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Sub → Physics

1. a)

(i)

L.H.S

Dimension of Pressure $= \frac{F}{A} = \frac{[M^1L^1T^{-2}]}{[M^0L^2T^0]}$

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

R.H.S

Dimension of energy per unit volume $= \frac{E}{V}$

$= \frac{[M^1L^2T^{-2}]}{[M^0L^3T^0]}$

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

∴ (i) is dimensionally correct

(ii)

L.H.S

Dimension of Pressure $= [M^1L^{-1}T^{-2}]$

R.H.S

Dimension of Momentum × velocity × time

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

$= [M^{1+0+0}L^{1+1+0}T^{-1-1+1}]$

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

∴ (ii) is not dimensionally correct.

Therefore, no. (i) is dimensionally correct

~~Proven~~
ans

(b) **Ans** ⇒ M^0

Dimensional formula of radian = $[M^0 L^0 T^0]$

(c) **Soln:**

By principle of homoginity

$[F] = [Kv^2]$

$[F] = [K]\,[v^2]$

$[K] = \dfrac{[F]}{[v^2]}$

$= \dfrac{[M^1 L^1 T^{-2}]}{[M^0 L^2 T^{-2}]}$

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

$\therefore$ Dimensions of $K = [M^1 L^{-1} T^0]$

(d) Given,

mass = 5.74 g

volume = 1.2 cm^3

$\therefore$ density, $\rho = \dfrac{5.74}{1.2}$

$= \dfrac{574}{120}$

$= 4.78334$

$= 4.8\ g/cm^3$

(e) Ans>

Limitations of dimensional analysis are:-

i> Constant proportionality cannot be determined.

ii> We cannot check the ~~eq correct the~~ correctness of an equation numerically.

Qn.2>

a> Soln

Given,

$$v^2 = u^2 + 2as \quad \text{——— (1)}$$

We know,

final velocity, $[v] = [M^0 L^1 T^{-1}]$

initial velocity, $[u] = [M^0 L^1 T^{-1}]$

acceleration, $[a] = [M^0 L^1 T^{-2}]$

displacement, $[s] = [M^0 L^1 T^0]$

2 is a constant, so it is dimensionless

ie, $[2] = [M^0 L^0 T^0]$

Putting these in eqn (1), we get

$$[M^0 L^1 T^{-1}]^2 = [M^0 L^1 T^{-1}]^2 + [M^0 L^0 T^0][M^0 L^1 T^{-2}][M^0 L^1 T^0]$$

$$\Rightarrow [M^0 L^2 T^{-2}] = [M^0 L^2 T^{-2}] + [M^{0+0+0} L^{0+1+1} T^{0-2+0}]$$

$$\Rightarrow [M^0 L^2 T^{-2}] = [M^0 L^2 T^{-2}] + [M^0 L^2 T^{-2}]$$

Since, each term of $v^2 = u^2 + 2as$, is having same dimensional formula, ∴ the equation $v^2 = u^2 + 2as$ must be correct by principle of homoginity.

(b) Soln.

$$\left(P + \frac{a}{V^2}\right)(V - b) = RT$$

Since, Pressure is added with $\frac{a}{V^2}$

$\therefore$ Dimensions of pressure = Dimensions of $\frac{a}{V^2}$

$$[P] = \left[\frac{a}{V^2}\right]$$

$$[P] = \frac{[a]}{[V^2]}$$

$$[a] = [P][V^2]$$

$$= \cancel{[M^1 L^{-4} T]}\ [M^1 L^{-1} T^{-2}]\ [M^0 L^6 T^0]$$

$$= [M^1 L^5 T^{-2}]$$

Now, since b is substracted from V

$\therefore$ Dimensions of V = Dimensions of b

$$\Rightarrow [M^0 L^3 T^0] = [b]$$

Now,

$$[ab] = [M^1 L^5 T^{-2}]\ [M^0 L^3 T^0]$$

$$[ab] = [M^1 L^8 T^{-2}] \quad \underline{\text{Ans}}$$

(c)

