According to new syllabus of all intermediate boards of Sindh.

Prof. Rawala's ....

PHYSICS

HELPING BOOK

For
Class XI
(All science students)

RAWALA'S PHYSICS XI free for all

UNIT -1

Physics and measurements.

Page No.

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- **Physics, branches of physics.**
- **Physical quantities, system of units.**
- **Dimensions, dimensional analysis.**
- **Uncertainty, errors, graph.**
- **Significant figures.**

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Thoroughly revised and updated 2026 – 2027

- ***Detailed notes.***
- ***Multiple Choice Questions (M.C.Q's).***
- ***Solution of text book numericals.***
- ***MCQs and solution of numericals from <u>Karachi board</u> past papers.***

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To ***HIM***

Who gives courage to struggle and chance to survive

To **those**

Who make its use in their life.

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e for all

Table of physical constants

Specific heat of water	$C = 4200$ J/kg-°C
B.P of water under 1 atm. Pressure	$= 100°C = 212°F = 373$ k
Melting point of ice under 1 atm.	$= 0°C = 32°F = 273$ k
Latent heat of vaporization of water	$= 2.26 \times 10^{6}$ J/kg.
Latent heat of fusion of ice	$= 3.36 \times 10^{5}$ J/kg.
Absolute zero	$= -273\,°C = 0$ k
Mass of the sun	$M_s = 1.97 \times 10^{30}$ kg.
Mass of the earth	$M_e = 5.98 \times 10^{24}$ kg.
Mass of the moon	$M_m = 7.36 \times 10^{22}$ kg.
Radius of the earth	$R_e = 6.38 \times 10^{6}$ m.
Radius of moon's orbit	$R_{m.} = 3.84 \times 10^{8}$ m
Universal gravitational constant	$G = 6.67 \times 10^{-11}$ N-m²/kg².
Universal gas constant	$R = 8.313$ J/mole-k.
Boltzmann constant	$k = 1.38 \times 10^{-23}$ J/k.
Plank's constant	$h = 6.63 \times 10^{-34}$ J-s.
Rydberg's constant for hydrogen	$R_H = 1.097 \times 10^{7}\ m^{-1}$.
Speed of light in vacuum	$c = 2.98 \times 10^{8}$ m/s.
Rest mass of electron	$m_e = 9.11 \times 10^{-31}$ kg.
Rest mass of proton	$m_p = 1.67 \times 10^{-27}$ kg.
Rest mass of neutron	$m_n = 1.68 \times 10^{-27}$ kg.
Charge on an electron	$e = -1.6021 \times 10^{-19}$ coul.
Charge on a proton	$e = +1.6021 \times 10^{-19}$ coul.
Permittivity of free space	$\varepsilon_o = 8.85 \times 10^{-12} C^2/N\text{-}m^2$.
Permeability of free space	$\mu_o = 4\pi \times 10^{-7}$ web. /A-m.
Avogadro's number	$N_A = 6.02 \times 10^{23}$
Radius of first orbit of hydrogen	$r = 0.53 \times 10^{-10}$ m $= 0.53$ Å

Commonly used geometrical formulae:

Circumference of a circle $= 2\,\pi\, r$

Area of a circle $= \pi\, r^2$

Surface area of a sphere $= 4\,\pi\, r^2$

Volume of a sphere $= \frac{4}{3}\,\pi\, r^3$

Quadratic formula:

If $ax^2 + bx + c = 0$ *then*

$$x = \frac{-b \pm \sqrt{b^2 - 4\,a\,c}}{2\,a}$$

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Unit. 1**.....**

Physics and measurements

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Physics:

Q.No.1**: *What is physics?***

Ans**:** Physics is a branch of science that deals with the study of matter and energy and the interaction between them; hence it is that branch of science that seeks to understand and describe the fundamental principles and laws governing the natural world.

Physics is basically an experimental science, it, therefore, depends upon the objective observations and accurate measurements of various physical phenomenon.

Main branches of physics:

Physics is divided into many branches, each branch deals with different aspects of physical world.

- ***Classical mechanics* (*Newtonian physics*)** is based on old but still valid theories and supported by old experiments. Newtonian physics can be classified as **classical** in nature. Classical physics, broadly speaking, is divided into:

(*i*) Mechanics (*ii*) Electricity (*iii*) Magnetism (*iv*) Electromagnetism (*v*) Sound (*vi*) Heat. (*vii*) Optics. (*viii*) Thermodynamics. (*ix*) Spectroscopy etc.

Electromagnetism is basically a study of interaction between electric and magnetic fields, interaction of these fields with charged particles and current carrying conductors, production and propagation of electromagnetic waves etc.

Thermodynamics is basically a study of conversion of heat energy into mechanical energy (work) and vice versa. It also deals with the study of entropy, behavior of gases at different temperatures.

Optics is the study of properties of light such as reflection, refraction, interference and polarization etc.

- ***Modern physics*** deals with new ideas supported by phenomenon (such as photoelectric effect, pair production etc.) some of which could not be explained by classical physics.

Modern physics was developed successfully during the last century by many famous scientists such as Max. Plank, Einstein, Compton, De Broglie, Bohr, Rutherford etc.

Some of the branches into which modern physics is divided are:

(*i*) Quantum mechanics (*ii*) Relativity (*iii*) Nuclear physics (*iv*)Solid state physics (*v*) Electronics (*vi*) Plasma physics (*vii*) Particle physics (*viii*) Space physics etc.

Quantum mechanics is a branch of modern physics that deals with the behavior of particles at atomic and subatomic levels, deals with wave-particle duality, quantum superposition etc.

Einstein's theory of Relativity (special theory and general theory) deals with behavior of objects at speeds close to speed of light, such as a change in mass of a body, length contraction, time dilation etc. It also deals with space-time.

***Q.No.2*: Give some applications of physics in various fields.**

- ***Engineering fields*:** Physics principles are applied in different branches of Engineering e.g. electrical engineer applies principles of electricity and magnetism, while designing a vehicle mechanical engineer applies laws of motion, momentum, torques and so on.
- ***Energy and power*:** generation, transmission and utilization of electrical energy, production and conversion of nuclear energy for peaceful purposes, solar energy, energy storage in lithium battery etc. could not be achieved without the knowledge and application of physics.
- ***Electronics and communication*:** telecommunication, development of various electronic devices and information technology depend on the study of semiconductors, quantum mechanics and electromagnetism.
- ***Medical applications*:** Knowledge and applications of various branches of physics contributed in the development of X-rays, MRI, CT scan, Ultrasound, laser surgery, radiation therapy etc.
- ***Material science*:** Research and understanding of properties of materials resulted in the development of new materials for various applications in electronics, transportation etc.
- ***Environmental studies*:** Physics plays a very important role in the study of climate change. It is used to monitor environmental changes and predict daily weather.
- ***Education and scientific literacy*:** Education in physics promotes critical thinking, problem solving skills and scientific mindset.
- ***Communication*:** Use of GPS navigation, communication satellites, military satellites, weather satellites etc. would not have been possible with the knowledge of physics.

