Physics Notes

BY

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Class:10+1
Unit: I
Topic: Physical World & Measurement

SYLLABUS: UNIT-I-B

Physics-scope and excitement; Physics, technology and society. Force in nature, conservation laws; Examples of gravitational, electromagnetic and nuclear forces form daily-life experiences (qualitative description only).

Need for measurement; Units of measurement; Systems of units; SI units, Fundamental and derived units, Length, mass and time measurements; Accuracy and precision of measuring instruments, Errors in measurement; Significant figures.

Dimensions of physical quantities, dimensional analysis and its applications.

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5.	What are various systems of units? Explain SI. Define SI units.	
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2.	Use dimension concept to convert one unit of a system to another system of units.	
3.	Use dimension analysis to check accuracy of dimensional formula i) Vel = $\sqrt{\frac{2GM}{R}}$ ii) E = mc^2	
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Q.1. What is the need for measurement in Physics?

Ans. Physics deals with nature and natural phenomenon. Laws of Physics are described in terms of Physical Quantities.

Measurement of Physical Quantities is must to have a Quantitative Analysis

Example:-

F = m x a

Numerical value of m and a is required to find the numerical value of F. If m = 2Kg, a = $3ms^{-1}$

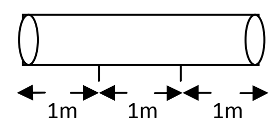
F = m x a

= (2)(3)

F = 6N

Q.2. Explain the measuring process with the help of one example.

Ans. First of all unit is chosen for measuring process. Secondly, measuring process is carried out to find how many such units are equal to given length, area, etc.



Example:-

Process of measuring length of a rod.

1. Unit (say m)
2. How many such units make 1 rod.
   Here it is 3 times.
   So, answer is 3m.

Physical Quantity

Q = n.u

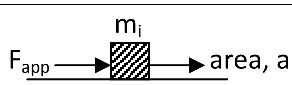
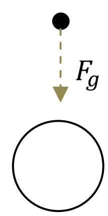
Q → Physical Quantity
n → no. of times
u → Unit

Q = $n_1 u_1$ = $n_2 u_2$

Eg:- (1)(Kg) = (1000)(gm)

Q.3. Compare 'Inertial Mass' and 'Gravitational Mass'.

Ans.

Inertial Mass	Gravitational Mass
Measure of Inertia of body	Measure of gravitational full of motion on body
 $F_{applied}$, a are measured $m_i = \frac{F_{app}}{a}$ $= \frac{100N}{20ms^{-2}}$ (say) m_i = 5 Kg	$M_{gravitation} = \frac{F_g}{acc.}$ due to gravitation $= \frac{100N}{10ms^{-2}}$ = 10 Kg 
Numerical value is same	Numerical value is same

Q.4. What are various systems of units? Explain SI.

Ans. Fundamental Units:-

Fundamental Units are basic units these cannot be written in terms of any other basic unit Eg: length, mass, time, etc.

Derived Units:-

Units of measurement of all physical quantities which can be obtained from fundamental units.

Example:-

Area = Length x Breath

= m x m

Area = m^2

Volume = m^3

Choice of Standard Unit:-

1. It should be of suitable size.
2. It should be accurately defined.
3. It should be easily accessible.
4. Easily reproducible ie.
5. It should not change with time.
6. It should not change with temperature, pressure, etc.

Q.5. What are various systems of units? Explain SI.

Ans.a) $f.p.s.$ System:-

f → foot (length)
p → pond (mass)
s → second (time)

b) $c.g.s.$ System:-

c → centimeter
g → gram
s → second

c) $m.k.s.$ System:-

m → meter
k → kilogram
s → second

d) SI System:-

S.No.	Basic Physical Qty.	Fundamental Unit	Symbol
1.	Mass	Kilogram	kg
2.	Length	Meter	m
3.	Time	Second	S
4.	Temperature	Kelvin	k
5.	Electric Current	Ampere	a
6.	Luminous Intensity	Candela	cd
7.	Quantity of Matter	Mole	mol

Q.6. Define SI unit.

Ans.1. Meter:-

The meter is the length of the path travelled by light in vacuum in 1/299, 792, 458 of a second.

