INDIAN SCHOOL AL WADI AL KABIR		
Class: XI	**Department: Science 2022 – 23** **Subject: Physics**	**Date of submission:** **11.09.2022**
Worksheet No:03 **With Answers**	**Topic: UNITS AND MEASUREMENT**	**Note:** **A4 FILE FORMAT**
CLASS/SEC.:	**NAME OF THE STUDENT:**	**ROLL NO.:**

OBJECTIVE TYPE QUESTIONS

1) A force F is given by $F = at + bt^2$, where t is time. What are the dimensions of a and b?
(a) $[MLT^{-1}]$ and $[MLT^0]$
(b) $[MLT^{-3}]$ and $[ML^2T^4]$
(c) $[MLT^{-4}]$ and $[MLT^1]$
(d) $[MLT^{-3}]$ and $[MLT^{-4}]$

2) In a system of units if force (F), acceleration (A) and time (T) are taken as fundamentals units then the dimensional formula of energy is
(a) $[FA^2T]$
(b) $[FAT^2]$
(c) $[FA^2T]$
(d) $[FAT]$

3) The acceleration due to gravity is $9.80\ m/s^2$. What is its value in ft/s^2
(a) $32.4\ ft/s^2$
(b) $28.4\ ft/s^2$
(c) $20.4\ ft/s^2$
(d) $3.24\ ft/s^2$

4) The dimensional representation of Planck’s constant is same as that of: [TIFR 2014]
(a) Angular momentum
(b) Momentum
(c) Torque
(d) Energy

5) Which of the following pairs of physical quantities does not have same dimensional formula?
(a) Work and torque.
(b) Angular momentum and Planck’s constant.

(c) Tension and surface tension.
(d) Impulse and linear momentum.

6) rad / s is the unit of
(a) Angular displacement
(b) Angular velocity
(c) Angular acceleration
(d) Angular momentum

7) On the basis of dimensions, decide which of the following relations for the displacement of a particle undergoing simple harmonic motion is not correct:
(a) $y = a \sin (2\pi t/T)$
(b) $y = a \sin vt$.
(c) $y = (a/T) \sin (t/a)$
(d) $y = a\sqrt{2} [\sin(2\pi t/T) – \cos(2\pi t/T)]$

8) The displacement of particle moving along x-axis with respect to time is $x=at+bt^2 -ct^3$ .The dimension of c is
(a) $[LT^{-2}]$
(b) $[T^{-3}]$
(c) $[LT^{-3}]$
(d) $[T^{-3}]$

9) The dimensional formula $[ML^2T^{-2}]$ represents
(a) momentum
(b) energy
(c) acceleration
(d) force.

10) If the units of length and force are increased four times, then the unit of energy will
(a) increase 8 times
(b) increase 16 times
(c) decreases 16 times
(d) increase 4 times

SHORT ANSWER QUESTIONS

11) Give an example of
(a) a physical quantity which has a unit but no dimensions.
(b) a physical quantity which has neither unit nor dimensions.
(c) a constant which has a unit.
(d) a constant which has no unit.

12) The velocity of a particle is given in terms of time t by the equation $v = at + b/(t + c)$. What are the dimensions of a, b and c?

13) Write the S.I & C.G.S units of the following physical quantities- (a) Force (b) Work

14) What are the uses of dimensions?

15) Explain different types of system of units.

16) Write the dimensional formula of the following physical quantity - (i) Momentum (ii) Power (iii) Surface Tension (iv) Strain

LONG ANSWER QUESTIONS

17) The centripetal force F acting on a particle moving uniformly in a circle may depend upon mass (m), velocity (v), and radius (r) of the circle. Derive the formula for F using the method of dimensions. **(JEE MAIN)**

18) Check the accuracy of the following relations:
(i) $E = mgh + \frac{1}{2} mv^2$
(ii) $v^3 - u^2 = 2as^2$

19) Using Principle of Homogeneity of dimensions, check the correctness of equation, $h = 2Td / rgCos\theta$, where h is height, T is surface tension, d is density, r is radius and g is acceleration due to gravity.

20) In the gas equation $(P + a/V^2)(V - b) = RT$, where T is the absolute temperature, P is pressure and V is volume of gas. What are dimensions of a and b?

