

Selina Solutions For Class 9 Physics
Chapter 1 – Measurements and Experimentation

Exercise-1(C)

1. **What is a simple pendulum? Is the pendulum used in a pendulum clock simple pendulum? Give reason to your answer.**

Solution:

It is a heavy point mass that is suspended from a rigid support by a massless and inextensible string.

No, the pendulum in the pendulum clock is not a simple pendulum as it is an ideal case. The mass cannot be heavy having the size of point and string having no mass.

2. **Define the terms: (i) oscillation, (ii) amplitude (iii) frequency (iv) time period as related to a simple pendulum**

Solution:

(i) **Oscillation** – one complete to and fro motion of the bob of pendulum

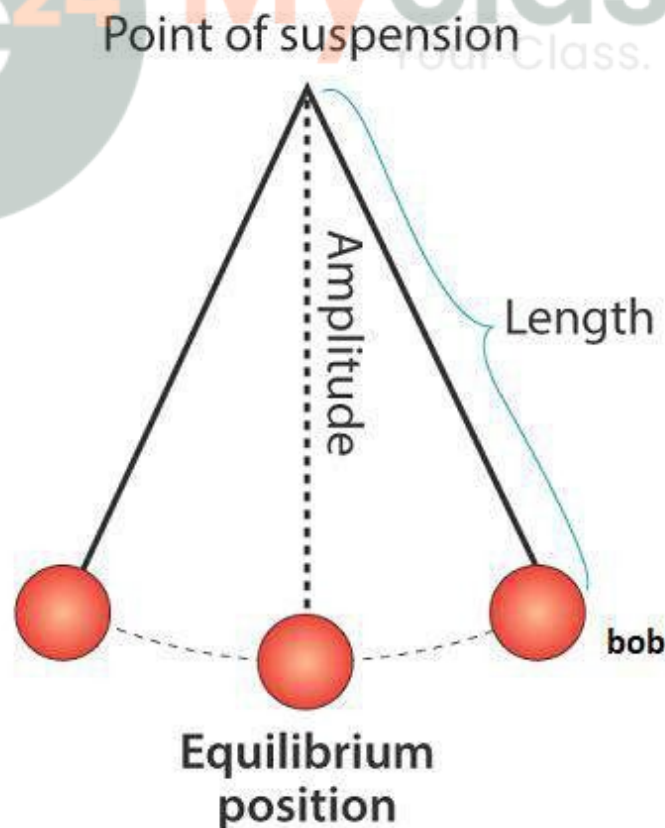
(ii) **Amplitude** – It is the maximum displacement of the bob from its mean position on either side

(iii) **Frequency** – It is the number of oscillations made in one second

(iv) **Time period** – It is the time taken to complete one oscillation

3. **Draw a neat diagram of a simple pendulum. Show on it the effective length of the pendulum and its one oscillation.**

Solution:



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4. Name two factors on which the time period of a simple pendulum depends. Write the relation for the time period in terms of the above named factors.

Solution:

The two factors on which the time period of a simple pendulum is dependent are:

- Acceleration due to gravity
- Length of the string of the pendulum

Time period in terms of the above named factors are:

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

Time period is directly dependent on length with square root and inversely proportional to 'g' – acceleration due to gravity with square root.

5. Name two factors on which the time period of a simple pendulum does not depend.

Solution:

The time period of a simple pendulum does not depend on the following factors:

- Mass of the bob
- Material of the pendulum

6. How is the time period of a simple pendulum affected, if at all, in the following situations:

(a) The length is made four times,

(b) The acceleration due to gravity is reduced to one-fourth.

Solution:

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

- (a) The length is made four times – 'T' is directly proportional to the square root of the 'l' – length of the string and inversely proportional to the acceleration due to gravity. Hence the length is doubled when the period is increased by two times.
- (b) The acceleration due to gravity is reduced to one-fourth – when g - acceleration due to gravity, is reduced by $1/4^{\text{th}}$, the period is increased by 2 times.

7. How are the time period T and frequency f of an oscillation of a simple pendulum related?

Solution:

The time period and frequency of an oscillation of a simple pendulum are related as stated below:

$$f = \frac{1}{T}$$

8. How do you measure the time period of a given pendulum? Why do you note the time for more than one oscillation?

Solution:

In order to measure the time period of pendulum, total time taken by the pendulum should be divided by the number of oscillations.

