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Class: XI
Subject: Physics
Topic: Units, Measurements and Dimensions
No. of Questions: 29

Q1. The physical quantity having the dimensional formula $[M^{-1}L^{-3}T^{3}A^{2}]$ is

A. resistance

B. resistivity

C. conductivity

D. electromotive force

Sol. (C)

The physical quantity having the dimensional formula $[M^{-1}L^{-3}T^{3}A^{2}]$ is conductivity

Q2. If the error in the measurement of radius of a sphere is 1%, what will be the error in the measurement of its volume?

A. 1%

B. 1/3%

C. 3%

D. 10%

Sol. (c)

In the product form, relative or percentage errors add up to give the net error, i.e.
Percentage error in r = 1%
$r^3 = r + r + r$
Percentage error in V = (1 + 1 + 1)% = 3%

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Q3. In the expression $S = a + bt + ct^2$, 'S' is measured in metres (m) and 't' in seconds (s). The unit of 'c' is

A. m^2

B. m

C. ms^{-1}

D. ms^{-2}

Sol. (D)

Here the left hand side of the expression has units of displacement. To make the right hand side equal to left hand side, units of each expression on right hand side should be metres. Since c is multiplied by the square of second, so value of c should be ms^{-2}so that when multiplied by time, s^2 will yield metre. Hence, option 4 is the answer

Q4. The volume of a cube in m^3 is equal to the surface area of the cube in m^2. The volume of the cube is

A. 64 m^3

B. 216 m^3

C. 512 m^3

D. 196 m^3

Sol. (B)

Let side of cube be 'a' metres.

Surface area of cube = Volume of cube

=> 6 x a x a = a x a x a

=> a = 6

=> Volume of cube = a^3 = 216 m^3

Q5. If 'C' and 'R' denote capacitance and resistance respectively, what will be the dimensions of 'C R'?

A. $[M^0L^0TA^0]$

B. $[ML^0TA^{-2}]$

C. $[ML^0TA^2]$

D. $[MLTA^{-2}]$

Sol. A

For a *R-C* circuit a time constant is calculated as product of *R* and *C*.

$\therefore$ Dimensions of *R C* = Dimensions of time

$= [M^0\ L^0TA^0]$.

Alternative : Dimensions of capacitance *C* and *R* are

$C = [M^{-1}L^{-2}T^4A^2]$, $R = [ML^2T^{-3}A^{-2}]$

$\therefore$ Dimensions of *CR*

$= [M^{-1}L^{-2}T^4A^2]\,[ML^2T^{-3}A^{-2}]$

$= [M^0L^0TA^0]$

Q6. The 'rad' is the correct unit used to report the measurement of

A. the ability of a beam of gamma ray photons to produce ions in a target

B. the energy delivered by radiation to a target

C. the biological effect of a radiation

D. the rate of decay of a radioactive source

Sol. C

A unit of energy absorbed from ionising radiation is equal to 100 ergs per gram or 0.01 joules per kilogram of irradiated material. It has been replaced as a standard scientific unit by the

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gray.The 'rad' is the correct unit used to report the measurement of the biological effect of a radiation

Q7. Match List I (physical quantities) with List II (related units).

List-I	List-II
A. Magnetic field intensity	1. Wb m^{-1}
B. Magnetic flux	2. Wb m^{-2}
C. Magnetic potential	3. Wb
D. Magnetic induction	4. Am^{-1}

A. A - 4, B - 3, C - 1, D - 2

B. A - 1, B - 4, C - 2, D - 3

C. A - 3, B - 1, C - 4, D - 2

D. A - 2, B - 4, C - 1, D - 3

Sol. A

Unit of magnetic field intensity is Am^{-1}.
Unit of magnetic flux is Wb (weber)
Unit of magnetic potential is Wbm^{-1}.
Unit of magnetic induction is Wbm^{-2}.

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Q8. The chosen standard quantity with which other quantities have to be compared is called the ________________.

A. measurement

B. unit

C. magnitude

D. direction

Sol. B

This is the definition of unit.

Q9. Out of the following four dimensional quantities, which one can be called a dimensional constant?

A. Acceleration due to gravity

B. Surface tension of water

C. Weight of a standard kilogram mass

D. Velocity of light in vacuum

Sol. D

Velocity (derived physical quantity) of light in vaccum is independent of all parameters. Thus, it is a constant.

Acceleration, Surface Tension & Weight all depends on some other physical quantity.

