# EXPERIMENT

## AIM

**To study the variation of time period of a simple pendulum of a given length by taking bobs of same size but different masses and interpret the result.**

## MATERIAL REQUIRED

A clamp and a long iron stand with a heavy base, thread/string, stopwatch/stop clock, meter scale, pendulum bobs of different masses, Vernier Caliper, a split cork and spring balance.

## THEORY

### Simple Pendulum

A simple pendulum is one that can be considered to be a point mass (bob) suspended from an inextensible string or rod of negligible mass. Simple pendulum (it is practically defined) has a heavy mass bob of brass and radius r much smaller than the length of the suspension. This bob is suspended with the help of thin, strong cotton thread from a rigid support.

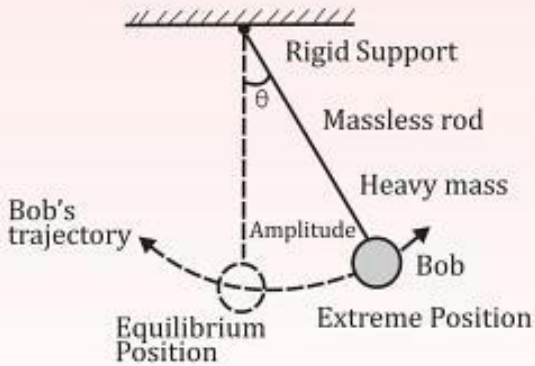



Fig.Simple Pendulum

We know that the time period of a simple pendulum is given by,

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

Here, the above formula shows that the time period of a simple pendulum is independent of the amplitude of oscillation of the pendulum. So, it clearly indicates that,

$$T \propto \sqrt{L} \Rightarrow (T)^{\frac{1}{2}} \propto L \qquad \text{_____ (i)}$$

and,

$$T \propto \frac{1}{\sqrt{g}}$$

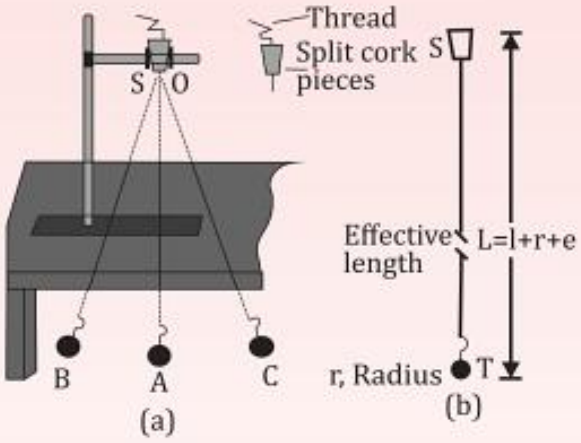
The equation (i) shows that, if we plot the graph between $T^2$ and L, then we will get a straight line passing through the origin. Here, we can also conclude that the time of the pendulum is independent of the mass of

the bob. So, if we plot a graph between time period by taking it along Y-axis and mass(m) by taking it along the X-axis, we will get a straight line parallel to the X-axis.

## PROCEDURE

### To Study the Effect of Bobs of Different Masses on the Time Period

1. Follow the steps of Experiment 7 for determining the effect of change in effective length on the time of the simple pendulum.
2. Then, determine the least count and zero error of the spring balance. The zero error of spring balance is found by suspending it freely.
3. Now, find out the masses of different metallic bobs with the help of spring balance.
4. Now, again repeat the steps of Experiment 7 with a constant length of the pendulum while using the bobs of different masses.
5. After measuring, note down the time of oscillation of the pendulum.