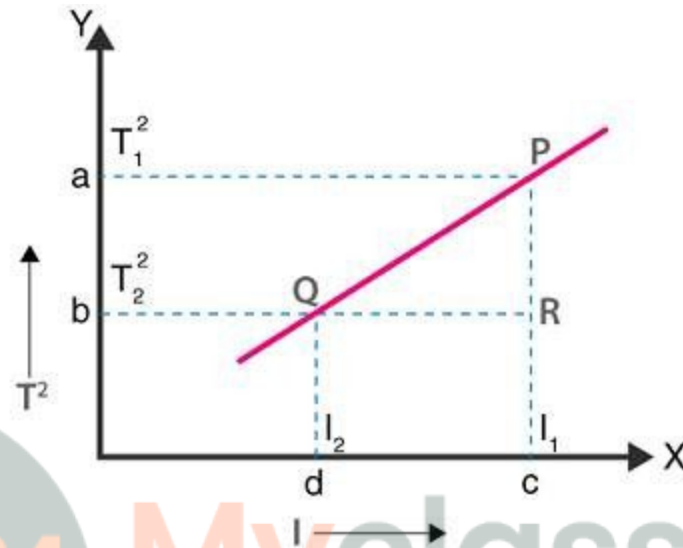
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9. How does the time period (T) of a simple pendulum depend on its length (l)? Draw a graph showing the variation of T² with l. How will you use this graph to determine the value of g (acceleration due to gravity)?

Solution:

In a simple pendulum, Time period is dependent on the length directly. Time period is directly proportional to the square root of its effective length.

i.e., $T \propto \sqrt{l}$



The acceleration due to gravity (g) can be calculated from the above mentioned graph:

To find the slope of the straight line, two points P and Q can be taken on the straight line. Draw two normals from these mentioned points on the X and Y axis respectively. Value of T² can be noted at a and b. To note the value at 'l', consider the points c and d.

$$\text{Slope} = \frac{PR}{QR} = \frac{ab}{cd} = \frac{T_1^2 - T_2^2}{l_1 - l_2}$$

The slope is observed to be constant at a point which is equal to $\frac{4\pi^2}{g}$, g=acceleration due to gravity at that place. Hence 'g' can be determined at a place with the help of these measurements with the help of this relation:

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

10. Two simple pendulum A and B have equal lengths, but their bobs weigh 50 gf and 100 gf respectively. What would be the ratio of their time periods? Give reason for your answer.

Solution:

The ratio of the time periods to the two pendulums A and B are 1:1 as the time period is a factor that is independent of the mass of the bob.

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- 11. Two simple pendulums A and B have lengths 1.0m and 4.0m respectively at a certain place. Which pendulum will make more oscillations in 1 minute? Explain your answer.**

Solution:

Pendulum A will take more time, twice to be precise in the given period of time as the time period (T) is directly proportional to the square root of the length, i.e., $T \propto \sqrt{l}$. Consequently, A will make more oscillations in a given period of time than B, as B has lesser oscillations.

- 12. State how does the time period of a simple pendulum depend on (a) length of pendulum, (b) mass of bob, (c) amplitude of oscillation and (d) acceleration due to gravity.**

Solution:

Time period varies in the following ways with the listed below factors:

- (a) length of pendulum – Time period is directly proportional to the square root of the length of the pendulum
- (b) mass of bob – Time period does not depend on the mass of the bob
- (c) amplitude of oscillation - Time period does not depend on the amplitude of oscillation
- (d) acceleration due to gravity – Time period inversely varies with the square root of 'g' – acceleration due to gravity.

- 13. What is a seconds' pendulum?**

Solution:

Seconds' pendulum is a pendulum with the time period of oscillation equal to two seconds.

- 14. State the numerical value of the frequency of oscillation of a seconds' pendulum. Does it depend on the amplitude of oscillation?**

Solution:

The numerical value of the frequency of oscillation of a seconds' pendulum is 0.5 s^{-1} . No, it does not depend on the amplitude of oscillation.

Multiple Choice Type:

- 1. The length of a simple pendulum is made one-fourth. Its time period becomes:**

- (a) Four times
- (b) One-fourth
- (c) Double
- (d) Half

Solution:

- (d) Half

Time period is directly proportional to the square root of the length of the pendulum.