(1) Ans> 3

(2) Ans> 3

(3) Ans> 4

(4) Ans 1

(d) Soln. Given, $A = \dfrac{a^2 b^3}{c\sqrt{d}}$ —— ①

Introducing error in A, a^2, b^3, c and $\sqrt{d}$, we get

$$\frac{\Delta A}{A} = 2\left(\frac{\Delta a}{a}\right) + 3\left(\frac{\Delta b}{b}\right) + 1\left(\frac{\Delta c}{c}\right) + \frac{1}{2}\left(\frac{\Delta d}{d}\right)$$

$$\Rightarrow \frac{\Delta A}{A}\times 100 = 2\left(\frac{\Delta a}{a}\times 100\right) + 3\left(\frac{\Delta b}{b}\times 100\right) + 1\left(\frac{\Delta c}{c}\times 100\right) + \frac{1}{2}\left(\frac{\Delta d}{d}\times 100\right)$$

$\Rightarrow$ percentage error of A $= 2\times 1\% + 3\times 3\% + 1\times 2\% + \frac{1}{2}\times 2\%$

$\Rightarrow$ percentage error of A $= 2\% + 9\% + 2\% + 1\%$

$= 14\%$ Ans

Qn.3

(a) Soln

Qn.3 >

(b) Sol:

Here,

$l_1 = 2.48\ m$

$l_2 = 2.46\ m$

$l_3 = 2.49\ m$

$l_4 = 2.50\ m.$

$l_5 = 2.52\ m$

$l_6 = 2.43\ m$

average length, $l_m = \frac{l_1+l_2+l_3+l_4+l_5+l_6}{6}$

$= \frac{14.88}{6}$

$= 2.48\ m$

absolute error

$\Delta l_1 = l_m - l_1 = 2.48 - 2.48 = 0\ m$

$\Delta l_2 = l_m - l_2 = 2.48 - 2.46 = 0.02\ m$

$\Delta l_3 = \cancel{2.48}\ l_m - l_3 = 2.48 - 2.49 = -0.01\ m$

$\Delta l_4 = l_m - l_4 = 2.48 - 2.50 = -0.02\ m$

$\Delta l_5 = l_m - l_5 = 2.48 - 2.52 = -0.04\ m$

$\Delta l_6 = l_m - l_6 = 2.48 - 2.43 = 0.05\ m$

Mean

$\overline{\Delta l}$

~~Percent~~

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Mean absolute error

$$\overline{\Delta l} = \frac{|\Delta l_1| + |\Delta l_2| + |\Delta l_3| + |\Delta l_4| + |\Delta l_5| + |\Delta l_6|}{6}$$

$$= \frac{0 + 0.02 + 0.01 + 0.02 + 0.04 + 0.05}{6}$$

$$= \frac{0.14}{6}$$

$$= 0.023\ m$$

~~Percentage~~ Result $= (l_m \pm \Delta l)$

$$= (2.48 \pm 0.023)\ m$$

Percentage error

$$\frac{\Delta l}{l_m} \times 100$$

$$= \frac{0.023}{2.48} \times 100$$

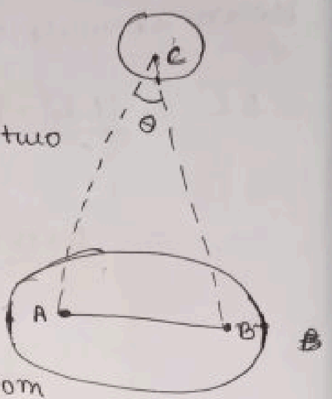
$$= 0.0093 \times 100$$

$$= 0.93\ \%$$ Ans

(C) Soln:

~~It~~ Parallactic angle is the angle formed by the lines of sight of two observatories observing an object in parallax method.

(c) Soln:



Let, A and B be the two observatories on earth ~~at a~~ apart from a ~~di~~ distance of 552 km.
Both are observing a point C on moon, from A along AC and from B along BC lines of sight

$\therefore \angle ACB = \theta = 2^\circ 36'$ is the parallax angle.

