn perpendicular to the horizontal axis. A line is drawn parallel to the horizontal axis corresponding to any period T. The line cuts the curve at A and B and line MN at G. The length of the equivalent simple pendulum is given by l_{eq}= AG+BG. Hence $\frac{l_{eq}}{T^2}$ is calculated. This is repeated for different values of T. $\frac{l_{eq}}{T^2}$ is found to be constant. Its mean value is taken. Using the formula g = $4\pi^2 \frac{l_{eq}}{T^2}$, acceleration due to gravity can be calculated.

From the graph, measure AB and BG. Then $\sqrt{AB \times BG}$ gives the radius of gyration k. Using this the moment of inertia of the pendulum can be found using $I = mk^2$, where m is the mass of the pendulum that can be found out by using a weighing balance.



Observations and tabular columns

Distance of centre of gravity from the end A =..........m

Trial No.	Lengh l_{eq} in metre		Mean $l_{eq} = \frac{AC+BD}{2}$ (m)	Period T (seconds)	$g = 4\pi^2\left(\frac{l_{eq}}{T^2}\right)$
	AC (m)	BD (m)			

To draw l versus T graph

To find g and l_{eq}

Trial No.	Distance l of the knife edge from A (cm)	Time t for 20 oscillations in seconds			Period $T = \frac{t}{20}$ s
		t_1	t_2	Mean $t = \frac{t_1 + t_2}{2}$ (s)	
1					
2					
3					
.					
.					
.					
.					

Mean acceleration due to gravity g = …ms^{-2}

Radius of gyration, $k=\sqrt{AB \times BG}$ = ... cm =...........m

Mass of the compound pendulum, m =............ kg

Moment of inertia of the compound pendulum, $I = mk^2$ = …kgm^2

References

- Experimental Physics – I, For First, Second, Third and Fourth Semester, BSc Degree Programme, Dr.P.Sethumadhavan, Prof. K.C. Abraham, Prof .Sunil John, **Manjusha Publications**