Test / Exam Name: Units And Measurements Standard: 11th Science Subject: Physics

Instructions

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Q1. Answer the following: **2 Marks**

A screw gauge has a pitch of 1.0mm and 200 divisions on the circular scale. Do you think it is possible to increase the accuracy of the screw gauge arbitrarily by increasing the number of divisions on the circular scale ?

Ans: It is not possible to increase the accuracy of a screw gauge by increasing the number of divisions of the circular scale. Increasing the number divisions of the circular scale will increase its accuracy to a certain extent only.

Q2. Is nuclear mass density dependent on the mass number? $(\text{Given : } r = r_0 A^{\frac{1}{3}})$ **2 Marks**

Ans: No, since density $= \frac{\text{Mass}}{\text{Volume}} = \frac{A}{\frac{4}{3}\pi r^3} = \frac{A}{\frac{4}{3}\pi r_0^3 A}$ is independent of A.

Q3. The resistance R is the ratio of potential difference V and current I. What is the percentage error in R if V is $(100 \pm 5)\text{V}$ and I is (10 ± 2) A? **2 Marks**

Ans: $\frac{\Delta R}{R} \times 100 = \pm\left[\frac{\Delta V}{V} + \frac{\Delta I}{\Delta I}\right] \times 100$

$= \pm\left[\frac{5}{100} + \frac{0.2}{10}\right] \times 100 = \pm 7\%$

Q4. Answer the following: **2 Marks**

You are given a thread and a metre scale. How will you estimate the diameter of the thread?

Ans: Wrap the thread on a uniform smooth rod in such a way that the coils thus formed are very close to each other. Measure the length of the thread using a meter scale. The diameter of the thread is given by the relation.

Q5. If force F, length L and time T are taken as fundamental units then what be the dimensions of mass? **2 Marks**

Ans: Suppose dimensions of mass M be $[F^aL^bT^c]$. Then,

We have:

$[M] = [MLT^{-2}]^a[L]^b[T]^c$

$= M^aL^{a+b}T^{-2a+c}$

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

$b = -a = -1 = 2a = 2$

Hence, dimensions of mass M are $[F^1L^{-1}T^2]$

Q6. The time of oscillation (t) of a small drop of liquid under surface tension depends upon the density ρ, radius r and surface tension σ. **2 Marks**

Prove dimensionally that to:

$t \propto \sqrt{\frac{\rho r^3}{\sigma}}$.

Ans: Time of oscillation,

$t \propto \rho^a r^b \sigma^c$

$t = k\rho^a r^b \sigma^c$, Where k = constant

Writing dimensions of both the sides, we have,

$[T] = [ML^{-3}]^a[L]^b[ML^2]^c$

$[M^{a+c}L^{-3a+b}T^{-2c}]$

Comparing the powers of M, L and T on both sides,

We have,

$a + c = 0 \ldots (i)$

$-3a + b = 0 \ldots (ii)$

$-2c = 1 \ldots (iii)$

$a = \frac{1}{2}, c = -\frac{1}{2}$ and $b = \frac{3}{2}$

Putting these values in,

$t = k\rho^a r^b \sigma^c$

We get $t = k\rho^{\frac{1}{2}} r^{\frac{3}{2}} \sigma^{\frac{-1}{2}}$

OR $t \propto \sqrt{\frac{\rho r^3}{\sigma}}$.

Q7. Write the order of following: **2 Marks**

1. Mass of a housefly.
2. Mass of average man.
3. Mass of an electron.
4. Mass of earth.

Ans: 1. 1×10^{-4}kg

2. 7×10^{1}kg
3. 9.1×10^{-31}kg
4. 6×10^{24}kg

Q8. A student measures the thickness of a human hair by looking at it through a microscope of magnification 100. He makes 20 observations and finds that the average width of the hair in the field of view of the microscope is 3.5mm. What is the estimate on the thickness of hair? **2 Marks**

Ans: Magnification of the microscope = 100

Average width of the hair in the field of view of the microscope = 3.5mm

∴ Actual thickness of the hair is 3.5/100 = 0.035mm

Q9. Moon is seen to be of $\left(\frac{1}{2}\right)^\circ$ diameter from the earth. What must be the relative size compared to the earth? **2 Marks**

Ans: According to the problem, moon is seen as $\left(\frac{1}{2}\right)^\circ$ diameter from earth and earth is seen as 2° diameter from moon.