Explanation:-

1. Speed of light = 3 x 10^8 m/sec.
2. Time = $\frac{Distance}{Speed}$

$= \frac{1m}{3 \text{ x } 10^8 \text{ m/sec}}$

Time = $\left(\frac{1}{3 \text{ x } 10^8}\right)$ sec

3. Time = $\frac{1}{2.99792468 \, x \, 10^8}$

2. Kilogram:-

One kilogram is defined as the mass of the international prototype of the kilogram (which is a standard block and Platinum Iridium Alloy preserved in the International Bureau of Weight and Measures at serves, near Paris, France.

3. Second:-

One second is the duration of 9,192,631,770 periods of radiation corresponding to unperturbed transition between the two superfine levels [F = 4, M = 0 and F = 3, M = 0] of the ground state of C_s - 133 atom. Atomic stocks are based on this definition.

Explanation:-

1. Phenomenon repeats itself after a fined interval of time.
2. Small units ensured better accuracy.
3. Atomic oscillations have time of order 10^{-9} sec.
4. C_s – 133 is used as atomic clock.
5. Accuracy of 1 sec in 5000 years.

4. Ampere:-

One ampere is the constant current, which when maintained in each of the two straight parallel conductor of infinite length and negligible cross section, hold 1m apart in vacuum shall produce a force/unit length of 2 x 10^{-7} N/m between them.

Explanation:-

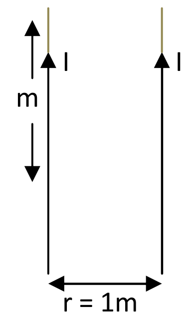
Force/l $= \left(\frac{M_0}{2\pi}\right) . \frac{I.I}{r}$

$= \left(\frac{4\pi \ x \ 10^{-7}}{2\pi}\right) . \frac{I.I}{r}$

Force/l $= 2 \text{ x } 10^{-7} \ . \frac{I.I}{r}$

$= 2 \text{ x } 10^{-7} \ . \frac{I.I}{I}$

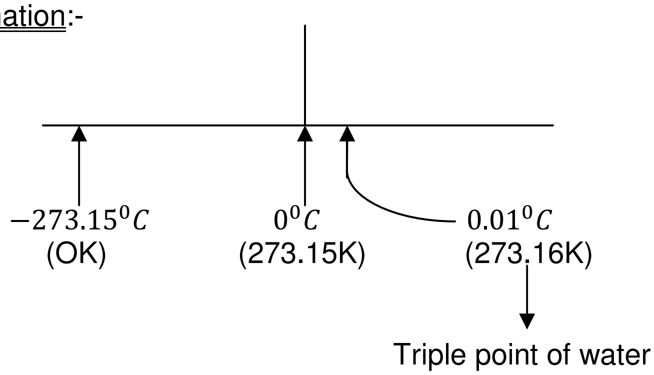
Force/l	$= 2 \text{ x } 10^{-7}$ N/m



5. Kelvin:-

It was adopted as the unit of temperature. One degree Kelvin is the fraction (1/273.16) of the thermodynamical temperature of the triple point of water.

Explanation:-



1. Triple point of water is 273.16K
2. 1K is $\frac{1}{273.16}$ of Triple point of water.
3. Triple point of water is temperature at which all the three state of water co-exists.

6. Candela:-

7. Mole:-

Explanation:-

1. 6.023 x 10^{23}
2. $C^{12} \rightarrow$ 12g = 6.023 x 10^{23}

Q.7. What is SI System of Units?
What is advantage of SI System of Units?

Ans. SI Units:-

International system of units having seven fundamental and two supplementary units.

Advantage of SI:

1. Coherent System:-

All derived units are obtained from fundamental without introducing numerical factors.

Example:-

Unit of Energy → joule
Unit of Force → newton
Unit of Length → m

work = force x distance

J = N x m

$= Kg \frac{m}{sec^2} m$

2. Rational System:-

It assigns only one unit to a particular physical quantity.

Example:-

Unit of Work → J
Unit of Heat → J

All forms of energy are assigned same unit i.e. joule.

3. Absolute System:-

Those are no gravitational units on are system.

Example:-

Weight = 10Nand is not → 1Kg.wt.