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Q10. The dimensions of (where permitivity of free space, E : electric field) are

A. $[MLT^{-1}]$

B. $[ML^{2}T^{-2}]$

C. $[ML^{-1}T^{-2}]$

D. $[ML^{2}T^{-1}]$

Sol. C

Dimensions = $[M^{-1}L^{-3}A^{2}T^{4}][MLA^{-1}T^{-3}]^{2} = [ML^{-1}T^{-2}]$

Q11. Which of the following is **not** a physical quantity?

A. Kilogram

B. Impulse

C. Energy

D. Density

Sol. A

Kilogram is the SI unit of mass, while all others are given physical quantities. Here mass is given as the physical quantity.

Q12. The velocity 'v' of a particle at time 't' is given by 'v' = at + , where 'a', 'b' and 'c' are constants. The dimensions of 'a', 'b' and 'c' respectively, are

A. $[LT^{-2}]$, [L] and [T]

B. $[L^{2}]$, [T] and $[LT^{2}]$

C. $[LT^{2}]$, [LT] and [L]

D. [L], [LT] and $[T^{2}]$

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Sol. A

'at' must have the dimensions of velocity.
So let the dimension of 'a' be $[M^xL^yT^z]$.
$[M^xL^yT^z][T] = [M^0L^1T^{-1}]$
$[M^xL^yT^z] = [M^0L^1T^{-2}]$
Hence, the dimensions of 'a' = $[L^1T^{-2}]$
Only option (1) satisfies the given result.

Q13. If a screw gauge moves 1mm in two rotations, the pitch of the screw gauge is _______.

A. 1 mm

B. 2 mm

C. 0.5 mm

D. 3 mm

Sol. C

Pitch = Distance covered by screw head / number of rotations
= 1 mm / 2
= 0.5 mm

Q14. What is the dimensional formula of thermal conductivity?

A. $[MLT^{-1}\theta^{-1}]$

B. $[MLT^{-3}\theta^{-1}]$

C. $[M^2LT^{-3}\theta^{-2}]$

D. $[ML^2T^{-2}\theta]$

Sol. D Q/dt= KA dT/dx

Q15. Which of the following units denotes the dimensions $[ML^2/Q^2]$, where 'Q' represents the electric charge?

A. Wb/m^2

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B. Henry(H)

C. H/m^2

D. Weber(Wb)

Sol. B

Units and Dimensional Formula of 'L'

S.I. unit : $\frac{\text{weber}}{\text{amp.}} = \frac{\text{tesla} \times m^2}{\text{amp.}}$

$= \frac{N \times m}{\text{amp}^2}$

$= \frac{\text{joule}}{\text{amp}^2}$

$= \frac{\text{coulomb} \times \text{volt}}{\text{amp}^2}$

$= \frac{\text{volt} \times \text{sec.}}{\text{amp.}}$

$= \text{ohm} \times \text{sec} \ (\Omega \times \text{sec})$

But practical unit is henry (H). Its dimensiona

$$[L] = [ML^2T^{-2}A^{-2}]$$

Since Q = AT, so second option is the correct answer, which is Henry (H).

Q16. In the relation $P = \frac{\alpha}{\beta} e^{\frac{-\alpha z}{k\theta}}$, 'P' is pressure, 'z' is distance, 'k' is Boltzmann constant and 'θ' is temperature, what will be the dimensional formula of β?

A. $[M^0L^2T^0]$

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B. $[ML^2T]$

C. $[ML^0T^{-1}]$

D. $[ML^2T^{-1}]$

Sol. A

In given equation, $\frac{\alpha z}{k\theta}$ should be dimensionless.

$$\therefore \quad \alpha = \frac{k\theta}{z}$$

$$\Rightarrow \quad [a] = \frac{[ML^2T^{-2}K^{-1} \times K]}{[L]} = [MLT^{-2}]$$

and

$$P = \frac{\alpha}{\beta}$$

$$\Rightarrow \quad [\beta] = \left[\frac{\alpha}{\rho}\right] = \frac{[MLT^{-2}]}{[ML^{-1}T^{-2}]} = [M^0L^2T^0]$$

Q17. A force 'F' is applied on a square plate of side 'L'. If percentage error in determination of 'L' is 3% and 'F' is 4%, the permissible error in pressure is

A. 2%

B. 4%

C. 6%

D. 10%

Sol. D

We know that, $p = \frac{F}{A} = \frac{F}{L^2} = FL^{-2}$

% error in pressure = (% error in F) + 2 (error in L)

= (4%) + 2 (3%)

= 10%

Q18. What is dimensional formula of Torque?

A. ML^2T^{-2}

B. MLT^2

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

D. None of these

Sol: A

Self Explanatory

Q19. The dimensional formula of electric potential are

A. $[ML^2T^{-3}A^{-1}]$

B. $[MLT^{-3}A^{-1}]$

C. $[ML^2TA]$

D. $[ML^2T^{-1}A]$

Sol: A

Q20. What is the difference between Ao and A.U.?