As θ is proportional to diameter,

Hence, $\frac{\text{Diameter of earth}}{\text{Diameter of moon}} = \frac{2}{\left(\frac{1}{2}\right)} = 4$

Q10. What is common between bar and torr? **2 Marks**

Ans: Both bar and torr are the units of pressure.

1 bar = 1 atmospheric pressure

= 760 mm of Hg column

= 10^5N/ m^2

1 torr = 1 mm of Hg column

∴ 1 bar = 760 torr

Q11. Name the device used for measuring the mass of atoms and molecules. **2 Marks**

Ans: Deflection of a charge particle or ionized atom or molecule depends on the magnitude of either magnetic or electric field. Mass and Charge of a particle by using this principle can be measured by using spectrograph or spectrometer which measures the mass of atoms and molecules.

Q12. The length and breadth of a rectangle are measured as $(a \pm \Delta a)$ and $(b \pm \Delta b)$ respectively. Find: **2 Marks**

1. Relative error.
2. Absolute error in the measurement of area.

Ans: Length $(l) = a \pm \Delta a$

Breadth $(b) = (b \pm \Delta b)$

Area (A) = ab

Relative error $\pm\frac{\Delta A}{A} = \pm\frac{\Delta a}{a} \pm \frac{\Delta b}{b}$

Absolute error $\pm\Delta A = \pm\left|\frac{\Delta a}{a} + \frac{\Delta b}{b}\right| ab$

$\Rightarrow \pm\Delta A = [(\Delta a)b + (\Delta b)a]$

Q13. If x = a + bt + ct^2, where x is in metre and t in second, what are the units of a, b and c? **2 Marks**

Ans: As x = a + bt + ct^2, where x is in metre and t in second. Hence, in accordance with the principle of homogeneity of dimensions,

We have:

Unit of a = x = metre

Unit of b = unit of $\frac{x}{t} = m/s$

Unit of c = $\frac{x}{t^2} = m/(s)^2$

Q14. Check the correctness of the relation v^2 - u^2 = 2as by method of dimensions. The symbol have their usual meaning. **2 Marks**

Ans: The relation is given us $v^2 - u^2 = 2as$

On LHS Dimension of $v^2 = [L^2T^{-2}]$

And $u^2 = [LT^{-1}] = [L^2T^{-2}]$

RHS $2as = [LT^{-2}][L] = [L^2T^{-2}]$

As dimensions of both terms on LHS are equal to the dimensions of RHS, the relation is dimensionally correct.

Q15. Check whether equation $F.S = \frac{1}{2}mv^2 - \frac{1}{2}mu^2$ is dimensionally correct, where m is mass of the body, v its final velocity, u its initial velocity, F is force applied and S is the distance moved. **2 Marks**

Ans: $F.S = \frac{1}{2}mv^2 - \frac{1}{2}mu^2$

$L.H.S = [ML^2T^{-2}]$

$R.H.S = \frac{1}{2}[M][LT^{-1}]^2 - \frac{1}{2}[M][LT^{-1}]$

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

$L.H.S = R.H.S$

Which is dimensionally correct.