Physical quantities:

***Q.No.1*: What is base or a fundamental quantity?**

Ans*:** Quantity which ***cannot be derived from another quantity or ***cannot be*** resolved into any other quantity more fundamental, is called a ***base or a fundamental quantity***.

***Q.No.2*: What are derived quantities?**

Ans*:** Quantities which ***can be expressed as some combination of base quantities are called ***derived quantities***.

- ***Units*** are standards of measurement used to express physical quantities.

Units of base quantities are called ***base or fundamental units*** and units of derived quantities are called ***derived units***.

🗣Derived units are obtained by multiplication, division or multiplication as well as division of base units.

***Q.No.3*: What is a system of units?**

***Ans*:** A set of base and derived units is called a system of units.

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There are various systems of units such as C.G.S system, British engineering system and S.I or international system of units. Out of these S.I system is most modern and is widely used throughout the world in scientific, engineering and technological applications.

***Q.No.4*: Name S.I base quantities?**

***Ans*:** There are seven base quantities in S.I system, they are:

(*i*) length (*ii*) mass (*iii*) time (*iv*) electric current (*v*) thermodynamic temperature (*vi*) amount of substance, (*vii*) luminous intensity,

***Q.No.5*:Name the S.I units of base or fundamental quantities?**

***Ans*:** S.I units of base quantities are:

	Quantity	S.I Unit	
1.	Length.	meter	m
2.	Mass.	Kilogram	kg.
3.	Time.	second	s
4.	Electric current.	ampere	A
5.	Thermodynamic temperature.	Kelvin	k
6.	Amount of substance.	mole	mol.
7.	Luminous intensity.	candela	cd

Supplementary units

Supplementary units are units of quantities that are not covered by SI system of units. Supplementary units are dimensionless units and are used along with base unit in SI system.

Supplementary quantities are **geometrical quantities** related with angle at the center of a circle or of a sphere.

Physical Quantity	Supplementary Unit	Symbol
Plane angle (angle at the center of a circle)	Radian	Rad
Solid angle (angle at the center of a sphere)	Steradian	Sr

***Q.No.6*: Define plane angle and its S.I unit.**

***Ans*:** It is the angle subtended at the center of a **circle** by an arc.

Angle subtended at the center of a circle by an arc is said to be I radian if length of the arc is equal to radius of the circle. **1 rad = 57.3°**.

***Q.No.7*: Define solid angle and its S.I unit.**

***Ans*:** It is the angle subtended at the center of a **sphere** by a certain area of its surface.

Angle subtended at the center of a sphere by the area of its surface is said to be I Steradian if the area of the surface is equal to square of radius of the sphere.

***Q.No.6*: Name some derived quantities and give their S.I. units.**

***Ans*:** Some of the derived quantities and their S.I units are:

	Quantity.	S.I unit	
1.	Area	square meter	m^2
2.	Volume	cubic meter	m^3
3.	Speed or velocity.	meter per second	m/s
4.	Acceleration.	meter per second square	m/s^2
5.	Force.	kilogram-meter per second^2 or newton	N
6.	Torque or moment of force.	newton-meter	N-m
7.	Momentum.	kilogram-meter per second	kg. m/s or N-s
8.	Work, energy	Joule.	J
9.	Power	Joule/sec. or watt	watt

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Note that: While specifying units they should be written in lowercase (small) letters and in singular form except when magnitude of the quantity is greater than 1. Symbol of a unit of a quantity derived from name of a scientist must be written in capital letter (such as Newton N as a unit of force, Kelvin K as a unit of absolute or thermodynamic temperature and so on.)

Q.No.7: What is light year?

Ans: It is the unit of **distance**.

Long distances such as distance between stars, galaxies etc. are measured in light year.

One light year **is the distance travelled by light in vacuum in one year.**

Since $S = v\,t$ $\therefore$ 1 light year (S) = 3×10^8 m/s $\times$ (365 $\times$ 24 $\times$ 60 $\times$ 60 s)

$\therefore$ $\boxed{1 \text{ light year} = 9.47 \times 10^{15} \text{ m}}$

Our beautiful little galaxy, called ***Milky way galaxy***, is spiral shaped. Sun is a star of intermediate size and luminosity. Sun along with the whole solar system (including our beautiful little EARTH) revolves in Milky way at some distance from its center.

There are more than about **two billion stars** in our galaxy. Some **larger and some smaller than the sun**. There is a large number of galaxies in our universe.

Galaxy nearest to our galaxy is called **ANDROMEDA**, is at about 2 million light years away. (***It means that*** light coming from Andromeda galaxy will take about 2 million years to reach us !!!....)

Q.No.8: What is angstrom unit Å?

Ans: It is the unit of **length** (distance).

It is used when we come across short lengths. Wave length of light is very short, therefore, it is usually measured in angstrom unit.

$\boxed{1\text{Å} = 10^{-10} \text{ m}}$

Q.No.9: What is electron volt (ev)?

Ans: Electron volt (ev.) is the unit of **energy**.

It is a small unit of energy. Energy in various nuclear reactions is measured in electron volt.

$\boxed{1 \text{ ev.} = 1.6021 \times 10^{-19} \text{ J}}$ (Multiples: Mev. and Bev.)

Dimensions:

Q.No.1: What are dimensions of a physical quantity?

Ans: Dimensions of a physical quantity represent the physical nature of the quantity. Dimensions of a physical quantity is some combination of dimensions of base quantities raised to some suitable power.

Q.No.2: What are dimensions of base quantities?

Ans: Dimensions of base quantities are "[L]" (for distance), "[M]" (for mass) "[T]" (for time), [A] for electrical current and [K] for thermodynamic temperature. Dimensions of all other quantities are derived from the dimensions of base quantities.

On the basis of their dimensions, physical quantities are classified as:

Dimensional quantities:

Quantities having dimensions are called dimensional quantities e.g. velocity, acceleration, force, momentum etc. are dimensional quantities.