Sol. A^0 and A.U both are the units of distances but 1 $A^0 = 10^{-10}$m and 1 A.U. = 1.496×10^{11}

Q21. Define S.I. unit of solid angle?

Sol. One steradian is defined as the angle made by a spherical plane of area 1 square meter at the centre of a sphere of radius 1m.

Q22. Name physical quantities whose units are electron volt and pascal?

Sol. Energy and pressure.

Q23. When a planet X is at a distance of 824.7 million kilometers from earth itsangular diameter is measured to be 35.72^{11} of arc. Calculate the diameter of 'X'.

Sol.

$r = 824.7 \times 10^6 \text{km}$

$\theta = 35.72^4$

$\theta = \frac{35.72}{60\times60} \times \frac{\pi}{180}$ radian

Diameter l=?

l=rθ

$l = 824.7\times10^6 \times \frac{35.72}{60\times60}\frac{\pi}{180}$

$l = 1.429 \times 10^5 \text{km}$

Q24. A radar signal is beamed towards a planet from the earth and its echo is received seven minutes later. Calculate the velocity of the signal, if the distance between the planet and the earth is $6.3\text{x}10^{10}$m?

Sol.

$x = c \times \frac{1}{2}$

$$\Rightarrow c = \frac{2x}{t} = \frac{2 \times 6.3 \times 10^{10}}{7 \times 60} = 3 \times 10^8 \text{m/s}$$

Q25. Give two methods for measuring time intervals?

Sol.

1. Radioavtive dating – to know age of fossil fuels, rocks etc.
2. Atomic clocks – used to note periodic vibrations taking place within two atoms.

Q26. Find the dimensions of latent heat and specific heat?

Sol.

1. Latent Heat $= \frac{\text{Q(Heat Energy)}}{\text{m(mass)}}$

   Latent Heat $= \frac{ML^2T^{-2}}{M} = [M^0L^2T^{-2}]$

2. Specific Heat $= (S) = \frac{Q}{m \times Q} \frac{ML^2T^{-2}}{M \times K}$

$$= (s) = [M^0L^2T^{-2}K^{-1}]$$

Q27. In wander waal's equation $\left(\frac{P+a}{V^2}\right)(V - b = RT)$

Sol.

$P = \frac{a}{v_2} \Rightarrow a = PV^2$

$a = \frac{F}{A} \times V^2$

$a = \frac{MLT^{-2}}{L^2} \times [L^3]^2$

$a = \frac{MLT^{-2}L^6}{L^2}$

$a = [ML^5t^{-2}]$

Also b=v

$V = [M^OL^3T^0]$

Q28. E, m, l and G denote energy, mass, angular momentum and gravitational constant respectively. Determine the dimensions of EL^2 / m^5G^2

Sol.

$E = [ML^2T^-]$

$L = [ML^2T^-]$

$m = [M]$

G= $[M^{-1}L^3T^{-2}]$

∴ Dimensions of EL^2/m^5G^2 = $\frac{[ML^2T^{-2}][ML^2T^{-1}]^2}{[M]^5[M^{-1}L^3T^{-2}]^2}$

$= \frac{M^3L^6T^{-4}}{M^3L^6T^{-4}} = 1$

Thus, it is dimension less

Q29. (a) State which of the following are dimensionally current

(i) Pressure = Energy per unit volume

(ii) Pressure = Momentum ��volume ��time

(b) The density of cylindrical rod was measured by the formula:- $P = \frac{4m}{\pi D^2 1}$

The percentage in m, D and l are 1%, 1.5% and 0.5%. Calculate the % error in the calculated value of density?

Sol.

(a) (i) Pressure = F/A = $\frac{MLT^{-2}}{L^2} = [ML^{-1}T^{-2}]$

$[ML^{-1}T^{-2}] = \frac{ML^2T^2}{L^3}$

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

Hence it is dimensionally correct

(ii) Pressure = Momentum ×volume × time

$[ML^{-1}T^{-2}] = [M][LT^{-1}]\times[L^3]\times[T]$

$[ML^{-1}T^{-2}] = [ML^4T^0]$

Hence, it is not correct

(b) $\rho = \frac{4m}{\pi D^2 l}$

$\frac{\Delta\rho}{P} = \frac{\Delta m}{m} + 2\frac{\Delta D}{D} + \frac{\Delta 1}{1}$

$\frac{\Delta P}{P}\% = 1\% + 2\times(1.5)\% + 0.5\%$

$\%\frac{\Delta l}{l} = 4.5\%$

$\Rightarrow \frac{\Delta P}{P}\% = 4.5\%$