Q16. If x = at + bt, where x is in metre and t in hour, what will be the unit of 'a' and 'b'? **2 Marks**

Ans: x = at + bt^2

So, the units of $a = \frac{x}{t} = m/\ hr$

And $b = \frac{x}{t^2} = m/(hr)^2$

Q17. The radius of atom is of the order of 2Å and radius of a nucleus is of the order of fermi. How many magnitudes higher is the volume of atom as compared to the volume of nucleus? **2 Marks**

Ans: R_A, i.e. radius of atom is $2\text{Å} = 2 \times 10^{-10} m$

R_N, i.e. radius of nucleas is 1 fermi $= 10^{-15} m$

$\frac{V_A}{V_N} = \frac{\frac{4}{3}\pi R^3 A}{\frac{4}{3}\pi R^3 N} = \left[\frac{R_A}{R_N}\right]^3$

$= \left[\frac{2\times10^{-10}}{10^{-15}}\right] = 8 \times 10^{15}$

Q18. Percentage error in the measurement of height and radius of cylinder are x and y respectively. Find percentage error in the measurement of volume. Which of the two measurements height or radius need more attention? **2 Marks**

Ans: Height of cylinder $= x$

Radius of cylinder$= y$

Volume of cylinder $v = \pi y^2 x$

Percentage error in measurement of volime

$\frac{\Delta V}{V} \times 100 = \pm\left(2\frac{\Delta y}{y} + \frac{\Delta x}{x}\right) \times 100$

Hence, radius needs more attention because any error in its measurement is multiplied two times.

Q19. The mean value of period of oscillation of a simple pendulum in an experiment is 2.62s. The arithmetic mean of all the absolute errors is 0.11s. Round off the period of simple pendulum to appropriate number of significant figures with reasons. **2 Marks**

Ans: $\mathrm{T} = 2.62 \text{ sec}. \overline{\mathrm{T}} = 0.11 \text{ sec}$

$\Rightarrow \mathrm{T} = 2.62 \pm 0.11 \text{ sec}$

Error is 0.11, which is $\frac{1}{10}\mathrm{th}$

Hence T = 2.6 seconds

uncertain digit is the '6'.

So, with significance figures we write

T = 2.6 seconds.

Q20. It is claimed that two cesium clocks, if allowed to run for 100 years, free from any disturbance, may differ by only about 0.02s. **2 Marks**

What does this imply for the accuracy of the standard cesium clock in measuring a time-interval of 1s?

Ans: Error in 100 years = 0.02s

Error in 1 sec $= \frac{0.02\mathrm{s}}{100 \times 365\frac{1}{4} \times 24 \times 60 \times 60} = \frac{2 \times 10^{-2} \times 4}{1461 \times 24 \times 36 \times 10^{4}}$

$7.9 \times 10^{-13}\mathrm{s} \approx 10^{-12}\mathrm{s}.$

Hence, the accuracy of a standard caesium clock in measuring a time interval of 1s is 10^{-12}s.

Q21. Find the value of one light year in giga metre. **2 Marks**

Ans: We know that:

$1 \text{ ly} = 9.46 \times 10^{15}\mathrm{m}$

$1 \text{ Gm} = 10^{9}\mathrm{m}$

$\therefore 1 \text{ ly} = \frac{9.46 \times 10^{15}}{10^{9}}$

$= 9.46 \times 10^{6}\mathrm{Gm}$

Q22. If velocity of sound in a gas depends on its elasticity and density, derive the relation for the velocity of sound in a medium by the method of dimensions. **2 Marks**

Ans: If u be the velocity of sound, E the elasticity of the medium and ρ the density of the medium,

Then:

$\mathrm{v} \propto \mathrm{E}^{\mathrm{a}}\rho^{\mathrm{b}} \text{ or } v\mathrm{k}\, \mathrm{E}^{\mathrm{a}}\rho^{\mathrm{b}} \ldots (\mathrm{i})$

Where k is a dimensionless constant of proportionality. Writing down the dimensions of both sides of equation (i),

We get:

$[\mathrm{M}^{0}\mathrm{LT}^{-1}] = [\mathrm{ML}^{-1}\mathrm{T}^{-2}]^{\mathrm{a}}[\mathrm{ML}^{-3}]^{\mathrm{b}}$

$[\mathrm{M}^{0}\mathrm{LT}^{-1}] = [\mathrm{M}^{\mathrm{a}+\mathrm{b}}\mathrm{L}^{-a-3\mathrm{b}}\mathrm{T}^{-2\mathrm{a}}]$