## OBSERVATIONS

### Table to Measure the Time Period when Bobs of Different Masses are Used.

| S. No. | Radius (cm) | Length of the thread from the top of bob to the point of suspension, l (cm) | Effective length L = l + r + e | | Mass of the bob, (m) | Number of oscillations, (n) | Time for oscillations, t(s) | | | | Time period, $T = \frac{t}{n}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | (cm) | (m) | | | (i) | (ii) | (iii) | Mean t (s) | |
| 1. | | | | | | | | | | | |
| 2. | | | | | | | | | | | |
| 3. | | | | | | | | | | | |
| 4. | | | | | | | | | | | |

**NOTE:** The effective length of the simple pendulum will be kept the same in each case.

## CALCULATIONS

Average time for 20 vibrations may be calculated as:

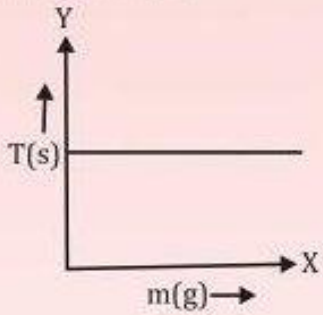
$$t = \frac{t_1 + t_2 + t_3}{3}$$

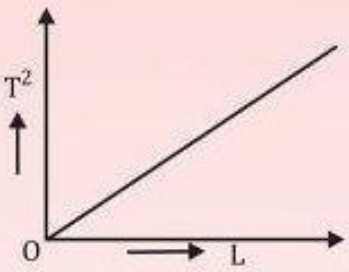
then calculate the time period, $T = \frac{t}{20}$ second and finally write in the table.

## PLOTTING GRAPH

From the observation table, if we plot a graph between L and $T^2$ by taking l along the x-axis and $T^2$ along the y-axis, we will get a straight-line graph passing through the origin.

If we plot a graph between m and T by taking mass along the x-axis and the time along y-axis, we will get a straight line parallel to x-axis.




## RESULT

1. From the graph between L and $T^2$, we notice that as the length of the pendulum increases, then the value of the square of time period increases in a linear form with it.
2. It means $T^2 \propto L$ i.e., $T \propto \sqrt{L}$
3. From the graph between (m) and (T), we notice that the time for a simple pendulum having bobs of different masses almost remains the same.
   **So, we can say that the time of a simple pendulum is independent of the mass of the bob used.**

## PRECAUTIONS

Same as Experiment (7).

## SOURCES OF ERROR

Same as Experiment (7).

# VIVA VOCE

**Q1. Whether a wall clock gain or lose time during summer?**

**Ans.** A wall clock runs fast in winter, and it loses its time during summer because its time period increases due to the increase of the length of the pendulum.

**Q2. How can you define damping?**

**Ans.** The opposition to the free vibrations of bob of a simple pendulum due to air presence around it, is known as damping.

**Q3. State the working principle of the simple pendulum.**

**Ans.** A pendulum repeats its motion after a regular interval of time. This constitutes the working principle of simple pendulum.

**Q4. On which factors does the time of a simple pendulum depend?**

**Ans.** The time of a simple pendulum depends upon the following factors:

(i) Length of the pendulum
(ii) Acceleration due to gravity at that place

**Q5. Mention the effect of buoyancy of air and viscous drag due to air on the time of the simple pendulum.**

**Ans.** Since the time of simple pendulum always increases due to the effect of buoyancy of air and viscous drag due to air.

**Q6. Mention the relation between the time of a simple pendulum and the acceleration due to gravity.**

**Ans.** Time period of a simple pendulum is given by $T = 2\pi\sqrt{\frac{L}{g}}$. It means, as acceleration due to gravity 'g' decreases at height and depth, time 'T' increases. Also, during free fall, when $g = 0$, then it becomes infinite.

**Q7. Give a reason, why does the pendulum clock become fast at the equator?**

**Ans.** Since a pendulum gives a right time at the equator but when it is taken to any pole then it becomes fast. It is due to a reason that the acceleration due to gravity at poles is greater than the acceleration due to gravity at the equator, due to which time period decreases and the clock becomes fast.

**Q8. What is the effect of damping on the amplitude?**

**Ans.** After each vibration, damping decreases the amplitude exponentially.