4. Metric System:-

Multiples and submultiples of units are in power of 1D.

Example:-

1Kg = 10^3 gram

1Km = 10^3 m

1m = 10^2 cm

Q.8. Explain

a) Astronomical Unit

b) Light year

c) Par Second

Find a relation between any two out of three.

Ans.a) Astronomical Unit (AU):-

It is the average distance between the centre of earth and centre of sun.

1 AU = 15 crore km

= 15 x 10^7 x 10^3 m

1 AU = 15 x 10^{10} m

1 AU = 15 x 10^{11} m

b) Light Year (LY):-

Distance travelled by light in vacuum in one year.

1LY = S x T

= 3 x 10^8 $\frac{m}{sec}$ (1 year)

= $\left(3 \text{ x } 10^8 \ \frac{m}{sec}\right)$ [365 x 24 x 60 x 60]

1LY = 9.46 x 10^{15}m

= 10 x 10^{15}

= 10^{16}m (approx)

c) Par.Second (PS):-

One Par second is the radius of circle at the centre of which an asc of length 1AU subtends an angle of 1".

θ^v = $\frac{l^v}{\mu}$ [θ μ l are given]

r = $\frac{l}{\theta}$

= $\frac{1\,AU}{1^{11}}$

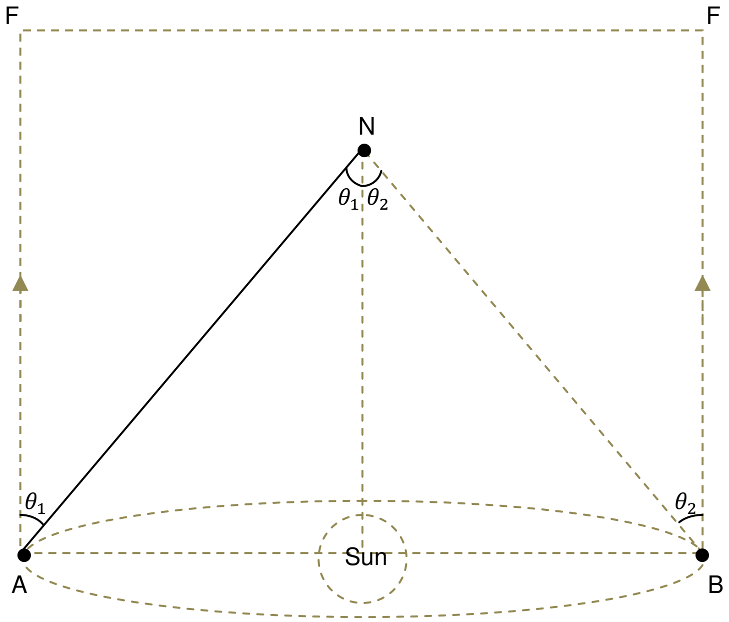
= $\frac{1.5 \ x \ 10^{11} m}{\left[\frac{1}{3600}\right]\left[\frac{2\pi}{360} rad\right]}$

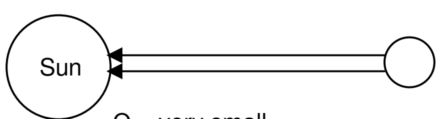
1PS = 3.09 x $10^{16}m$

= 3.1 x $10^{16}m$ (approx)

Q.1. Objective to measure distance of nearby star.

Ans.



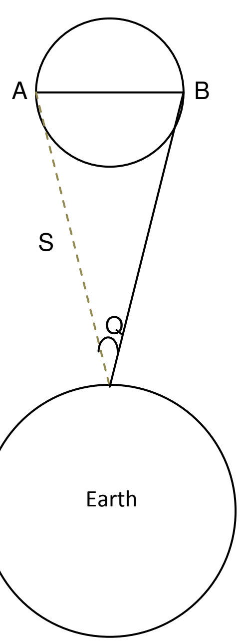


Θ = very small

Lines are ıı

Q.2. To measure size of moon.

Ans.

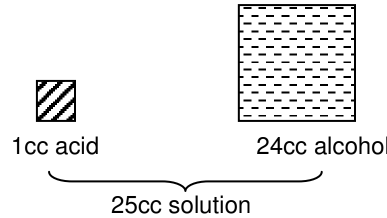


AB = ?

