RADIANT 2026

Physics

Measurements and Experimentation

Lecture - 07

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Topics *to be covered*

1. Fundamental Quantities and Units
2. Derived Quantities and Units
3. Least Count and Vernier Calipers
4. Screw Gauge
5. Error Calculation

Topics *to be covered*

6. Common Conversions
7. Derived Units of Some Physical Quantities
8. Guidelines for Writing the Units
9. Questions Practice (Part - 02)

Recap *of previous lecture*

1. Measurement of Time
2. Simple Pendulum
3. Measurement of time period of a simple pendulum
4. Zero Error Vernier Callipers
5. Question's

Fundamental Quantities and Units

Quantity	Unit (SI)	Symbol
Length	metre	m
Mass	kilogram	kg
Time	second	s
Temperature	kelvin	K
Electric Current	ampere	A
Luminous Intensity	candela	cd
Amount of Substance	mode	mol

Derived Quantities and Units

Quantity	Formula	SI Unit
Area	Length × Breadth	m^2
Volume	Length × Breadth × Height	m^3
Density	Mass / Volume	kg/m^3
Speed/Velocity	Distance / Time	m/s
Acceleration	Change in velocity / Time	m/s^2
Force	Mass × Acceleration	newton (N)
Pressure	Force / Area	pascal (Pa)

Least Count and Vernier Calipers

- Least Count (LC)
- LC = Value of one main scale division – Value of one vernier scale division
- Vernier Caliper Formula
- LC = 1 MSD –1 VSD
- Measurement = Main Scale Reading + (Vernier Coincidence × LC)

Screw Gauge

- **Pitch**
  - Pitch = Distance moved by the screw / Number of rotations
- **Least Count of Screw Gauge**
  - LC = Pitch / Number of divisions on circular scale
- **Measurement Using Screw Gauge**
  - Reading = Main Scale Reading + (Circular Scale Reading × LC)

Error Calculation

Type of Error	Formula
Absolute Error	
Relative Error	Absolute Error / True Value
Percentage Error	(Relative Error × 100)%

Common Conversions

Quantity	From → To	Conversion Factor
Length	$\text{cm} \to m$	$\div$ 100
mass	$g \to \text{kg}$	$\div$ 1000
Time	$\text{min} \to s$	$\times$ 60
Area	$\text{cm}^2 \to m^2$	$\div$ 10,000
Volume	$\text{cm}^2 \to m^2$	$\div$ 1,000,000

Question

The least count of stop watch generally

(A) 1 s

(B) 1 min

(C) 0.5 s

(D) 1 h

Question

The least count of stop watch generally

(A) 1 s

(B) 1 min

(C) 0.5 s

(D) 1 h

ANSWER

(C) 0.5 s

Question

Which among the following instruments is most accurate?

(A) Screw gauge

(B) Vertices caliper

(C) Metre scale

(D) Meanining tape

100%

2026

ANSWER

(A) Screw gauge

Question

A cube has an edge of length 5 cm. Calculate its volume in SI units.

$l = 5\,cm$

$l = 5 \times 10^{-2}\,m$

$l = 0.05\,m$

$V = l^3$

$= (0.05)^3$

$V = 1.25 \times 10^{-4}\,m^3$

Solution:

