RADIANT 2026

Physics

Measurements and Experimentation

Lecture - 05

By - Akash Shravan Sir

Topics *to be covered*

1. Measurement of Time
2. Simple Pendulum
3. Measurement of time period of a simple pendulum
4) Screw Gauge

Recap *of previous lecture*

1. Vernier Callipers
2. Principle of Vernier
3. Least Count
4. Zero Error Vernier Callipers
5. Question's

Measurement of Time

Time → [Second]

1 मिनट = 60 Sec

60 min = 1 Hr

24 Hr = 1 Day

1 Month = 28/29/30/31

1 year = 365.25 Days

Decade = 10 साल

1 Century = . . .

#

Leap year

A → 7 Days

B → 365 Days

K → 365.25 Days

D → 366 Days

1 Shake = ... Sec

A → 10^{-6}

B → 10^{-8}

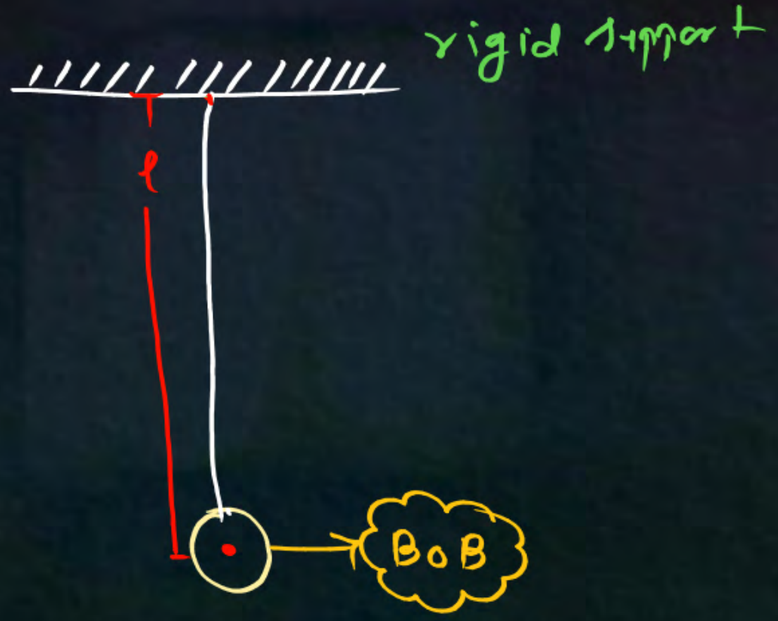
C → 10^{-10}

D → 10^{8}