21) Check the correctness of the following formulae by dimensional analysis.
(i) $F = mv^2/r$
(ii) $t = 2\pi\sqrt{l/g}$
Where all the letters have their usual meanings.

22) Check the correctness of the relation λ = h /mv; where λ is wavelength, h- Planck's constant, m is mass of the particle and v - velocity of the particle.

23) The volume of a liquid flowing out per second of a pipe of length l and radius r is written by a student as

$$v = \frac{\pi}{8}\frac{\mathrm{Pr}^4}{\eta l}$$

where P is the pressure difference between the two ends of the pipe and η is coefficient of viscosity of the liquid having dimensional formula $[ML^{-1}T^{-1}]$. Check whether the equation is dimensionally correct.

24) In the expression $P = El^2m^{-5}G^{-2}$, E, m, l and G denote energy, mass, angular momentum and gravitational constant, respectively. Show that P is a dimensionless quantity.

Q. NO.	ANSWERS
1	$[MLT^{-3}]$ and $[MLT^{-4}]$
2	$[FAT^{2}]$
3	32.4 ft/s^2
4	Angular momentum
5	Impulse and linear momentum.
6	Angular velocity
7	y = a sin vt. y = (a/T) sin (t/a)
8	$[LT^{-3}]$
9	energy
10	increase 16 times
11	a) Angle b) Strain, relative density etc. c) Gravitational constant, Plank's constant d) Avogadro number
12	v = at + b/(t + c) Two entities can only be added if their dimensions are same $\Rightarrow$ [c]=[T] $[at]=[v]=[LT^{-1}]$ $\Rightarrow [a]=[T][LT-1]=[LT^{-2}]$ $[T][b]=[LT^{-1}]$ $\Rightarrow$[b]=[L]
13	S.I unit of force:- Newton (Kg. m /s2) CGS unit of force:- Dyne (g. cm /s2) S.I unit of work:- Joule (N-m) or Newton-meter. CGS unit of work:- Erg (dyne-cm) or Dyne-centimetre
14	Uses of dimensional analysis To check the correctness of a physical relation To convert the value of a physical quantity from one system to another. To derive relation between various physical quantities.
15	Explain the following in detail: Fundamental units: MKS, CGS and FPS system Derived units Supplementary units
16	Momentum = mass × velocity = $[MLT^{-1}]$ Power = work/time = $[ML^{2} T^{-3}]$ Surface tension = Force/length = $[ML^{0}T^{-2}]$

	Strain = (ratio) = dimensionless
17	Let $F=k(m)^x(v)^y(r)^z$ Here, k is a dimensionless constant of proportionality. Writing the dimensions of RHS and LHS in Eq. (i), we have $[MLT^2]=[M]^x[LT^{-1}]^y[L]^z = [M^xL^{y+z}T^{-y}]$ Equation the powers of M, L and T of both sides, we have, x=1,y=2 and y+z=1 or z=1−y=−1 Putting the values in Eq. (i), we get $F=kmv^2r^{-1}=kmv^2/r$ $F=mv^2/r$ (where k=1)
18	i) $E = mgh + ½ mv^2$ Here, dimensions of the term on L.H.S. Energy, $E = [M^1L^2T^{-2}]$ Dimensions of the terms on R.H.S, Dimensions of the term, $mgh = [M] \times [LT^{-2}] \times [L] = [M^1L^2T^{-2}]$ Dimensions of the term, $½ mv^2 = [M] \times [LT^{-1}]^2 = [M^1L^2T^{-2}]$ Thus, dimensions of all the terms on both sides of the relation are the same, therefore, the relation is dimensionally correct. (ii) The given relation is, $v^3 - u^2 = 2as^2$ Dimensions of the terms on L.H.S $v^3 = [LT^{-1}]^3 = [M^0L^3T^{-3}]$ $u^2 = [LT^{-1}]^2 = [M^0L^2T^{-2}]$ Dimensions of the terms on R.H.S $2as^2 = [LT^{-2}] \times [L]^2 = [M^0L^3T^{-2}]$ The dimensions of all the terms on both sides are not same; therefore, the relation is dimensionally not correct.
19	The given formula is, $h = 2Td/rgCos\theta$. Dimensions of term on L.H.S Height (h) = $[L^1]$ Dimensions of terms on R.H.S T= surface tension = $[M^1L^0T^{-2}]$ D= density = $[M^1L^{-3}T^0]$ r =radius = $[L^1]$ g = $[L^1T^{-2}]$ $Cos\theta$ = no dimensions So, Dimensions of $2Td/rgCos\theta = [M^1L^0T^{-2}] x [M^1L^{-3}T^0] / [L^1] x [L^1T^{-2}] = [M^2L^{-5}T^0]$ Dimensions of terms on L.H.S are not equal to dimensions on R.H.S. Hence, formula is dimensionally not correct.
20	Like quantities are added or subtracted from each other i.e., $(P + a/V^2)$ has dimensions of pressure = $[ML^{-1}T^{-2}]$ Hence, a/V^2 will be dimensions of pressure = $[ML^{-1}T^{-2}]$