Edge = 5 cm = 0.05 m

Volume = side^3 = $(0.05)^3$

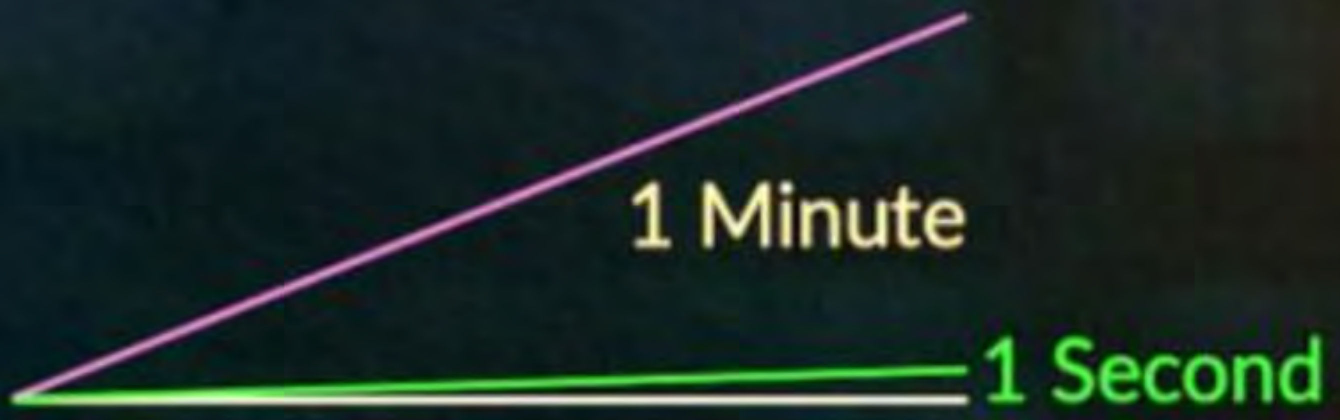
= $1.25 \times 10^{-4}\ m^3$

Answer: $1.25 \times 10^{-4}\ m^3$

Converting Degrees to Minutes and Seconds

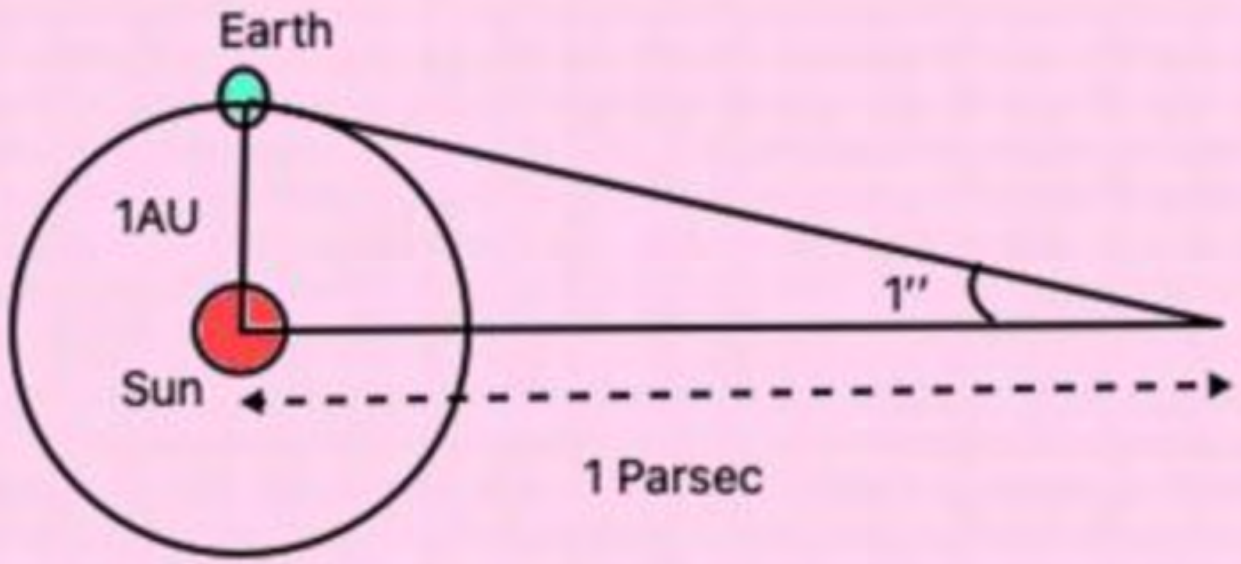
1 Degree = 60 Minutes

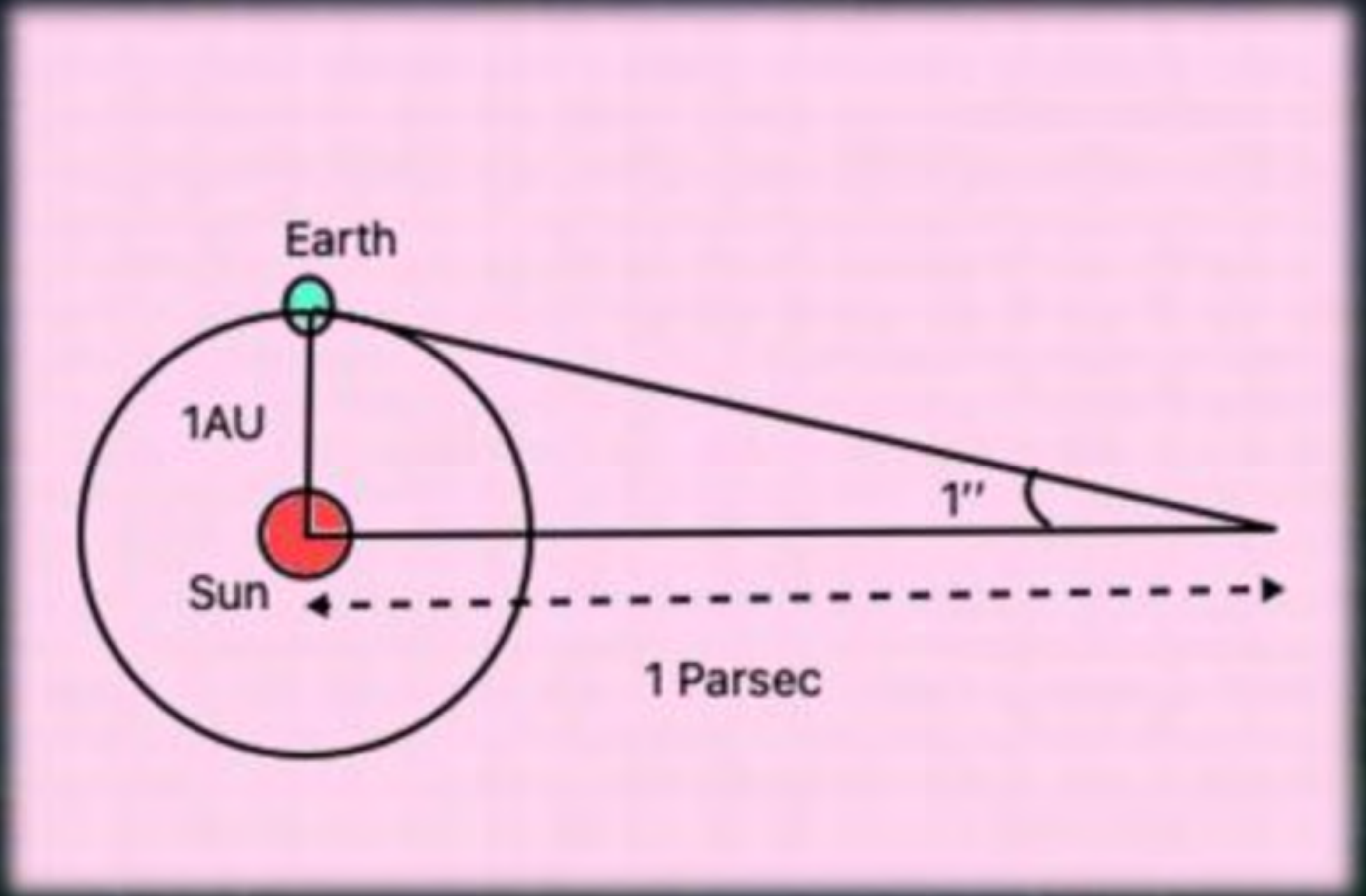
1 Minute = 60 Seconds



Basic Conversions

- 1 degree= 60 minutes
- $1° = 60'$
- 1 minute = 60 seconds
- $1' = 60''$
- 1 degree = 3600 seconds
- $1° = 3600''$


Earth
1AU
1″
Sun
1 Parsec


Earth
1AU
1″
Sun
1 Parsec

Guidelines for Writing the Units

$Kg\ m^{-1} = \frac{Kg}{m}$

(iii) The full name of the unit, irrespective of the fact whether it is named after a scientist or not, is always written with a lower initial letter e.g., unit for mass is written as kilogram, not as Kilogram; unit of length is written as metre, not as Metre; unit of force is written as newton and not as Newton ; unit of energy is written as joule and not as Joule; unit of power is written as watt and not as Watt.

Nm N×m N.m

(iv) A compound unit formed by multiplication of two or more units is written after putting a dot, cross or leaving a space between the two symbols. For example, the unit of torque is written as N. m or N × m or Nm.

(v) Negative power is used for compound units, which are formed by dividing one unit by the other.

Guidelines for Writing the Units

Examples:

(1) The unit of velocity is $\frac{\text{metre}}{\text{second}}$ · It is expressed as ms^{-1}.

(2) The unit of power is $\frac{\text{joule}}{\text{second}}$. It is expressed as Js^{-1}.

(vi) A unit in its short form is never written in plural.

For example, 10 metres can not be written as 10 ms, because ms would mean millisecond.