Simple Pendulum

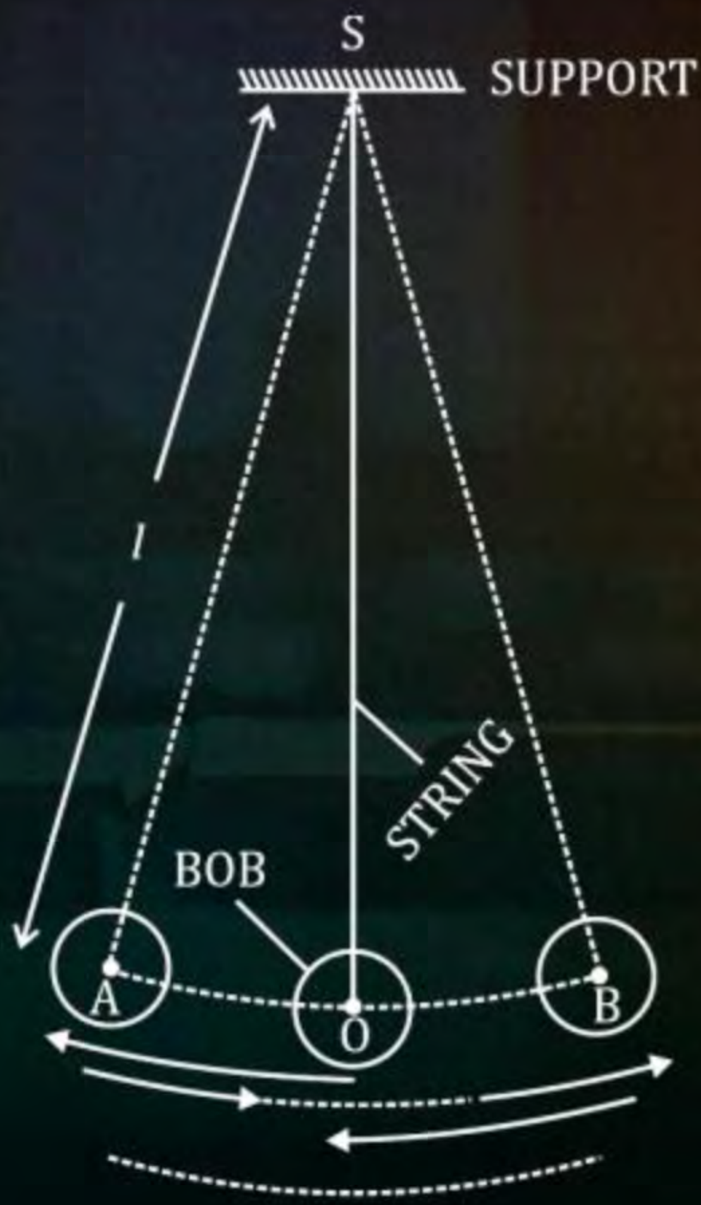
सरल लोलक

- A simple pendulum is a heavy point mass (known as bob) suspended from a rigid support by a massless and inextensible string.
- This is an ideal case because we cannot have a heavy mass having the size of a point and a string which has no mass.
- Here a heavy solid (iron or brass) ball is suspended by a light, but strong thread from a rigid support. The ball is called the bob

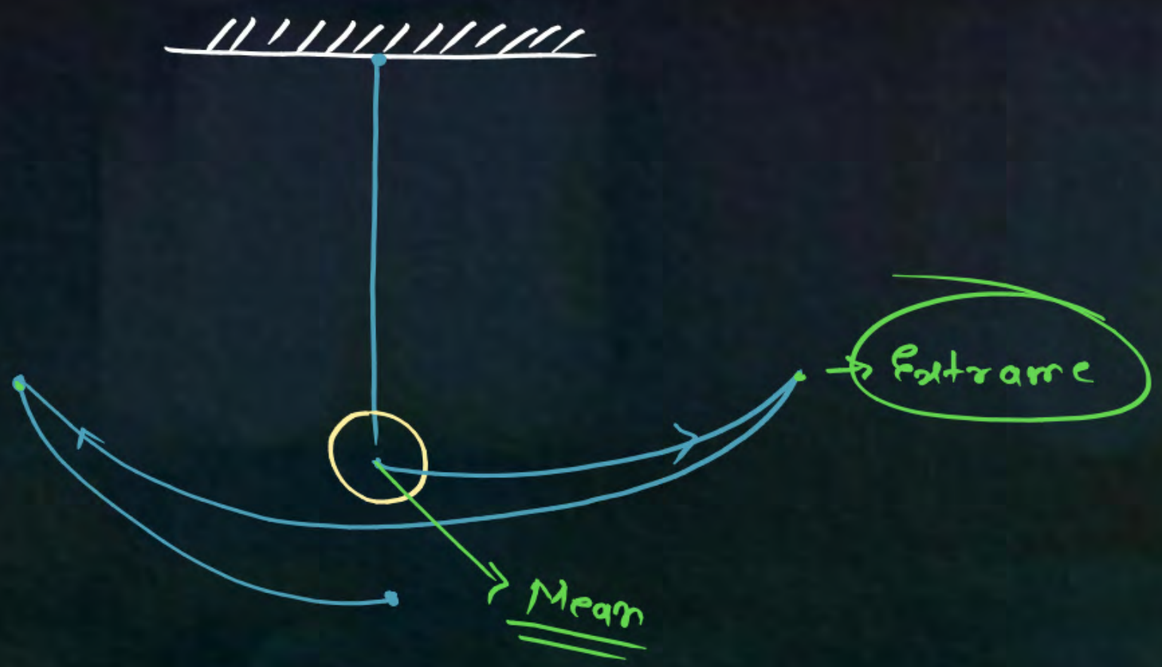

rigid support
l
BoB

Simple Pendulum

When the bob from its mean position is pulled to one side and then released, the pendulum is set in motion and the bob moves alternately on either side of its mean position.