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***Dimensionless quantities*:**

Quantities having no dimension are called dimensionless quantities e.g. strain, angle etc. are dimensionless quantities.

***Dimensional constants*:**

Quantities having a constant value and at the same time having a dimension are called dimensional constants e.g. Universal gravitational constant "G", Plank's constant "h", speed of light in vacuum "c", permittivity of free space "ε_o", permeability of free space "μ_o" etc. are dimensional constant.

***Dimensionless constants*:** Quantities having a constant value but do not have any dimension are called dimensionless constants, they are merely numbers e.g. 2, 3, π, $\sqrt{5}$, $(7)^2$ etc.

***Use of dimensional analysis*:** Dimensional analysis can be used for the following purposes:

1. For checking a result:

Any equation can be verified for correctness by finding out the dimensions of different terms.

2. Derivation of a result:

Various quantities can be derived with the help of dimensional analysis.

3. For changing units:

Units can be changed from one system to another.

***Limitations of dimensional analysis*:**

Some of the limitations of dimensional analysis are:

1. It doesn't give information about dimensional constant.
2. Relations involving trigonometric, exponential and logarithmic functions cannot be derived.
3. It does not provide any information about whether the quantity is scalar or a vector.

***Dimensions of various physical quantities*:**

***Find the dimensions of following quantities*:**

1. Area
2. Volume
3. Density
4. Speed or velocity
5. Acceleration
6. Force
7. Momentum
8. Work or energy (K.E, P.E or any form)
9. Power
10. Pressure
11. Torque
12. Frequency "ν"
13. Wave length "λ"
14. Universal gravitational constant "G"
15. Plank's constant "h"
16. Angular velocity "ω"
17. Angular acceleration "α".
18. Angular momentum "L".
19. Electric charge "q".

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1-Area:

Area = length × breadth

(Dimensions of area = dimensions of length × dimensions of breadth)

$= [L] \times [L] = [L^2]$.

- Dimensions of area are $[L^2]$.

2-Volume:

Volume = length × breadth × height

$= [L] \times [L] \times [L] = [L^3]$.

- Dimensions of volume are $[L^3]$.

3- Density:

$$\text{Density} = \frac{\text{mass}}{\text{Volume}} = \frac{[M]}{[L^3]} = [M\,L^{-3}].$$

- Dimensions of density are $[ML^{-3}]$

4- Speed or velocity:

$$\text{Speed} = \frac{\text{distance covered}}{\text{Time taken}} = \frac{[L]}{[T]} = [LT^{-1}]$$

Dimensions of speed or velocity are $[LT^{-1}]$

5- Acceleration:

$$\text{Acceleration} = \frac{\text{change in velocity } (\Delta v)}{\text{Time taken} \quad (t)}$$

$$= \frac{[LT^{-1}]}{[T]} = [LT^{-1}]\times[T^{-1}] = [LT^{-2}].$$

- Dimensions of acceleration are $[LT^{-2}]$.

6- Force (any type):

Force = mass × acceleration

$= [M]\times[LT^{-2}] = [MLT^{-2}]$.

- Dimensions of force are $[MLT^{-2}]$

7- Momentum:

Momentum = mass × velocity

$= [M]\times[LT^{-1}] = [MLT^{-1}]$.

- Dimensions of momentum are $[MLT^{-1}]$.

8- Work or energy (K.E, P.E any form)

Work = Force × distance covered in the direction of force.

$= [MLT^{-2}] \times [L] = [ML^2T^{-2}]$.

- Dimensions of work or energy are $[ML^2T^{-2}]$
  - K.E = $\frac{1}{2}$ m v^2.

"$\frac{1}{2}$" is a dimensionless constant, hence the dimensions of K.E will be:

$= [M] \times [(LT^{-1})^2] = [ML^2T^{-2}]$

- Dimensions of K.E are $[ML^2T^{-2}]$.
  - P.E = m g h.

Hence the dimensions of P.E will be:

$= [M]\times[LT^{-2}]\times[L] = [ML^2T^{-2}]$

- Dimensions of P.E are $[ML^2T^{-2}]$

This shows that dimensions of all forms of energy will be $[ML^2T^{-2}]$.

9- Power:

Power is rate of doing work or rate at which energy is converted from one form to another form.

$$\text{Power} = \frac{\text{Work done or energy converted}}{\text{time}}$$

Dimensions of work or energy= $[ML^2T^{-2}]$

$\therefore$ Dimensions of power $= \frac{[ML^2T^{-2}]}{[T]}$

Dimensions of power=$[ML^2T^{-2}]\times[T^{-1}]=[ML^2T^{-3}]$

- Dimensions of power are $[M\,L^2\,T^{-3}]$.

10- Pressure:

$$\text{Pressure} = \frac{\text{Force}}{\text{Area}}$$

- Dimensions of pressure=$\frac{[MLT^{-2}]}{[L^2]}$

$= [MLT^{-2}] \times [L^{-2}] = [ML^{-1}T^{-2}]$

- Dimensions of pressure are $[ML^{-1}T^{-2}]$

11- Torque:

Torque = Force × moment arm.

Dimension of torque=$[MLT^{-2}]\times[L]=[ML^2T^{-2}]$

- Dimensions of torque are $[ML^2T^{-2}]$.

12- Frequency:

$$\text{Frequency} = \frac{\text{Number of vibrations}}{\text{Time}}$$

Dimensions of frequency = $\frac{\text{Dimensionless}}{\text{Dimension of time}}$

Dimensions of frequency = $\frac{\text{dimensionless}}{[T]}$

Dimensions of frequency = $\frac{1}{[T]} = [T^{-1}]$

- Dimensions of frequency are $[T^{-1}]$

13- Wave length "λ".

Wave length= distance between two consecutive crests or troughs.

- Dimensions of wave length are [T]

14- Universal gravitational constant "G":

According to law of gravitation:

$$F = G\,\frac{m_1 m_2}{r^2} \qquad G = \frac{F\,r^2}{m_1 m_2}$$

$\therefore$ Dimensions of G = $\frac{[MLT^{-2}]\times[L^2]}{[M][M]}$

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$\therefore$ Dimensions of G= $[MLT^{-2}]\times[L^2]\times[M^{-2}]$

• Dimensions of Universal gravitational constant "G" are $[M^{-1}L^3T^{-2}]$.