Guidelines for Writing the Units

(vii) To avoid powers of ten in the magnitude of a quantity, prefix can be used with its unit. But a unit must not be written with more than one prefixes. For example, instead of kMW, we must write GW.

(viii) When prefix is used with the symbol of unit, the prefix and symbol combined becomes the new symbol of the unit.

For example, km^3 means $(10^3\ m)^3 = 10^9\ m^3$; it does not mean $10^3\ m^3$.

Question

Which part of vernier callipers is used to measure

(a) external diameter of a cylinder

(b) internal diameter of a hollow cylinder

(c) internal length of a hollow cylinder?

ANSWER

(a) External Jaws of a vernier callipers are used to measure the external diameter of cylinder.

(b) Internal Jaws are used to measure internal diameter of a hollow cylinder.

(c) Tail of vernier callipers is used to measure the internal length of a hollow cylinder.

Question

State the formula for calculating length if :

(i) Number of vernier scale division coinciding with main scale and number of division of main scale on left hand side of zero of vernier scale are known.

(ii) The reading of main scale is known and the number of vernier scale divisions coinciding with main scale are known.

ANSWER

(i) If we know the number of vernier scale divisions (V.S.D.) coinciding with main scale and number of main scale divisions (M.S.D.) on left hand side of zero of vernier scale then Length recorded = Main scale reading + L.C. × V.S.D.

(ii) Same as in part (i).

Question

Which of the following is not a fundamental unit?

(A) Second

(B) Ampere

(C) Candela

(D) Newton

F

Question

Which of the following is not a fundamental unit?

(A) Second

(B) Ampere

(C) Candela

(D) Newton

ANSWER

(D) Newton

Question

Which of the following is a fundamental unit?

(A) m/s^2

(B) Joule

(C) Newton

(D) Metre

Question

Which of the following is a fundamental unit?

(A) m/s^2

(B) Joule

(C) Newton

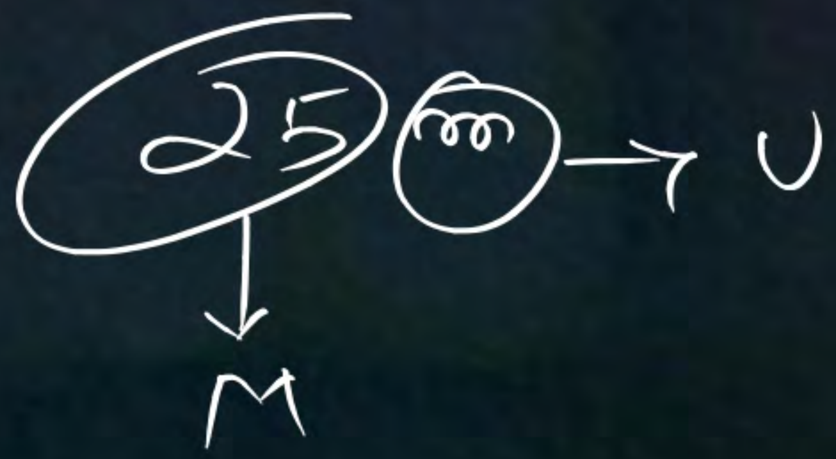
(D) Metre

ANSWER

(D) Metre

Question

A body measures 25 m. State the unit and the magnitude of unit in the statement.



ANSWER

Here S.I. unit of length i.e. metre (m) has been used. Magnitude of the given quantity = 25

Question

State four characteristics of a standard unit.

ANSWER

Characteristics of standard unit:

I. It should be of convenient size.
II. It should not change with respect to place and time.
III. It should be well defined.
IV. It should be easily reproduced.

Question

How many units are fundamental and complementary?

(A) 2 fundamental, 7 complementary

(B) 3 fundamental, 6 complementary

(C) 7 fundamental, 2 complementary

(D) 4 fundamental, 5 complementary

ANSWER

(C) 7 fundamental, 2 complementary

Question

The fundamental unit is

(A) newton

(B) pascal

(C) hertz

(D) second

ANSWER

(D) second

Question

One astronomical unit is equal to:

(A) 1.496×10^{11} metre

(B) 1.596×10^{12} metre

(C) 1.498×10^{10} metre

(D) 1.398×10^{11} metre

ANSWER

(A) 1.496×10^{11} metre

Question

One metric tonne is equal to:

1000 kg

(A) 10 quintal

(B) 100 quintal

(C) 1000 quintal

(D) 25 quintal

Question

One metric tonne is equal to:

(A) 10 quintal

(B) 100 quintal

(C) 1000 quintal

(D) 25 quintal

ANSWER

(A) 10 quintal

Question

Light-year is the unit of:

(A) Time

(B) Length

(C) Mass

(D) None of these

Question

Light-year is the unit of:

(A) Time

(B) Length

(C) Mass

(D) None of these

ANSWER

(B) Length

Question

Which one of the following is a derived unit?