Comparing powers of M, L and T, We get

$\mathrm{a} + \mathrm{b} = 0$

$-\mathrm{a} - 3\mathrm{b} = 1$

$-2\mathrm{a} = -1 \text{ or } \mathrm{a} = \frac{1}{2}$

$\therefore \frac{1}{2} + \mathrm{b} = 0 \text{ or } \mathrm{b} = \frac{-1}{2}$

From equations. (i) $\mathrm{v} = \mathrm{k}\, \mathrm{E}^{\frac{1}{2}}\rho^{\frac{-1}{2}}$

Or $\mathrm{v} = \mathrm{k}\sqrt{\frac{\mathrm{E}}{\rho}}$

Where the value of k can be determined experimentally.

Q23. The distance of a galaxy is of the order of 10^{25}m. Calculate the order of magnitude of time taken by light to reach us from the galaxy. **2 Marks**

Ans: According to the problem, distance of the galaxy = 10^{25}m.

Speed of light = 3 x 10^{8}m/s

Hence, time taken by light to reach us from galaxy is,

$\mathrm{t} = \frac{\text{Distance}}{\text{Speed}} = \frac{10^{25}\mathrm{m}}{3 \times 10^{8}\mathrm{m/s}} = \frac{1}{3} \times 10^{17}$

$= \frac{10}{3} \times 10^{16} = 3.33 \times 10^{16}\mathrm{s}$

Q24. Find the height of a rock mountain, if the angle of elevation of its top increases from 30° to 45° on moving 100m towards the rock in the horizontal direction through the base of the rock. **2 Marks**

Ans: $\text{In } \Delta\mathrm{ABC}, \frac{\mathrm{h}}{\mathrm{x}} = \tan 45^{\circ} \Rightarrow \mathrm{h} = \mathrm{x}$

$\text{In } \Delta\mathrm{ABC}, \frac{\mathrm{h}}{100+\mathrm{x}} = \tan 30^{\circ}$

$\frac{h}{100+h} = \frac{1}{\sqrt{3}}$
$\sqrt{3}h = 100 + h$
$h = \frac{100}{\sqrt{3}-1}$
$= 50(\sqrt{3}+1) = 136.5m$

Q25. Using the principle of homogeneity of dimensions, find which of the following is correct: **2 Marks**

1. $T^2 = 4\pi^2 r^2|$
2. $T^2 = \frac{4\pi^2 r^2}{G}|$
3. $T^2 = \frac{4\pi^2 r^3}{GM}$

where T is time period, G is gravitational constant, M is mass and r is radius of orbit.

Ans: 1. $T^2 = 4\pi^2 r^2|$

Dimensionally, $M^0L^0T^2 = M^0L^2T^0|$ As LHS ≠ RHS, the formula is incorrect.

2. $T^2 = \frac{4\pi^2 r^3}{G}|$

Dimensionally, $M^0L^0T^0 = \frac{L^3}{M^{-1}L^3T^{-2}} = M^1L^0T^2|$ As LHS ≠ RHS, the formula is incorrect.

3. $T^2 = \frac{4\pi^2 r^3}{GM}|$

Dimensionally, $M^0L^0T^0 = \frac{L^3}{M^{-1}L^3T^{-2}M} = M^1L^0T^2|$ As LHS = RHS, the formula is correct.

Q26. The viscous force 'F' acting on a body of radius 'r' moving with a velocity 'v' in a medium of coefficient of viscosity $'\eta'$ is given by $F = 6\pi\eta rv$ Check the correctness of the formula. **2 Marks**

Ans: $F = 6\pi\eta rv$

$[F] = MLT^{-2} \ldots (i)$

$[r][\eta][v] = L.ML^{-1}T^{-1}LT^{-1}$

$= MLT^{-2} \ldots (ii)$

since (i) and (ii) are equal. So the equation is correct.