15- Plank's constant "h":

According to quantum theory energy of each photon is: $E = h\nu \quad \therefore \quad h = \frac{E}{\nu}$

$$\therefore \text{ Dimensions of } h = \frac{[ML^2T^{-2}]}{[T^{-1}]}$$

$$= [ML^2T^{-2}] \times [T]$$

Dimensions of plank's constant are $[ML^2T^{-1}]$

16- Angular velocity "ω":

$$\omega = \frac{\theta}{t}$$

"θ" is a dimensionless quantity, hence

• Dimensions of ω are $= \frac{1}{[T]} = [T^{-1}]$.

17- Angular acceleration:

Angular acceleration $\alpha = \frac{\Delta\omega}{\Delta t}$

Dimensions of acceleration $= \frac{[T^{-1}]}{[T]}$

$= [T^{-1}] \times [T^{-1}] = [T^{-2}]$.

• Dimensions of angular acceleration are $[T^{-2}]$.

18- Angular momentum "L":

Angular momentum = m v r Sin θ

Sinθ is a dimensionless quantity, hence

Dimensions of angular momentum

$=[M]\times[LT^{-1}]\times[L]= [ML^2T^{-1}]$

• Dimensions of angular momentum are $[ML^2T^{-1}]$.

19- **Electric charge "q"**

Electric current is the rate of flow of electric charge through a cross section of a conductor:

Electric current = Electric charge / time

Electric charge = Electric current × time

Dimensions of charge is [A]

and of time is [T]

Dimensions of electric charge = [A]×[T]

Dimensions of electric charge = [AT]

Dimensional analysis:

Basic rule for dimensional analysis:

While verifying the dimension wise correctness of an equation, the basic rule to be followed is that if an equation contains a number of terms which are to be added and/or subtracted, all terms must have the same dimensions.

***Prove that the following relations are dimensionally correct*:**

1. $v_f = v_i + a\,t$.
2. $S = v_i t + \frac{1}{2} a t^2$.
3. $2aS = v_f^2 - v_i^2$.

(1–3: Equations of uniformly accelerated rectilinear motion. (Equations of motion))

4. $E = mc^2$. 5. $E = h\nu$.
6. Total time of flight of a projectile (or total time taken by a projectile to move from point of projection to target) is given by: $t = 2V_o \sin\theta / g$
7. Maximum height reached by a projectile: $h = \frac{1}{2} V_o^2 \sin^2\theta / g$ or $h = V_o^2 \sin^2\theta / 2g$
8. $R = \frac{V_o^2 \sin 2\theta}{g}$ Horizontal range of a projectile.
9. $\nu\lambda = v$
10. Time period of a simple pendulum executing S.H.M (or when amplitude of vibrations is small). $T = 2\pi\sqrt{\frac{L}{g}}$

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11. Frequency "f" with which a string must vibrate so that one loop is produced is given by:

$$f = \frac{1}{2L}\sqrt{\frac{T}{\mu}}$$

"μ" is linear density of the string, "L" length of one loop and "T" is tension in the string.

12. Centripetal acceleration a_c: $a_c = \frac{v^2}{r}$
13. Centripetal acceleration a_c: $a_c = r\,\omega^2$
14. Centripetal acceleration a_c: $a_c = \frac{4\pi^2 r}{T^2}$
15. Centripetal force F_c: $F_c = \frac{m v^2}{r}$
16. Fringe spacing (Young's double slit experiment) $\Delta x = \lambda L/D$

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Solution:

In order to prove that a physical relation is dimensionally correct we will have to show that both sides of an equation must have the same dimensions.

1. $v_f = v_i + at$

Substituting the dimensions of each quantity we get: $[LT^{-1}] = [LT^{-1}] + [LT^{-2}] \times [T]$

$[LT^{-1}] = [LT^{-1}] + [LT^{-1}]$

$\therefore \quad [LT^{-1}] = [LT^{-1}]$

Both sides of the equation have same dimensions, therefore, the given equation is dimensionally correct.

2. $S = v_i t + \frac{1}{2} a t^2$

"$\frac{1}{2}$" is a dimensionless quantity:

$[L] = [LT^{-1}] \times [T] + [LT^{-2}] \times [T^2]$

$[L] = [LT^0] + [LT^0]$ But $([T^0] = 1)$

Hence $[L] = [L] + [L] \quad \therefore \quad [L] = [L]$

Both sides of the equation have same dimensions, therefore, the given equation is dimensionally correct.

3. $2 a S = v_f^2 - v_i^2$

"2" is a dimensionless quantity,

$[LT^{-2}] \times [L] = [(LT^{-1})^2] + [(LT^{-1})^2]$

$[L^2T^{-2}] = [L^2T^{-2}] + [L^2T^{-2}]$

$\therefore \quad [L^2T^{-2}] = [L^2T^{-2}]$

Both sides of the equation have same dimensions, therefore, the given equation is dimensionally correct.

4. $E = m c^2$

(Einstein's equation, "E" is energy, "c" is speed of light and "m" is mass converted into or produced from energy). Substituting the dimensions of each quantity we get: $[ML^2T^{-2}] = [M] [(LT^{-1})^2]$

$\therefore \quad [ML^2T^{-2}] = [ML^2T^{-2}]$

Both sides of the equation have same dimensions, therefore, the given equation is dimensionally correct.

5. $E = h\nu$.

According to quantum theory energy of each quantum (or photon) is given by this equation.

$[ML^2T^{-2}] = [ML^2T^{-1}] \times [T^{-1}]$

$\therefore \quad [ML^2T^{-2}] = [ML^2T^{-2}]$

Both sides of the equation have same dimensions, therefore, the given equation is dimensionally correct.

6. Total time of flight of a projectile is given by: $t = \dfrac{2 V_o \sin\theta}{g}$

"2 and Sin θ" are dimensionless quantities,

$[T] = \dfrac{[LT^{-1}]}{[LT^{-2}]}$

$[T] = [LT^{-1}] \times L^{-1}T^2$

$[T] = [L^0T^{-1}] \quad \therefore \quad [T] = [T]$

Both sides of the equation have same dimensions, therefore, the given equation is dimensionally correct.

7. Maximum height reached by a projectile:

$h = \frac{1}{2} \dfrac{V_o^2 \sin^2\theta}{g}$ OR $h = \dfrac{V_o^2 \sin^2\theta}{2g}$

"$\frac{1}{2}$ and Sin θ" are dimensionless quantities,

$[L] = \dfrac{[(LT^{-1})^2]}{[LT^{-2}]}$ OR $[L] = [L^2T^{-2}] \times [L^{-1}T^2]$

$[L] = [L\,T^0] \quad \therefore \quad [L] = [L]$

Both sides of the equation have same dimensions, therefore, the given equation is dimensionally correct.