(A) Metre

(B) Kelvin

(C) Metre^3

(D) Mole

ANSWER

(C) Metre^3

Question

Complete the following:

i. 1 light year = ______ m 9.46×10^{15}

ii. 1 m = 10^{10} Å

iii. 1 m = 10^{6} μ

iv. 1 micron = 10^{4} Å

v. 1 fermi = 10^{-15} m

ANSWER

i. 1 light year = 9.46×10^{15} m

ii. 1 m = 10^{10} Å

iii. 1 m = 10^{6} μ

iv. 1 micron = 10^{4} Å

v. 1 fermi = 10^{-15} m

Question

The year 2024 will have February of 29 days. Is this statement true?

1395

$\frac{2024}{4} = \frac{106}{}$

1854

ANSWER

Yes the statement is true.
We know that, if any year is divisible by 4, then it is a leap year and in a leap year, February has 29 days. As, the year 2024 is divisible by 4, so it will have 29 days in February.

Question

Name the S.I. unit of time and define it.

Second

$\frac{1 \text{ Solar Day}}{86400} = 1 \text{ Sec}$

ANSWER

The S.I. unit of time is second (s).

A second can be defined as $1/86400^{th}$ part of a mean solar day,

i.e., $1s = 186400\times$ one mean solar day$1s = 864001\times$ one mean solar day

Question

The distance of a galaxy from the earth is 5.6×10^{25} m. Assuming the speed of light to be 3×10^{8} ms^{-1}, find the time taken by light to travel this distance.

Given

$d = 5.6 \times 10^{25}$ m

$s = 3 \times 10^{8}$ m/s

$t = ?$

$s = \frac{d}{t}$

$3 \times 10^{8} = \frac{5.6 \times 10^{25}}{t}$

$t = 1.8 \times 10^{17}$

ANSWER

1.87×10^{17} s.

Question

The wavelength of light is 589nm. What is its wavelength in Å?

$\lambda = 589\,nm$

$1\,nm = 10\,Å$

$\lambda = 589 \times 10\,Å$

$\lambda = 5890\,Å$

ANSWER

5890 Å

Question

Name the instrument which can measure accurately the following

i. the diameter of a needle,

ii. the thickness of a paper,

iii. the internal diameter of the neck of a water bottle,

iv. the diameter of a pencil.

ANSWER

The given physical quantities can be measured accurately with the help of the following instruments —
the diameter of a needle — **screw gauge**.
the thickness of a paper — **screw gauge**.
the internal diameter of the neck of a water bottle — **vernier callipers**.
the diameter of a pencil — **screw gauge**.

Question

Name the instrument which has the least count:

i. 0.1 mm VC

ii. 1 mm m ✓

iii. 0.01 mm SG

ANSWER

The following instruments have the given least count —

i. 0.1 mm — **vernier callipers**

ii. 1 mm — **metre rule**

iii. 0.01 mm — **screw gauge**

Question

The number of oscillations made in one second is called:

(A) Amplitude

(B) Time period

(C) Frequency

(D) None of these

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

sec^{-1} or Hz

ANSWER

(C) Frequency

Question

The unit of time period is:

(A) Hertz (f)

(B) Nanometre (l)

(C) Second → (T)

(D) Centimetre (l)

ANSWER

(C) Second

Question

The length of a seconds' pendulum is nearly

(A) 0.5 m

(B) 9.8 m

(C) 1.0 m

(D) 2.0 m

Question

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

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

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

$$\frac{T_1}{T_2} = \frac{1}{1}$$

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

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

ANSWER

$T_1 : T_2 = 1 : 1$

SOLUTION

The fundamental units in S.I. system along with their symbols are as follows-

Quantity	Unit	Symbol
Length	metre	m
Mass	kilogram	kg
Time	second	s
Temperature	kelvin	K
Luminous intensity	candela	cd
Electric current	ampere	A
Amount of substance	mole	mol
Angle	radian	rd
Solid angle	steradian	st–rd

Question

Name two units of length which are bigger than a metre.
How are they related to the metre?