$\Theta = \frac{AB}{S}$

$AB = \Theta . S$

Q.3. To measure size of Molecule.



Ans. Step 1. acid = $\frac{1}{25}$

Step 2. 1cc of this sol. 1acc of alcohol

$\frac{1}{25}$cc of acid $\frac{24}{25}$cc of alcohol

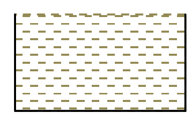
20cc of sol.

$\frac{1}{25}$cc + [19cc alcohol + $\frac{24}{25}$cc of alcohol]

Solution of oleic acid = $\frac{1}{500}$

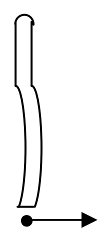
with concentration

Step 3. $\frac{1}{500}$ sol.



1 unit of acid and 499 unit of alcohol

Step 4. n drops



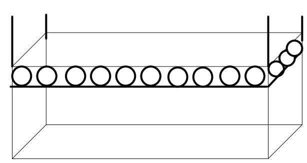
Total volume = nv

Acid volume = $\left(\frac{nv}{500}\right)$ ----------- (1)

Step 5. Area = A

Thickness = t

Volume = At



From (1) At = $\frac{n.v}{500}$

Step 6. t = $\frac{n.v}{500} \times \frac{1}{A}$

Thickness of layer = size of molecule

Q.1. Explain

a) Dimensions

b) Dimensional formula

c) Dimensional equation, with examples.

Ans.a) Dimesions:-

Dimensions are powers of L, M ,T, etc. to represent a physical quantity.

Example:-

1. Velocity = $\frac{Distance}{Time}$

$= \frac{L}{T}$

$= L^1 . T^{-1}$

$= [M^0 . L^1 . T^{-1}]$

Dimensions of velocity are 0 in Mass, 1 in length and -1 in time.

2. Acceleration $= \frac{L}{T^2}$

$= L^1 . T^{-2}$

Acc. = $[M^0 . L^1 . T^{-2}]$

Dimensions of Acc. Are 0 in Mass, 1 in length and -2 in time.

b) Dimensional Formula:-

It is an expression which tells us how a physical quantity depends on M, L, T etc.

Example:-

1. $[M^0 . L^1 . T^{-1}]$ is dimensional formula of velocity.
2. $[M^0 . L^1 . T^{-2}]$ is dimensional formula of acceleration.

c) Dimensional Equations:-

When a physical quantity is equated to its dimensional formula, it is called dimensional equation.

Example:-

1. [V] = $[M^0 . L^1 . T^{-1}]$
2. [acc] = $[M^0 . L^1 . T^{-2}]$

Q.2. Use dimension concept to convert one unit of a system to another system of units.

Ans. Dimensional analysis can be used to convert one unit of a system to another.

Example:-

1. Convert $\frac{1\ km}{1\ hr}$ to $\frac{m}{sec}$

Step 1. Identify the physical quantity
Eg:- here it is speed.

Step 2. $n_1 v_1 = n_2 v_2$

Step 3. $n_1 [M_1^0 L_1^0 T_1^{-1}] = n_2 [M_2^0 L_2^0 T_2^{-1}]$

Step 4. $(1)\left(\frac{km}{hr}\right) = (?)\left(\frac{m}{sec}\right)$

$$[n_1][M_1^0 L_1^0 T_1^{-1}] = [n_2][M_2^0 L_2^0 T_2^{-1}]$$

$$(1)\ [M_1^0 \underset{\text{Km}}{L_1^0} \underset{\text{hr}}{T_1^{-1}}] = (n_2)[M_2^0 \underset{\text{m}}{L_2^0} \underset{\text{sec}}{T_2^{-1}}]$$

$$(1)\ \left[\left(\frac{M_1}{M_2}\right)^0 \left(\frac{L_1}{L_2}\right)^1 \left(\frac{T_1}{T_2}\right)^{-1}\right] = n_2$$

$$(1)\ \left[(1)\left(\frac{1km}{1m}\right)^1 \left(\frac{1hr}{1sec}\right)^{-1}\right] = n_2$$

$$(1)\ \left[(1)\left(\frac{1000m}{1m}\right)^1 \left(\frac{3600sec}{1sec}\right)^{-1}\right] = n_2$$

$$(1)\ (1)\ (1000)\ (3600)^{-1} = n_2$$

$$\frac{1000}{3600} = n_2$$

$$\boxed{\frac{5}{18} = n_2}$$

2. Convert 1 newton to dyne

Step 1. Identify the physical quantity

Eg:- here it is force.