8. $R = \dfrac{V_o^2 \sin 2\theta}{g}$

"Sin 2θ" is a dimensionless quantity,

$[L] = \dfrac{[(LT^{-1})^2]}{[LT^{-2}]}$ OR $[L] = [(LT^{-1})^2] \times [L^{-1}T^2]$

$[L] = [L^2T^{-2}] \times [L^{-1}T^2]$

$[L] = [LT^0] \quad \therefore \quad [L] = [L]$

Both sides of the equation have same dimensions, therefore, the given equation is dimensionally correct.

9. $\nu \lambda = v$

we get: $[T^{-1}] \times [L] = [LT^{-1}]$

$\therefore \quad [LT^{-1}] = [LT^{-1}]$

Both sides of the equation have same dimensions, therefore, the given equation is dimensionally correct.

10. Time period of a simple pendulum:

$T = 2\pi\sqrt{\dfrac{L}{g}}$ "2π" is a dimensionless quantity:

$[T] = \left\{\dfrac{[L]}{[LT^{-2}]}\right\}^{\frac{1}{2}}$ or $[T] = ([L] \times [L^{-1}T^2])^{\frac{1}{2}}$

$[T] = (T^2)^{\frac{1}{2}} \quad \therefore \quad [T] = [T]$

Both sides of the equation have same dimensions, therefore, the given equation is dimensionally correct.

11. f (or ν) $= \dfrac{1}{2L}\sqrt{\dfrac{T}{\mu}}$

This formula gives us the "fundamental frequency" (or frequency with which a string vibrates when one stationary wave is formed).

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"T" is tension in the string, "L" length of one loop and "μ" is the linear density (or mass per unit length) of the string. "2" is a dimensionless quantity:

$$[T^{-1}] = \frac{1}{[L]}\left\{\frac{[MLT^{-2}]}{[M]/[L]}\right\}^{\frac{1}{2}}$$

$$[T^{-1}] = [L^{-1}]\,([MLT^{-2}] \times [M^{-1}] \times [L])^{\frac{1}{2}}$$

$$[T^{-1}] = [L^{-1}]\,([M^0 L^2T^{-2}])^{\frac{1}{2}} \quad (M^0 = 1)$$

$$[T^{-1}] = [L^{-1}]\,([L^2T^{-2}])^{\frac{1}{2}} = [L^{-1}] \times L\,T^{-1}$$

$$[T^{-1}] = [L^0] \times [T^{-1}] \qquad [L^0] = 1$$

$$\therefore \quad [T^{-1}] = [T^{-1}]$$

Both sides of the equation have same dimensions, therefore, the given equation is dimensionally correct.

12. Centripetal acceleration a_c:

$$\mathbf{a_c = \frac{v^2}{r}}$$

$$[LT^{-2}] = \frac{([LT^{-1}])^2}{[L]} \text{ OR } [LT^{-2}] = [L^2T^{-2}] \times [L^{-1}]$$

$$\therefore \quad [LT^{-2}] = [LT^{-2}]$$

Both sides of the equation have same dimensions, therefore, the given equation is dimensionally correct.

13. Centripetal acceleration a_c: $\mathbf{a_c = r\,\omega^2}$

$$[LT^{-2}] = [L]([T]^{-1})^2 \quad \therefore \quad [LT^{-2}] = [LT^{-2}]$$

Both sides of the equation have same dimensions, therefore, the given equation is dimensionally correct.

14. Centripetal acceleration a_c

$$\mathbf{a_c = \frac{4\,\pi^2 r}{T^2}}$$

"$4\pi^2$" is a dimensionless quantity:

$$[LT^{-2}] = \frac{[L]}{[T^2]}$$

$$[LT^{-2}] = [L \times T^{-2}] \quad \therefore \quad [LT^{-2}] = [LT^{-2}]$$

Both sides of the equation have same dimensions, therefore, the given equation is dimensionally correct.

15. Centripetal force F_c:

$$\mathbf{F_c = \frac{m\,v^2}{r}}$$

$$[MLT^{-2}] = \frac{[M]\,[(LT^{-1})^2]}{[L]}$$

$$[MLT^{-2}] = [ML^2T^{-2}] \times [L^{-1}]$$

$$\therefore \quad [MLT^{-2}] = [MLT^{-2}]$$

Both sides of the equation have same dimensions, therefore, the given equation is dimensionally correct.

16. Fringe spacing (Young's double slit experiment)

$$\mathbf{\Delta x = \frac{\lambda\,L}{d}}$$

Fringe spacing "Δx" is the distance between two adjacent bright or dark fringes (its dimension will be L). Hence:

$$[L] = \frac{[L][L]}{[L]} \quad \text{OR} \quad [L] = [L^2] \times [L^{-1}]$$

$$\therefore \quad [L] = [L]$$

Both sides of the equation have same dimensions, therefore, the given equation is dimensionally correct.

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Uncertainty:

Uncertainty is the degree of doubt in the measurement or an estimate. There is always a certain degree of uncertainty in measurement which may be caused by the equipment used or techniques employed. Uncertainty is the difference between actual value and the standard value.

Uncertainty in a measurement from a single instrument is half the least count of the instrument used.

Fractional and percentage uncertainties:

Fractional uncertainty in a measurement is given by:

$$\text{Fractional uncertainty} = \frac{\text{Uncertainty in the measurement}}{\text{Value of the measurement}}$$

Whereas percentage uncertainty is actually the fractional uncertainty which is expressed in percentage,

$$\text{Percentage uncertainty} = \frac{\text{Uncertainty in the measurement}}{\text{Value of the measurement}} \times 100\%$$

Errors:

Error in a measurement is the difference (discrepancy) between measured and true (or actual) value.

Systemic errors:

Errors that have a clear cause and can be eliminated are known as systemic errors.

Types of systematic errors:

Ther are four different types of systematic errors ***Instrumental errors, Environmental errors, Observational errors*** and ***Theoretical errors***.

- ***Instrumental error*** is caused by improper or defective instrument.
- ***Environmental error*** is caused by the surrounding environment.
- ***Observational error*** is caused by observer taking inaccurate measurements.
- ***Theoretical error*** is caused by wrong theoretical assumptions.

Random errors: Errors that occur randomly and apparently may not have any cause. These errors are difficult to identify and therefore, are difficult to fix.

Graph:

Graph shows relationship between various quantities that is easy to understand and remember.