	a = $[ML^{-1}T^{-2}]$ [volume]^2= $[ML^{-1}T^{-2}]$ $[L^3]^2$ a = $[ML^{-1}T^{-2}]$ $[L^6]$= $[ML^5T^{-2}]$ Dimensions of a = $[ML^5T^{-2}]$ (V – b) have dimensions of volume i.e., b will have dimensions of volume i.e., $[L^3]$
21	$\boldsymbol{F} = \boldsymbol{mv}^2/\mathbf{r}$ Dimensions of the term on L.H.S Force, F = $[M^1L^1T^{-2}]$ Dimensions of the term on R.H.S $\boldsymbol{mv}^2/\mathbf{r}$ = $[M^1][L^1T^{-1}]^2 / [L]$ =$[M^1L^1T^{-2}]$ The dimensions of the term on the L.H.S are equal to the dimensions of the term on R.H.S. Therefore, the relation is dimensionally correct. $\boldsymbol{t} = \boldsymbol{2\pi}\sqrt{\boldsymbol{l}/\boldsymbol{g}}$ Here, Dimensions of L.H.S, t = $[T^1]$ = $[M^0L^0T^1]$ Dimensions of the terms on R.H.S Dimensions of (length) = $[L^1]$ Dimensions of g = $[L^1T^{-2}]$ 2π being constant have no dimensions. Hence, the dimensions of terms $2\pi\sqrt{l/g}$ on R.H.S = $([L^1] / [L^1T^{-2}])^{1/2}$ = $[[T^1]$ = $[M^0L^0T^1]$ Thus, the dimensions of the terms on both sides of the relation are the same Therefore, the relation is dimensionally correct.
22	λ = h/mv Where: h = Planck's constant m = mass v = Velocity λ = wavelength [λ] = [L] [h] = [angular momentum] = [L][linear momentum] = [L][M][velocity] =[L][M][L/T] [v]=[L/T] So we now have [L] = [L][M][velocity] / ([M][velocity]) which simplifies to [L] = [L] which means the equation is dimensionally correct
23	Dimension V= Volume per second =V/T=$[L^3T^{-1}]$ Dimension of P=F/A= $[MLT^{-2}]/[L^2]$=$[ML^{-1}T^{-2}]$ Dimension of r=[L] Dimension of η=$[ML^{-1}T^{-1}]$ Dimension of l=[L] ∴ Dimension of R.H.S. =$[ML^{-1}T^{-2}][L^4] / ([ML^{-1}T^{-1}][L])$=$[M^0L^3T^{-1}]$ Dimension of L.H.S. V=$[M^0L^3T^{-1}]$ As dimensions of both sides are equal. Therefore, the equation is

	dimensionally correct.
24	Expression is $P = El^2 m^{-5} G^{-2}$ where E is energy $[E]=[ML^2T^{-2}]$, m is mass $[m]=[M]$ l is angular momentum $[L]=[ML^2T^{-1}]$, G is gravitational constant $[G]=[M^{-1}L^3T^{-2}]$ Substituting dimensions of each physical quantity in the given expression, $[P]= [ML^2T^{-2}] [ML^2T^{-1}]^2[M]^{-5}[M^{-1}L^3T^{-2}]^{-2}$ $=[M^{1+2-5+2}L^{2+4-6} T^{-2-2+4}]$ $= [M^0L^0T^0]$ This shows that P is a dimensionless quantity.

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