Step 2. $n_1 v_1 = n_2 v_2$

Step 3. $n_1[M_1^1 L_1^1 T_1^{-2}] = n_2[M_2^1 L_2^1 T_2^{-2}]$

Step 4. $n_1[M_1^1 \; L_1^1 \; T_1^{-2}] = n_2[M_2^1 \; L_2^1 \; T_2^{-2}]$

$M_1 \to$ 1kg, $L_1 \to$ 1m, $T_1 \to$ 1sec (SI)

$M_2 \to$ 1g, $L_2 \to$ 1cm, $T_2 \to$ 1sec (cgs)

Step 5. $n_1 \left[\left(\frac{M_1}{M_2}\right)^1 \left(\frac{L_1}{L_2}\right)^1 \left(\frac{T_1}{T_2}\right)^{-2} \right] = n_2$

Step 6. $(1) \left[\left(\frac{1kg}{1g}\right)^1 \left(\frac{1m}{1cm}\right)^1 \left(\frac{1sec}{1sec}\right)^{-2} \right] = n_2$

Step 7. $(1) \left[\left(\frac{1000g}{1g}\right)^1 \left(\frac{100m}{1cm}\right)^1 (1)^{-2} \right] = n_2$

Step 8. (1) (1000) (100) = n_2

$10^5 = n_2$

1 newton = 10^5 dyne

Q.3. Use dimension analysis to check accuracy of dimensional formula

i) Vel = $\sqrt{\frac{2GM}{R}}$

ii) E = mc^2

Ans.

i) Velocity = $\sqrt{\frac{2GM}{R}}$

LHS = Velocity $\left(\frac{D}{T}\right)$

Vel = $[M^0.L^1.T^{-1}]$

RHS = $\sqrt{\frac{2GM}{R}}$

= $\frac{2GM^{½}}{R}$

= $\left[\frac{(M^{-1}.L^3.T^{-2})\ M^1}{L^1}\right]^{½}$

= $[M^0.L^2.T^{-2}]^{½}$

= $(M)^{0/2}.(L)^{\sqrt[2]{2}}.(T)^{\frac{-2}{2}}$

= $[M^0.L^1.T^{-1}]$

= LHS

The formula is dimensionally correct.

ii) E = mc^2

LHS = Energy

= Force x distance

= $M^1.L^1.T^{-2}$ x L

= $M^1.L^2.T^{-2}$

RHS = mass x $(speed\ of\ light)^e$

= M x $\left(\frac{L}{T}\right)^2$

= $M^1.L^2.T^{-2}$

= LHS

The equation is dimensionally correct.

Q.4. Use dimensional analysis to derive formula.

Example: T depends on

- Mass
- Length
- Acc. Due to gravity.

Ans. T α m^a l^b g^c

a, b, c → ?

Step 1.

$[M^0.L^0.T^1]$ = $(mass)^a\ (length)^b (acc. due\ to\ gravity)^c$

= $[M^1.L^0.T^0]^a\ [M^0.L^1.T^0]^b\ [M^0.L^1.T^{-2}]^c$

Step 2.

= M^{a+o+a}, L^{o+b+c}, T^{o+o-2c}

Step 3.

As two sides are dimensionally same

$M^0.L^0.T^1$ = M^a, L^{b+c}, T^{-2c}

Compare powers

a = 0, b + c = 0, -2c = 1

a = 0 | b = $\frac{1}{2}$ | c = $\frac{1}{-2}$

Step 4.

T α M^0 $l^{½}$ $g^{-½}$

T α $l^{½}$ $g^{-½}$

T α $\frac{l^{½}}{g^{½}}$

T α $\left(\frac{l}{g}\right)^{½}$

T α $\sqrt{\frac{l}{g}}$

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