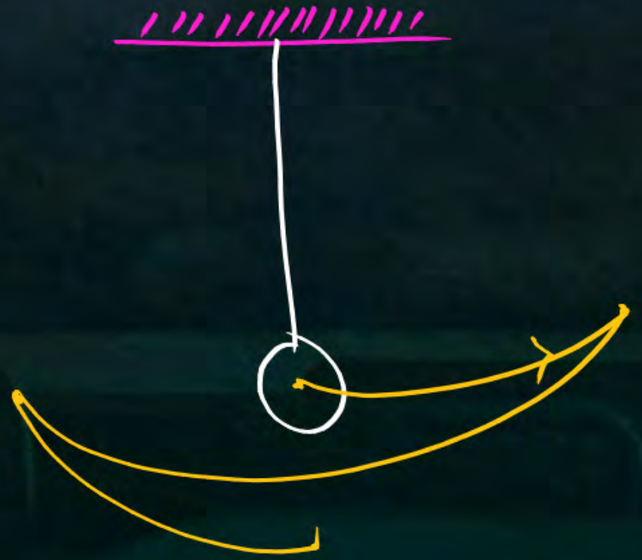
To and fro



Some Terms Related too Simple Pendulum

➤ **Oscillation:**

One complete to and fro motion of the bob of pendulum is called one oscillation.



Some Terms Related too Simple Pendulum

Period of oscillation or time period:

This is the time taken to complete one oscillation. It is denoted by the symbol T. Its unit is second (s).

Frequency of oscillation:

It is the number of oscillations made in one second. It is denoted by the letter *f* or *n*. Its unit is per second (s^{-1}) or hertz (Hz).

Some Terms Related too Simple Pendulum

Relationship between time period and frequency:

If T is the time period of a simple pendulum, then

In time T second, the number of oscillation is 1.

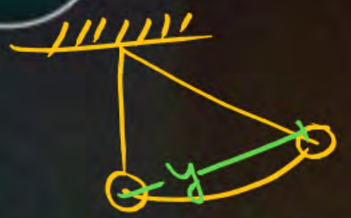
$\therefore$ In time 1 second, the number of oscillations will be $\frac{1}{T}$ which is the frequency f.

i.e., $f = \frac{1}{T}$ or $T = \frac{1}{f}$

f or ν [न्यू नय]

$f = \frac{1}{T}$ [Hz or Sec^{-1}]

Some Terms Related too Simple Pendulum



Amplitude:

The maximum displacement of the bob from its mean position on either side, is called the amplitude of oscillation. In Fig., the amplitude measured in metre (m).

Effective length of a pendulum:

It is the distance of the point of oscillation O (i.e., the centre of gravity of the bob) from the point of suspension S. In Fig. it is shown by *l*.

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

$$T^2 = 4\pi^2 \frac{l}{g}$$

$$g = 4\pi^2 \frac{l}{T^2}$$

$l \rightarrow FL$

$g \rightarrow gA$

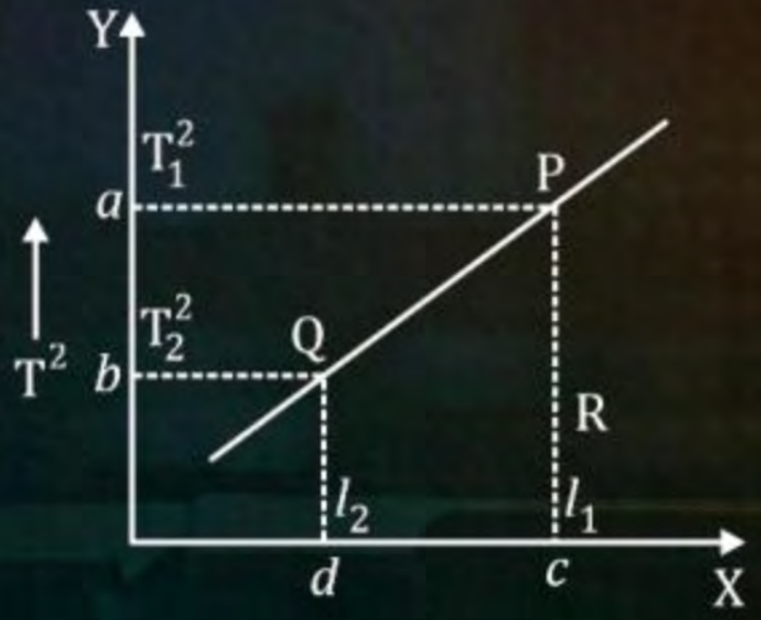
$$T = 2\pi\sqrt{\frac{l}{g}}$$

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

$g = 9.8\ m/s^2$

Graph showing the variation of square of time period (T^2) with the length (l) of a pendulum

$$g = \frac{4\pi^2}{\text{Slope of } T^2 \text{ vs } l \text{ graph}}$$



Factors affecting the time period of a simple pendulum

The time period of oscillation is directly proportional to the square root of its effective length

i.e., $T \propto \sqrt{l}$ or in other words, the square of time period of oscillation (T^2) is directly proportional to its effective length (l) i.e., $T^2 \propto l$.