Q27. Distinguish between dimensional variables and dimensional constants. Give example too. **2 Marks**

Ans: Dimensional variables are those quantities which have dimensions and whose numerical value may change. Speed, velocity, acceleration etc., are dimensional variables.

Dimensional constants are quantities having dimensions but having a constant value, e.g., gravitation constant (G), Planck's constant (H), Stefan's constant (σ) etc.

Q28. Rule out or accept the following formulae for kinetic energy on the basis of dimensional arguments. **2 Marks**

1. $K = \frac{3}{16}mv^2$
2. $K = \frac{1}{2}mv^2 + ma$
3. $K = \frac{1}{2}mv^2$

Ans: Dimension of L.H.S. and R.H.S. are same in (i) and (iii).

So they are accepted.

1. $K = \frac{1}{2}mv^2 + ma$ and $\left[\frac{1}{2}mv^2\right] \neq [ma]$.

So it is wrong.

Q29. If Length, Time and Energy are fundamental units, find the dimension of mass. **2 Marks**

Ans: $K.E. = E = \frac{1}{2}mv^2$

$[M] = \left[\frac{E}{V^2}\right] = [EL^{-2}T^{+2}]$

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

Q30. If $A = (12.0 \pm 0.1)cm$ and $B = (8.5 \pm 0.5)cm$, find: **2 Marks**

1. $A + B$
2. $A - B$

Ans: 1. $A + B = 20.5 \pm 0.6cm$

2. $A - B = 3.5 \pm 0.6cm$

Q31. Write down the number of significant figures in the following: **2 Marks**

1. 5238N
2. 4200kg
3. 34.000m
4. 0.02340N/ m

Ans: 1. 5238N has four significant digits.

2. 4200kg = 4.200 × 10^3kg has four significant figures.
3. 34.000m has five significant digits.
4. 0.02340N/ m has four significant digits.

Q32. If displacement of a body is $\mathrm{S} = (200 \pm 0.5)\mathrm{m}$ and time taken by it is $\mathrm{t} = (20 \pm 0.2)\mathrm{s}$, then find the percentage error in the calculation of velocity. **2 Marks**

Ans: Here, $\mathrm{S} = 200\mathrm{m}$

$\Delta\mathrm{S} = 10.5\mathrm{m},$

$\mathrm{t} = 20\mathrm{s},$

$\Delta\mathrm{t} = 10.2\mathrm{s}$

As, velocity $\mathrm{v} = \frac{\mathrm{s}}{\mathrm{t}}$

∴ Percentage error in velocity

$\frac{\Delta\mathrm{v}}{\mathrm{v}} = \left[\frac{\Delta\mathrm{S}}{\mathrm{S}} + \frac{\Delta\mathrm{t}}{\mathrm{t}}\right] \times 100\%$

$= \left[\frac{0.5}{200} + \frac{0.2}{20}\right] \times 100\% = 1.25\%$

Q33. The vernier scale of a travelling microscope has 50 divisions which coincide with 49 main scale divisions. If each main scale division is 0.5mm, calculate the minimum inaccuracy in the measurement of distance. **2 Marks**

Ans: Here, parts on Vernier scale = n = 50 parts

No. of division of M.S. coinciding with n parts of V.S. = (n - 1)

∴ L.C. of instrument $= \frac{\text{L.C. of Mainscale}}{\text{No. of parts on V.S.}} = \frac{0.5\text{mm}}{50}$

Or minimum inaccuracy = 0.01mm.

Q34. Which of the following length measurement is most accurate and why? **2 Marks**

1. 4.00cm.
2. 0.004mm.
3. 40.00cm.

Ans: 1. $\frac{\Delta\mathrm{x}}{\mathrm{x}} = \frac{0.01}{4.00} = 0.0025$

2. $\frac{\Delta\mathrm{x}}{\mathrm{x}} = \frac{0.001}{0.004} = 0.25$
3. $\frac{\Delta\mathrm{x}}{\mathrm{x}} = \frac{0.01}{40.00} = 0.00025$

The last observation has the least fractional error and hence, it is more accurate.