SOLUTION

The units of length which are bigger than a metre are-

1. **Astronomical Unit (A.U.)**- One astronomical unit is equal to the mean distance between the earth and the sun. Relation between metre and astronomical unit is expressed as:

   $$A.U. = 1.496 \times 10^{11} m$$

2. **Light year (ly)**- A light year is the distance travelled by light in vacuum, in one year. Relation between metre and light year is expressed as:

   $$1 \text{ light year} = 9.46 \times 10^{15} m$$

Question

The least count of a vernier callipers is:

(A) 1 cm

(B) 0.001 cm

(C) 0.1 cm

(D) 0.01 cm

ANSWER

(D) 0.01 cm

Question

A vernier has 10 divisions and they are equal to 9 divisions of main scale in length. If the main scale is calibrated in mm, what is its least count?

(i) As we know,

$$L.C. = \frac{\text{Value of 1 main scale div } (x)}{\text{total no. of div on vernier } (n)}$$

$Lc = \frac{x}{n} =$

Given,

Total number of divisions on vernier = 10

Value of one main scale division(x) = 1 mm

Substituting the values in the formula given above we get,

$$L.C. = \frac{1mm}{10}$$

$\Rightarrow L.C. = 0.1mm$

$\Rightarrow L.C. = 0.01cm$

Hence, least count of the vernier callipers is 0.01cm.

Question

A simple pendulum is made by suspending a bob of mass 1 kg by a string of length l. Now if the length of this pendulum is increased to 4l, then its time period T will:

(A) remain the same

(B) become twice

(C) become four times

(D) become half

ANSWER

(B) become twice

Question

The time period of two pendulums of length 1 m and 16 m are in ratio:

(A) 1 : 16

(B) 1 : 4

(C) 16 : 1

(D) 4 : 1

$T_1^2 \propto l_1$

$T_2^2 \propto l_2$

$\frac{T_1^2}{T_2^2} = \frac{1}{16}$

$= \frac{1}{4}$

Question

The time period of two pendulums of length 1 m and 16 m are in ratio:

(A) 1 : 16

(B) 1 : 4

(C) 16 : 1

(D) 4 : 1

ANSWER

(B) 1 : 4

Question

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

(A) four times

(B) one-fourth

(C) double

(D) half

ANSWER

(D) half

Question

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

H.W

SOLUTION

As we know that,

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

and T for a seconds' pendulum = 2s.

So, substituting the value of T in equation above we get,

$$f = \frac{1}{2}$$

$$\Rightarrow f = 0.5$$

Hence, 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.

Question

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

H.W

SOLUTION

As we know that,

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

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

In the case when,

$T_1/T_2 = 2:1$ [Equation 1]

we know that,

$T_1 : T_2 = \sqrt{l_1} : \sqrt{l_2}$ [Equation 2]

SOLUTION

So we get:

$\sqrt{l_1} : \sqrt{l_2} = 2 : 1$

$\Rightarrow \frac{\sqrt{l_1}}{\sqrt{l_2}} = \frac{2}{1}$

Squaring both sides we get,

$\frac{l_1}{l_2} = \frac{4}{1}$

$\Rightarrow \frac{l_1}{l_2} = \frac{4}{1}$

$\Rightarrow l_1 : l_2 = 4 : 1$

Hence, ratio of lengths = 4 : 1

Question

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

H.W

SOLUTION

As we know,

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

Given,

$g = 10\ ms^{-2}$

$\pi = 3.14$

$T = 2s$

SOLUTION

Substituting the values in the formula above we get,

$$2 = 2 \times 3.14 \sqrt{\frac{l}{10}}$$

$$\Rightarrow \left(\frac{2}{2\times3.14}\right) = \sqrt{\frac{l}{10}}$$

$$\Rightarrow \left(\frac{2}{2\times3.14}\right)^2 = \frac{l}{10}$$

$$\Rightarrow \left(\frac{1}{3.14}\right)^2 = \frac{l}{10}$$

$$\Rightarrow (0.3184)^2 = \frac{l}{10}$$

$$\Rightarrow 0.10142 = \frac{l}{10}$$

$$\Rightarrow l = 1.0142$$

Hence, length of a seconds' pendulum = $1.0142m$


Thank You