Q.No. 1: What is meant by proportional quantities?

Ans: If changes in one quantity depend upon the changes in some other quantity then they are called proportional quantities.

The exact mathematical relation between these quantities may be different. One of the quantities is called ***independent variable***, Whereas the other quantity is called ***dependent variable***.

Independent variable is that which we change or changes by itself. The independent variable is sometimes also called an **input variable**.

Dependent variable is that which changes because of changes in the independent variable. Sometimes it is also called an **output variable**.

Different types of graphs can be used to represent the relationship between dependent and independent variables. Choice of graph depends upon the type of data and nature of relationship between the variables.

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<u>Q.No. 2</u>: What is meant by <u>directly proportional</u> quantities?

<u>Ans</u>*: If on changing one physical quantity the other ***<u>one also changes in the same way and in the same proportion</u> i.e. by ***<u>increasing</u>*** one quantity (independent variable) the other quantity (dependent variable) also ***<u>increases</u>*** or vice versa. (***In other words,*** if one quantity is doubled the other also doubles or if one quantity is halved the other also reduces to half.) then the quantities are said to be ***<u>directly proportional</u>*** to each other.

Graph between directly proportional quantities is a ***<u>straight line</u>***.

<u>Q.No. 3</u>: What is meant by <u>inversely proportional</u> quantities?

<u>Ans</u>*: If on changing one physical quantity the other ***<u>one changes in the opposite way in the same proportion</u> i.e. by ***<u>increasing</u>*** one quantity the other quantity ***<u>decreases</u>*** or vice versa. ***In other words,*** if one quantity is doubled (increased two times) the other one <u>decreases</u> by two times (means it becomes half) and so on, then the quantities are said to be ***inversely proportional*** to each other.

***<u>Significant figures</u>*:**

Significant figures in a measurement are defined as the figures in a number which can be realized (i.e. number of digits which can actually be measured accurately with a given instrument.).

Greater the number of significant figures in a measurement greater is the accuracy and smaller is the percentage error in that measurement.

The limit of accuracy in a measurement is equal to the least count of the measuring instrument used.

<u>Q.No.1</u>: Give general rules to find the significant figures in a given number.

***<u>Ans</u>*: Rules which are generally followed to find significant figure are:

1. All non-zero digits are significant.
2. Zeroes lying between non-zero digits are significant.
3. Zeros to the right of decimal point and to the right of a non-zero digit are significant.
4. Zeros to the left of first non-zero digit in a number are not significant.
5. Zeros at the end of a number after the decimal point but the last non-zero digit are significant.
6. When two or more numbers are used in a calculation, the number of significant figures in the answer will be equal to the smallest number of significant figures in any one of the original factors.

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***<u>Section–A Multiple-Choice Questions MCQs</u>*:**

***<u>Q.No.1</u>*:** The respective number of significant figures for the numbers 23.023, 0.0003, and 2.1×10^{-3} are:
(A) 5, 1, 2 (B) 5, 1, 5 (C) 5, 4, 2 (D)4, 4, 2

***<u>Q.No.2</u>*:** Which among the following is the supplementary quantity:
(A) Mass (B) Time (C)Solid angle (D) Luminosity

***<u>Q.No.3</u>*:** The unit of solid angle is:
(A)Second (B) Steradian (C) Kilogram (D) Candela

***<u>Q.No.4</u>*:** The quantity having the same unit in all systems of unit is:
(A) Mass (B)Time (C) Length (D) Temperature

***<u>Q.No.5</u>*:** Random errors can be eliminated by:
(A) Number of observations and their mean.
(B)Measuring the quantity with more than one instrument
(C) Eliminating the cause (d) careful observations

***<u>Q.No.6</u>*:** Systemic error can be:
(A) Either positive or negative (B) Positive only
(C) Negative only. (D) Zero error.

***<u>Q.No.7</u>*:** $[MLT^{-2}]$ is the dimensional formula of:
(A) Strain (B) Displacement.(C)Force (D) Pressure

***<u>Q.No.8</u>*:** Which of the following pair has the same dimension?
(A) Moment of inertia and Torque
(B) Impulse and Momentum
(C) Surface tension and Force
(D) Specific heat and Latent heat

***<u>Q.No.9</u>*:** Dependent variable is:
(A) Cause (B) Cause and effect
(C) Effect (D) Reason

***<u>Q.No.10</u>*:** The dimension of force is:
(*2013 Karachi Board*)
(A) $[MLT]$ (B) $[MLT^{-1}]$ (C) $[MLT^{2}]$ (D) $[MLT^{-2}]$

***<u>Q.No.11</u>*:** The dimensions of torque are:
(A) $[ML^{2}T]$ (B) $[ML^{2}T^{-2}]$ (C) $[ML^{2}T^{2}]$ (D) $[MLT^{-2}]$
(*2014, 2008 Karachi board*)

***<u>Q.No.12</u>*:** The dimension of ''G'' is:
(*2016,2015,2011,2003 Karachi board*)
(A) $[ML^{-2}T^{3}]$ (B) $[M^{-1}L^{-2}T^{3}]$
(C) $[M^{-1}L^{3}T^{-2}]$ (D) $[M^{-1}L^{2}T^{2}]$

***<u>Q.No.13</u>*:** The unit of luminous intensity is:
(*2018,2014,2007 Karachi board*)
(A) Decibel. (B) Candela (C) Diopter (D) W/m^2

<u>Q.No.14</u>*:** The dimensions of angular velocity are: (2018, 2002 Karachi Board***)
(A) $[ML^{0}T^{-1}]$ (B) $[ML^{0}T^{-2}]$ (C) $[M^{0}L^{0}T^{-1}]$ (D) $[M^{0}L^{0}T^{-3}]$

<u>Q.No.15</u>*:** The dimensions of physical quantity "force" are: (2019 Hyderabad Board***)
(A) $M^{0}L^{1}T^{1}$ (B) $M^{1}L^{1}T^{-1}$
(C) $M^{0}L^{1}T^{-1}$ (D) $M^{1}L^{1}T^{-2}$

***<u>Q.No.16</u>*:** The quantity having the same unit in different systems of unit is:
(***2025 Karachi Board***)
(A) Mass (B) Time (C) Length (D) Temperature

<u>Q.No.17</u>*:** The significant figures in number 406,058 are: (2026 Karachi Board***)
(A) 06 (B) 04 (C) 03 (D) 05

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Answers:

(1) (C) 5, 4, 2
(2) (C) Solid angle.
(3) (B) Steradian.
(4) (B) Time.
(5) (A) Number of observations and their mean
(6) (A) Either positive or negative.
(7) (C) Force.
(8) (B) Impulse and Momentum.
(9) (C) Effect.
(10) (D) $[MLT^{-2}]$
(11) (D) $[ML^2T^{-2}]$.
(12) (C) $[M^{-1}L^3T^{-2}]$
(13) (B) Candela.
(14) (C) $[M^0L^0T^{-1}]$
(15) (D) $M^1L^1T^{-2}$
(16) (B) Time.
(17) (A) 06

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Numericals:

***Q.No.1*: What is the percent uncertainty in the measurement 3.67± 0.25 m?**

***Solution*:**

Value of measurement = 3.67 m

Uncertainty in measurement = ± 0.25 m

$$\%\ \text{uncertainty} = \frac{\text{Uncertainty in measurement}}{\text{Value of measurement}} \times 100\%$$

$$\%\ \text{uncertainty} = \frac{0.25}{3.67} \times 100\%$$

% uncertainty = 6.81 %

Percentage uncertainty is **6.81 %**

***Q.No.2*: What is the area and its approximate uncertainty of a circle with radius 3.7×10^4cm.**

***Solution*:** $r = 3.7\times10^4$cm. A =?

$A = \pi r^2 = 22/7 \times (3.7\times10^4)^2 = 4.3\times10^9\ cm^2$.

Area of the given circle is **$4.3\times10^9\ cm^2$.**

***Q.No.3*: An aero plane travels at 850 km/h. How long does it take to travel 1.00 km?**

***Data*:**

Speed of aero plane v = 850 km/h.

Distance d =1.00 km. Time t = ?

***Solution*:**

$v = \frac{d}{t}$ $t = \frac{d}{v} = \frac{1.00}{850}$ = 0.00118 h=**4.23 sec**

Aero plane will take **4.23 sec** to travel 1.00 km.

***Q.No.4*: A rectangular holding tank 25 m in length and 15.0 m in width is used to store water for a short period of time in an industrial plant. If 2980 m^3 water is pumped into the tank. What is the depth of water?**

***Data*:**

L = 25 m W = 15.0 m D = ?

Volume V = 2980 m^3.

***Solution*:**

Since volume of the tank = volume of water stored

∴ V = length(L) width(W) depth(D) ∴D = V / L W

$D = \frac{2980}{25\times15}$ = **7.95 m.**

Depth D of the tank is **7.95 m.**

***Q.No.5*: Find the volume of a rectangular underground water tank which has storage facility of 1.9 m by 1.2 m by 0.8 m?**

***Data*:**

L= 1.9 m. W = 1.2 m. D = 0.8 m.

***Solution*:**

V = L W D

V = 1.9 × 1.2 × 0.8 = **1.824 m^3.**

Volume of the tank is **1.824 m^3.**

***Q.No.6*: Two students derive the following equations in which "x" refers to the distance traveled, "v" the speed, "a" the acceleration and "t" time and the subscript "o" means a quantity at time t = 0.**

(a) $x = v\,t^2 + 2at$ and

(b) $x = v_o\,t + 2at^2$

Which of these could possibly be correct according to dimensional analysis.

***Solution*:**

Dimensionally an equation will be correct if dimensions on both sides of equation are same.

Hence substituting dimensions of various quantities on both sides of given equations we get:

(a) **$x = v\,t^2 + 2at$** (2 is dimensionless)

$[L] = [LT^{-1}] \times [T^2] + [LT^{-2}]\times[T]$

$[L] = [LT^1] + [LT^{-1}]$

Since dimensions of both sides of this equation are **not the same** therefore, this equation is dimensionally **incorrect**.

(b) **$x = v_o\,t + 2at^2$** (2 is dimensionless)

$[L] = [LT^{-1}] \times [T] + [LT^{-2}]\times[T^2]$

$[L] = [LT^0] + [LT^0]$ $(T^0 = 1)$

$[L] = [L] + [L]$

$[L] = [L]$

Since both sides of above equation has **same dimensions** hence this equation is dimensionally **correct.**

***Q.No.7*: One hectare is defined as $10^4\ m^2$. One acre is $4\times10^4\ ft^2$. How many acres are in one hectare? (1 m = 3.28 ft)**

***Data*:**

1 hectare = $10^4\ m^2$ 1 acre = $4\times10^4\ ft^2$.

1 m =3.28 ft. No. of acres in 1 hectare=?

***Solution*:**

Since 1 m = 3.28 ft. ∴ $1m^2 = (3.28)^2 = 10.7584\ ft^2$

1 hectare = $10^4\ m^2 = 10.7584 \times10^4\ ft^2$

No. of acres in 1 hectare = $\frac{10.7584 \times10^4}{4\times10^4}$ = **2.69**

Hence there are **2.69** acres in 1 hectare.

***Q.No.8*: A watch factory claims that its watches gain or lose not more than 10 seconds in a year. How accurate is this watch, express in percentage.**

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Solution:

Uncertainty = ± 10 sec. per year.

No. of seconds in one year = 365 × 24 × 60 × 60

= 31,536,000 seconds.

$$\% \text{ uncertainty} = \frac{10}{31{,}536{,}000} \times 100\%$$

%uncertainty=<u>**0.0000 317 %**</u> OR <u>**3.17×10^{-5}%**</u>

Q.No.9: **Diameter of the moon is 3480 km. What is volume of the moon? How many moons would be needed to create a volume equal to that of the earth?**

(Radius of earth = 6380 km)

Data:

Diameter of moon D = 3480 km

Radius of moon R_m =3480/2 =1740 km.

Volume of moon V =?

Radius of the earth R_e = 6380 km.

No. of moons equal to volume of the earth =?

Solution:

Volume of moon $V_m = 4/3 \times \pi R_m^3$

$V_m = 4/3 \times 22/7 \times (1740)^3 = \mathbf{2.2075 \times 10^{10}\ km^3}$

Volume of earth $V_e = 4/3 \times \pi R_e^3$

$V_m = 4/3\times 22/7 \times(6380)^3 = \mathbf{1.08824 \times 10^{12}\ km^3}$

No. of moons required to have volume equal to the volume of earth $= \dfrac{1.08824 \times 10^{12}}{2.2075 \times 10^{10}} = \mathbf{49.296}$

<u>**49.296**</u> moons will be required to have volume equal to the volume of the earth.