Q35. If the length and time period of an oscillating pendulum have errors of 1% and 2% respectively, what is the error in the estimate of g? **2 Marks**

Ans: We Know:

$\mathrm{T} = 2\pi\sqrt{\frac{\mathrm{l}}{\mathrm{g}}} \therefore \mathrm{g} = 4\pi 2\frac{\mathrm{l}}{\mathrm{T}^2}$

$\frac{\Delta\mathrm{g}}{\mathrm{g}} = \frac{\Delta\mathrm{l}}{\mathrm{l}} + 2\frac{\Delta\mathrm{T}}{\mathrm{T}}$

$\%\ \text{error in g } = 1 \times +2 \times 2 = 5\%$

Q36. Calculate the solid angle subtended by the periphery of an area of 1cm^2 at a point situated symmetrically at a distance of 5cm from the area. **2 Marks**

Ans: Solid angle, $\Omega = \frac{\text{Area}}{(\text{Radial distance})^2}$

$= \frac{1\text{cm}^2}{(5\text{cm})^2} = \frac{1}{25} = 4 \times 10^{-2}\ \text{steradian}$

(∵ Area = 1cm^2, distance = 5cm)

Q37. The speed of sound in a solid is given by the formula: **2 Marks**

$$v = \sqrt{\frac{E}{\rho}}$$

Where, E is coefficient of elasticity and pis density of given solid. Check the relation by method of dimensional analysis.

Ans: In the given relation dimensions of LHS terms v are $[LT^{-1}]$

Dimensional formula for E and p are $[ML^{-1}T^{-2}]$ and $[ML^{-3}]$

Dimesnsions of $\mathrm{RHS} = \sqrt{\frac{ML^{-1}T^{-1}}{ML^{-3}}}$

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

As dimensions of LHS and RHS of the equation are same Hence the equation is dimensionally correct.

Q38. Each side of a cube is 7.203m. Calculate the surface area and volume of the cube upto correct number of significant figure. **2 Marks**

Ans: Significant figure in length = 4

$\therefore$ Significant figure in surface area and volume = 4

Surface area of cube = $6(7.203)^2 m^2$

= $311.299254 = 311.3m^2$

Volume of cube = $(7.203)^3 m^3$

= $373.714754\ m^2 = 373.7m^3$

Q39. For the determination of 'g' using a simple pendulum, measurements of I and T are required. Error in the measurement of which of these will have larger effect on the value of 'g' thus obtained and why? What is done to minimize this error? **2 Marks**

Ans: Error in measurement of time period T has larger effect on the value of g.

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

Thus, time for large number ofoscillations is measured to minimise error.

Q40. The length and breadth of a rectangle are $(5.7 \pm 0.1)cm$ and $(3.4 \pm 0.2)cm$ Calculate area of the rectangle with error limits. **2 Marks**

Ans: $l = 5.7 \pm 0.1cm$

$b = 3.4 \pm 0.2cm$

$Area = lb = 5.7 \times 3.4 = 19.38cm^2 = 19.4cm^2$

$\Delta A = \left(\frac{\Delta l}{l} + \frac{\Delta b}{b}\right) \times A$

$= \left(\frac{0.1}{5.7} + \frac{0.2}{3.4}\right) \times 19.4$

$= (0.017 + 0.059) \times 19.4$

$= 1.47 \simeq 1.5$

So, $A = (19.4 \pm 1.5)cm^2$

Q41. Give the dimensional formula for surface energy, moment of inertia, angular velocity and gravitational force. **2 Marks**

Ans: Dimensional formula for:

Surface energy = $[ML^2T^{-2}]$

Moment of inertia = $[ML^2]$

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

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

Q42. The mass of a proton is 1.67×10^{-27}kg. How many protons would make 1g? **2 Marks**

