Physical World, Units and Measurements

1. The density of a material in SI unit is 128 kg m^{-3}. In certain units in which the unit of length is 25 cm and the unit of mass is 50 g, the numerical value of density of the material is:
2. The least count of the main scale of a screw gauge is 1 mm. The minimum number of divisions on its circular scale required to measure 5μ m diameter of a wire is:
3. In the density measurement of a cube, the mass and edge length are measured as (10.00 ± 0.10)kg and (0.10 ± 0.01) m, respectively. The error in the measurement of density is:
4. The area of a square is 5.29 cm^2. The area (in cm^2) of 7 such squares taking into account the significant figures, is:
5. A student has measured the length of a wire equal to 0.04580 m. This value of length has the number of significant figures equal to
6. The period of revolution (T) of a planet moving round the sun in a circular orbit depends upon the radius (r) of the orbit, mass (M) of the sun and the gravitation constant (G). Then T is proportional to r^a. The value of a is
7. Error in the measurement of radius of a sphere is 1%. Then maximum percentage error in the measurement of volume is
8. Position of a body with acceleration ' a ' is given by $x = ka^m t^n$, where t is time and k is numeric constant. Find the value of m.
9. The displacement of a particle moving along x-axis with respect to time t is $x = at + bt^2 - ct^3$. The dimensions of c is LT^{-x}. The value of x is
10. Subtract 0.2 J from 7.26 J and express the result with correct number of significant figures.
11. Multiply 107.88 by 0.610 and express the result with correct number of significant figures.
12. The velocity of water waves (v) may depend on their wavelength λ, the density of water ρ and the acceleration due to gravity, g. The method of dimensions gives the relation between these quantities as $v^2 = kg^x \lambda^x$. The value of x is (Here, k is a constant)
13. To determine the Young's modulus of a wire, the formula is $Y = \frac{F}{A} \times \frac{L}{\Delta L}$: where L = length, A = area of crosssection of the wire, ΔL = change in length of the wire when stretched with a force F. The conversion factor to change it from CGS to MKS system is
14. Let Q denote the charge on the plate of a capacitor of capacitance C. The dimensional formula for $\frac{Q^2}{C}$ is $[ML^x T^{-x}]$. Find the value of x.
15. If the error in the measurement of the volume of sphere is 6%, then the error (in percent) in the measurement of its surface area will be

SOLUTIONS

1. **(40)** Density of material in SI unit,

$$= \frac{128\text{kg}}{\text{m}^3}$$

Density of material in new system

$$= \frac{128(50\text{g})(20)}{(25\text{cm})^3(4)^3}$$

$$= \frac{128}{64} \times (20) = 40\,\text{Unit}$$

2. **(200)** Least count of main scale of screw gauge = 1 mm

Least count of screw gauge

$$= \frac{\text{Pitch}}{\text{Number of division on circular scale}}$$

$$5 \times 10^{-6} = \frac{10^{-3}}{\text{N}}$$

$$\Rightarrow \quad \text{N} = 200$$

3. **(0.31)** $d = \frac{M}{V} = \frac{M}{L^3} = ML^{-3}$

$$\frac{\Delta d}{d} = \frac{\Delta M}{M} + 3\frac{\Delta L}{L}$$

$$= \frac{0.10}{10.00} + 3\left(\frac{0.01}{0.10}\right) = 0.31\text{kgm}^{-3}$$

4. **(37.0)** $A = 7 \times 5.29 = 37.03\ \text{cm}^2$

The result should have three significant figures, so $A = 37.0\ \text{cm}^2$

5. **(4)** The given value of length has four significant figures 4, 5, 8 and 0.

6. **(1.5)** Take $T \propto r^a M^b G^c$ and solving we get $a = \frac{3}{2}$.

7. **(3)** $V = \frac{4}{3}\pi r^3$;

$$\frac{\Delta V}{V} \times 100 = 3\left(\frac{\Delta r}{r}\right) \times 100 = 3 \times 1\% = 3\%$$

8. **(1)** As $x = ka^m \times t^n$

$[M^0LT^0] = [LT^{-2}]^m [T]^n = [L^m T^{-2m+n}]$

$\therefore\ m = 1 \text{ and } -2m + n = 0 \Rightarrow n = 2$

9. **(3)** $x = at + bt^2 - ct^3$

$$\therefore\ ct^3 = x \Rightarrow c = \frac{x}{t^3} = \frac{[L]}{[T^3]} = [LT^{-3}]$$

10. **(7.1)** Subtraction is correct upto one place of decimal, corresponding to the least number of decimal places.

$7.26 - 0.2 = 7.06 = 7.1$ J.

11. **(65.8)** Number of significant figures in multiplication is three, corresponding to the minimum number

$107.88 \times 0.610 = 65.8068 = 65.8$

12. **(1)** $v = k\lambda^a \rho^b g^c$

$$[M^0 LT^{-1}] = L^a (ML^{-3})^b (LT^{-2})^c = M^b L^{a-3b+c} T^{-2c}$$

$\therefore\ \ b = 0;\ a - 3b + c = 1$

$-2c = -1 \Rightarrow\ c = 1/2 \qquad \therefore\ \ a = \frac{1}{2}$

$v \propto \lambda^{1/2} \rho^0 g^{1/2}$ or $v^2 \propto \lambda g$

13. **(0.1)** $Y = \frac{F}{A}.\frac{L}{\Delta L} = \frac{\text{dyne}}{\text{cm}^2} = \frac{10^{-5}\text{N}}{10^{-4}\text{m}^2} = 0.1\text{N/m}^2$

14. **(2)** We know that $\frac{Q^2}{2C}$ is energy of capacitor so it represent the dimension of energy $= [ML^2T^{-2}]$.

15. **(4)** $\frac{\Delta V}{V} = 3\frac{\Delta r}{r}$ or $6\% = 3\frac{\Delta r}{r}$ or $\frac{\Delta r}{r} = 2\%$

Now surface area $s = 4\pi r^2$ or $\log s = \log 4\pi + 2\log r$

$\therefore \quad \frac{\Delta s}{s} = 2\frac{\Delta r}{r} = 2 \times 2\% = 4\%.$