- 2. The time period of a pendulum clock is:**

- (a) 1s
- (b) 2s
- (c) 1 min
- (d) 12h

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Solution:

(b) 2s

Time period is found using the number of oscillations more than once as least count of stop watch is either 1s or 0.5s.

3. The length of a seconds' pendulum is nearly:

(a) 0.5m

(b) 9.8m

(c) 1.0m

(d) 2.0m

Solution:

(c) 1.0m

The effective length of a pendulum is the distance of the point of oscillation from the point of suspension

Numericals:

1. A simple pendulum completes 40 oscillations in one minute. Find its (a) frequency, (b) time period.

Solution:

Given: oscillations = 40

Time taken = 1 minute or 60s

(a) In one second the frequency is $40/60 = 0.67$ hertz

(b) Frequency = 1/time period

\therefore time period = 1/frequency

$$= 1/0.67$$

$$= 1.5\text{s}$$

2. The time period of a simple pendulum is 2s. What is its frequency? What name is given to such a pendulum?

Solution:

Given:

Time period = 2s

Frequency = ?

Frequency = 1/time period

$$= \frac{1}{2} = 0.5 \text{ s}^{-1}$$

The name given to such a pendulum is seconds' pendulum.

3. A seconds' pendulum is taken to a place where acceleration due to gravity falls to one-fourth. How is the time period of the pendulum affected, if at all? Give reason. What will be its new time period?

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Solution:

The time period is affected by acceleration due to gravity. The relation given below clearly states that:

$T \propto \sqrt{\frac{l}{g}}$. Time period is inversely proportional to the square root of acceleration due to gravity. Hence, when 'g' falls one-fourth, time period increases, it doubles.
Hence the new time period is $2 \times 2 = 4s$.

- 4. Find the length of a seconds' pendulum at a place where $g=10ms^{-2}$ (Take $\pi=3.14$).**

Solution:

For seconds' pendulum $T=2s$, $g=10ms^{-2}$

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

\therefore Length of pendulum, $l = \frac{gT^2}{4\pi^2}$

$$l = \frac{10 \times 2^2}{4 \times 3.14^2}$$
$$= \frac{10 \times 4}{4 \times 3.14^2}$$
$$= \frac{10}{9.8956} = 1.0142m$$

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

Solution:

We know that time period of pendulum is:

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

'l' = length of the pendulum

'g' = acceleration due to gravity

As per the above relation, time period is proportional to the square root of the length.
Let $T(1)$ and $T(2)$ be the time period and $L(1)$ and $L(2)$ be the length of the pendulum respectively, accordingly;

$$T(1) : T(2) = \sqrt{L(1)} : \sqrt{L(2)}$$
$$= \sqrt{1} : \sqrt{9}$$
$$= 1 : 3$$

- 6. A Pendulum completes 2 oscillations in 5s. (a) What is its time period?
(b) If $g=9.8 ms^{-2}$, find its length.**

Solution:

Given: oscillations = 2

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(a) Time period = 1/oscillations per second

$$= \frac{1}{2 \div 5} = \frac{5}{2} = 2.5\text{s}$$

(b)

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

$$\therefore \text{Length of pendulum, } l = \frac{gT^2}{4\pi^2}$$

$$= \frac{9.8 \times (2.5)^2}{4 \times (3.14)^2}$$

$$= 1.55\text{m}$$

7. The time periods of two simple pendulums at a place are in the ratio 2:1. What will be the ratio of their lengths?

Solution:

We know that time period of pendulum is:

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

As per the above relation, time period is proportional to the square root of the length. Let $T(1)$ and $T(2)$ be the time period and $L(1)$ and $L(2)$ be the length of the pendulum respectively, accordingly;

$$T(1) : T(2) = \sqrt{L(1)} : \sqrt{L(2)}$$

Or

$$L1 : L2 = (T1)^2 : (T2)^2$$

$$L1 : L2 = (2)^2 : (1)^2 \\ = 4:1$$

8. It takes 0.2s for a pendulum bob to move from mean position to one end. What is the time period of pendulum?

Solution:

Time taken to complete one oscillation is the time period

$$= (4 \times 0.2)\text{s}$$

$$= 0.8\text{s}$$

9. How much time does the bob of a seconds' pendulum take to move from one extreme of its oscillation to the other extreme?

Solution:

We know that the time period of a seconds' pendulum is 2seconds

\therefore The time taken for a seconds' pendulum to make half oscillation is $\frac{1}{2} \times 2$ seconds = 1 second.