The time period of oscillation is inversely proportional to the square root of acceleration due to gravity i.e., $T \propto \frac{1}{\sqrt{g}}$

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

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

The time period of oscillation does not depend on the mass or material of the body suspended (i.e., bob).

If we take two pendulums of equal lengths, but with bobs of different masses or different materials, their time periods will remain same.

The time period of oscillation does not depend on the extent of swing on either side (i.e., on amplitude) provided the swing is not too large.

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

Second's Pendulum

- The pendulum of a clock which we use to note time in our house, is a seconds' pendulum.
- It takes time 1 s in moving from one extreme to the other extreme, so its time period is 2 s. Thus, *a pendulum with a time period of oscillation equal to two seconds, is known as a seconds pendulum.*
- The effective length of the seconds' pendulum, at a place where $g = 9.8\ ms^{-2}$ (the average value).

Question

Compare the time periods of a simple pendulum at places where g is $9.8\ \text{m s}^{-2}$ and $4.36\ \text{m s}^{-2}$ respectively.

$\frac{T_1}{T_2} = ?$

$g_1 = 9.8\ m/s^2$

$g_2 = 4.36\ m/s^2$

$T_1 \propto \frac{1}{\sqrt{g_1}}$

$T_2 \propto \frac{1}{\sqrt{g_2}}$

Solution.

$g_1 = 9.8\ \text{ms}^{-2}, g_2 = 4.36\ \text{ms}^{-2}$

Since $T \propto \frac{1}{\sqrt{g}} \therefore \frac{T_1}{T_2} = \sqrt{\frac{g_2}{g_1}}$

or $\frac{T_1}{T_2} = \sqrt{\frac{4.36}{9.8}} = \frac{1}{1.5} = \frac{2}{3}$

i.e., $T_1 : T_2 = 2 : 3$ (or $0.667 : 1$)

$\frac{T_1}{T_2} = \frac{1}{\sqrt{g_1}} \div \frac{1}{\sqrt{g_2}}$

$= \frac{1}{\sqrt{g_1}} \times \frac{\sqrt{g_2}}{1}$

$\frac{T_1}{T_2} = \frac{\sqrt{g_2}}{\sqrt{g_1}}$

$= \sqrt{\frac{4.36}{9.8}}$

$= \frac{10}{15} = \frac{2}{3}$

$\frac{T_1}{T_2} = \frac{2}{3}$

Question

Compare the time periods of two pendulums of length 1 m and 9 m.

L.W

$\frac{T_1}{T_2}$ $\quad l_1 = 1\,m$ $\quad l_2 = 9\,m$

$T_1 \propto \sqrt{l_1}$ $\quad T_2 \propto \sqrt{l_2}$

$$\frac{T_1}{T_2} = \frac{\sqrt{l_1}}{\sqrt{l_2}}$$

$$= \frac{\sqrt{1}}{\sqrt{9}} = \frac{1}{3}$$

ANSWER

1 : 3

Question

Calculate the length of a seconds' pendulum at a place where $g = 9.8\ m\ s^{-2}$.

$l = ?$ $\quad t = 2\ sec$

$T = 2\pi\sqrt{\frac{l}{g}}$ $\quad l = .994\ m$

$T^2 = 4\pi^2 \frac{l}{g}$

$\frac{T^2 g}{4\pi^2} = l$

$\frac{2 \times 2 \times 9.8}{4 \times 3.14 \times 3.14} = l$

Solution.

$G = 9.8\ ms^{-2}$

Time, T For seconds pendulum = 2 s

Now, $T = 2$ 'pisqrt (l/g)

$T^2 = 4\pi^2\ l/g$

$L = T^2\ g/4\pi^2$

$= 2^2 \times 9.8/4 \times 3.14^2$

$= 0.994$ m

Question

The time period of a pendulum clock is:

A 1 s

B 2 s

C 1 min

D 12 h

Question

The time period of a pendulum clock is:

(A) 1 s

(B) 2 s

(C) 1 min

(D) 12 h

ANSWER

(B) 2 s


Thank you