Q.No.10: **Show that the following formulae are dimensionally correct:**

(a) $V = f\lambda$ (b) $T = 2\pi\sqrt{\dfrac{m}{k}}$

(*2016, 2013 Karachi Board*)

Solution:

(a) $V = f\lambda$

Dimensions of "V", "f" and "λ"are $[LT^{-1}]$,$[T^{-1}]$ and [L] respectively. ∴ $[LT^{-1}] = [T^{-1}] \times [L]$

∴ $[LT^{-1}] = [LT^{-1}]$

Both sides of the equation <u>have same dimensions</u>, hence, the given equation is <u>dimensionally correct</u>.

(b) $T = 2\pi\sqrt{\dfrac{m}{k}}$

"k" represents the force constant or spring constant; it is given by:

$k = \dfrac{F}{x}$ (Hook's law)

∴ Dimensions of $k = \dfrac{[MLT^{-2}]}{[L]}$

∴ Dimensions of $k = [MLT^{-2}]\times[L^{-1}]= [ML^0T^{-2}]$

"2π" is a dimensionless quantity,

$[T] = \left\{\dfrac{[M]}{[ML^0T^{-2}]}\right\}^{\frac{1}{2}}$ ($[L^0] = 1$)

$[T] = ([M] \times [M^{-1}T^2])^{\frac{1}{2}}$

$[T] = (M^0\, T^2)^{\frac{1}{2}}$ ($[M^0] = 1$)

$[T] = [T]$

Since both sides of the equation <u>have the same dimensions</u>, therefore, the given formula is dimensionally correct.

Q.No.11: **Show that the equation $f = \dfrac{1}{2l}\sqrt{\dfrac{F\times l}{m}}$ is dimensionally correct and find the dimensions of kinetic energy.**

(***2017 Karachi Board***)

Solution:

"2" is a dimensionless quantity, hence:

$[T^{-1}] = \dfrac{1}{[L]}\left\{\dfrac{[MLT^{-2}][L]}{[M]}\right\}^{\frac{1}{2}}$

$[T^{-1}] = [L^{-1}]\,([ML^2T^{-2}] \times [M^{-1}])^{\frac{1}{2}}$

$[T^{-1}]= [L^{-1}]\,([M^0L^2T^{-2}])^{\frac{1}{2}}$ ($[M^0]$ =1)

$[T^{-1}] = [L^{-1}]\,([L^2T^{-2}])^{\frac{1}{2}}$

$[T^{-1}] = [L^{-1}] \times [L^1T^{-1}]$

$[T^{-1}] = [L^0T^{-1}]$ (L^0 =1)

$[T^{-1}] = [T^{-1}]$

Since both sides of the equation <u>have the same dimensions</u>, therefore, the given equation is <u>dimensionally correct</u>.

Dimensions of K.E = $\frac{1}{2}$ m v^2.

"$\frac{1}{2}$" is a dimensionless constant, hence the dimensions of K.E will be:

$= [M] \times ([LT^{-1}])^2 = [ML^2T^{-2}]$

Dimensions of K.E are <u>$[ML^2T^{-2}]$</u>.

Q.No.12: **Prove that the equation $T = 2\pi\sqrt{\dfrac{L}{g}}$ is dimensionally correct .**

(***2025 Karachi Board***)

Solution:

Time period of a simple pendulum:

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

"2π" is a dimensionless quantity:

∴ $[T] = \left\{\dfrac{[L]}{[LT^{-2}]}\right\}^{\frac{1}{2}}$

or $[T] = ([L] \times [L^{-1}T^2])^{\frac{1}{2}}$

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or $[T] = [L]^{\frac{1}{2}} \times [L^{-1}T^2]^{\frac{1}{2}}$

or $[T] = [L]^{\frac{1}{2}} \times [L]^{-\frac{1}{2}} \times [T^2]^{\frac{1}{2}}$

$[T] = [T^2]^{\frac{1}{2}}$ $\therefore$ $[T] = [T]$

Both sides of the equation have same dimensions, therefore, the given equation is dimensionally correct.

Q.No.13*: Prove that the following equation is dimensionally correct.** (2025 Karachi Board***)

$$F = \frac{m\,v^2}{r}$$

This is the formula for centripetal force.

Dimensions of any force = $[MLT^{-2}]$

Substituting the dimensions of F, m, v and r in the given equation we will get:

$\therefore$ $[MLT^{-2}] = \frac{[M]\ [LT^{-1}]^2}{[L]}$

$[MLT^{-2}] = [M]\,[L^2T^{-2}] \times [L^{-1}]$

$[MLT^{-2}] = [MLT^{-2}]$

Since both sides of the equation have the same dimensions, therefore, the given equation is dimensionally correct.

***Q.No.14*: Prove that the following equations are dimensionally correct.**

(***2026 Karachi Board***)

- **$V = f\lambda$** • **$2\,a\,S = v_f^2 - v_i^2$**

Proof: • **$V = f\lambda$**

Dimensions of "V", "f" and "λ" are $[LT^{-1}]$, $[T^{-1}]$ and $[L]$ respectively.

$\therefore$ $[LT^{-1}] = [T^{-1}] \times [L]$

$\therefore$ $[LT^{-1}] = [LT^{-1}]$

Both sides of the equation have same dimensions, hence, the given equation is dimensionally correct.

- **$2\,a\,S = v_f^2 - v_i^2$**

"2" is a dimensionless quantity,

$\therefore$ $[LT^{-2}] \times [L] = [(LT^{-1})^2] + [(LT^{-1})^2]$

$[L^2T^{-2}] = [L^2T^{-2}] + [L^2T^{-2}]$

$\therefore$ $[L^2T^{-2}] = [L^2T^{-2}]$

Both sides of the equation have same dimensions, therefore, the given equation is dimensionally correct.

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Did you know that ....

Speed of light in vacuum is about 3×10^8 m/s.

It means that it travels 3×10^8 m (300,000,000 meters or 300,000 kilometers) in one second.

$\therefore$ Distance traveled by light in one second = 3×10^8 m

Distance traveled by light in one minute = $3 \times 10^8 \times 60$ m

Distance traveled by light in one hour = $3 \times 10^8 \times 60 \times 60$ m

Distance traveled by light in one day (24 h)= $3 \times 10^8 \times 60 \times 60 \times 24$ m

Distance traveled in one year (365 days)=$3 \times 10^8 \times 60 \times 60 \times 24 \times 365$ m

Distance traveled in one year (365 days)= 9.46×10^{15} m

- This distance traveled by light in one year is called "**Light year**".

- Hence: **1 light year = 9.46×10^{15} m**.