Ans: Number of protons $= \frac{\text{Total mass}}{\text{mass of each proton}}$

$= \frac{10^{-3}}{1.67 \times 10^{-27}}$

$= 5.99 \times 10^{23}$

Q43. Write the order of following intervals in seconds: **2 Marks**

1. Time between two heart beats.
2. Time of earth's revolution.
3. Time of earth's rotation.
4. Human life.

Ans: 1. $1 \times 10^0 s$
2. $3 \times 10^7 s$
3. $8.6 \times 10^4 s$
4. $2 \times 10^9 s$

Q44. Out of formulae: **2 Marks**

1. $y = a \sin \frac{2\pi t}{T}$
2. $y = a \sin vt$

for the displacement y of a particle undergoing a certain periodic motion, rule out the wrong formula on dimensional grounds.
[where a = maximum displacement of the particle, v = speed of the particle, T = time period of motion.]

Ans: $\frac{2\pi t}{T}$ have dimensions $M^0L^0T^0$
$\therefore y = a$ Hence correct.
vt have dimensions $M^0L^1T^0$ not dimensionless, so it is wrong.

Q45. What is the technique used for measuring large time intervals? **2 Marks**

Ans: For measuring large time intervals, we use the technique of radioactive dating. Large time intervals are measured by studying the ratio of number of radioactive atoms decayed to the number of surviving atoms in the specimen.

Q46. How many metric tons are there in teragram? **2 Marks**

Ans: In 1 teragram = 10^2g
In 1 metric ton = 10^3kg = $10^3 \times 10^3 = 10^6$g
$\therefore$ Number of metric tons are in teragram.
$= \frac{10^{12}g}{10^6 g} = 10^6$

Q47. Answer the following: **2 Marks**

The mean diameter of a thin brass rod is to be measured by vernier callipers. Why is a set of 100 measurements of the diameter expected to yield a more reliable estimate than a set of 5 measurements only?

Ans: A set of 100 measurements is more reliable than a set of 5 measurements because random errors involved in the former are very less as compared to the latter.

Q48. The radius of a solid sphere is measured to be 11.24cm. What is the surface area of the sphere to appropriate significant figures? **2 Marks**

Ans: r = 11.24cm
Surface area $= 4\pi r^2 = 4\pi(11.24)^2$
$= 4 \times \frac{22}{7} \times (11.24)^2$
$= 1588 cm^2$

Q49. A physical quantity X is given by: **2 Marks**

$$X = \frac{P^2 Q^{\frac{3}{2}}}{R^4 S^{\frac{1}{2}}}$$

The percentage errors in P, Q, R and S are 1%, 2%, 4% and 2%. Calculate the percentage error in X.

Ans: The maximum fractional error in X is given by:
$\frac{\Delta X}{X} = \pm\left[\frac{2\Delta P}{P} + \frac{3}{2}\frac{\Delta Q}{Q} + \frac{4\Delta R}{R} + \frac{1}{2}\frac{\Delta S}{S}\right]$
$\frac{\Delta X}{X} = \pm\left[2 \times \left(\frac{1}{100}\right) + \frac{3}{2}\left(\frac{2}{100}\right) + 4 \times \left(\frac{4}{100}\right) + \frac{1}{2} \times \left(\frac{2}{100}\right)\right]$
$\frac{\Delta X}{X} = \pm\frac{2}{100} + \frac{3}{100} + \frac{16}{100} + \frac{1}{100}$
$= \pm\frac{22}{100} = \pm 0.22$
Percentage error in $X = \frac{\Delta X}{X} \times 100$
$= \pm 0.22 \times 100 = \pm 22$

Q50. Rule out or accept the following formulae for kinetic energy on the basis of dimensional arguments: **2 Marks**

1. $\frac{3}{16}mv^2$

2. $\frac{1}{2}mv^2 + ma$

Ans: $K.E = \frac{1}{2}mv^2$

Dimension of $K.E = [ML^2T^{-2}]$

Since Dimension of K.E. = Dimension of $\frac{3}{16}mv^2$ It is dimensionally corrct.

$\frac{1}{2}mv^2 + ma$

Dimensions $= [ML^2T^{-2}] + [MLT^{-2}]$

Which is dimensionally incorrect.