Now,

$$\theta = 2^\circ 36' = 2^\circ + 36'$$

$$= 2^\circ + \left(\frac{36}{60}\right)^\circ$$

$$= 2.6^\circ$$

$$= \left(2.6 \times \frac{\pi}{180}\right)^c$$

$$= \left(\frac{2.6 \times 3.14}{180}\right)^c$$

$$= (0.045)^c$$

arc, $AB = 552\ km = 552 \times 10^3\ m$

$$= 5.52 \times 10^5\ m$$

∵ we know,

$$\theta = \frac{arc}{radius}$$

$$radius = \frac{arc}{\theta}$$

∴ radiu

∴ distan

(d) Soln.

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∴ from (ii)

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$\therefore$ radius $= \dfrac{5.52 \times 10^5}{0.045}$

$= 122.67 \times 10^5$ m

$= 1.2267 \times 10^7$ m

$\approx 1.23 \times 10^7$ m

$\therefore$ distance of the moon from the earth

$= 1.23 \times 10^7$ m.

(d) Soln.

Given,

$T \propto p^a \rho^b E^c$ ——— (i)

$\therefore T = K p^a \rho^b E^c$ ——— (ii) where K is dimensionless constant

we know,

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

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

$[\rho] = [M^1 L^{-3} T^0]$

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

$\therefore$ from (ii), we get

$[M^0 L^0 T^{-1}] = [M^1 L^{-1} T^{-2}]^a [M^1 L^{-3} T^0]^b [M^1 L^2 T^{-2}]^c$

$[M^0 L^0 T^{-1}] = [M^a L^{-a} T^{-2a}] [M^b L^{-3b} T^0] [M^c L^{2c} T^{-2c}]$

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

Comparing a, b and c, we get

$a+b+c=0$

$a+c+b=0$

$-\frac{1}{2}+b=0$

$b=\frac{1}{2}$

$-a-3b+2c=0$

$-a+2c-\frac{3}{2}=0$

$-\frac{1-2c}{2}+\cancel{2b}\cancel{\frac{3}{2}}=$

$+2c-\frac{3}{2}=0$

$\frac{-1-2c+4c-3}{2}=0$

$+2c=4$

$c=2$

$-2a-2c=1$

$\cancel{-2a=1+2c}$

$a+c=-\frac{1}{2}$

$a=\frac{-1-2c}{2}$

$a=\frac{-1-4}{2}$

$a=\frac{-5}{2}$

$\therefore\ a=\frac{-5}{2},\ b=\frac{1}{2},\ c=2$ Ans

(a) Sol.

Let,

~~Tension~~ $\nu \propto T^{a}$ —— (i)

$\nu \propto M^{b}$ —— (ii)

$\nu \propto L^{c}$ —— (iii)

$\nu = K\, T^{a} M^{b} L^{c}$ —— (iv) where K is dimensionless constant

We know,

Frequency, $[\nu] = [M^{0} L^{0} T^{-1}]$

Tension, $[T] = [M^{1} L^{0} T^{-2}]$

Mass per unit length, $[M] = [M^{1} L^{-1} T^{0}]$

Vibrating length of string, $[L] = [M^{0} L^{1} T^{0}]$

∴ from (iv), we get

$$[M^{0}L^{0}T^{-1}] = [M^{0}L^{0}T^{0}][M^{1}L^{0}T^{-2}]^{a}[M^{1}L^{-1}T^{0}]^{b}[M^{0}L^{1}T^{0}]^{c}$$

$$[M^{0}L^{0}T^{-1}] = [M^{a+b+0}\, L^{0-b+c}\, T^{-2a+0+0}]$$

$$[M^{0}L^{0}T^{-1}] = [M^{a+b}\, L^{-b+c}\, T^{-2a}]$$

Comparing a, b and c we get

$a+b=0$

$a+b=0$

$b=-a$

$b=-\frac{1}{2}$

$-b+c=0$

$-b+c=0$

$\frac{1}{2}+c=0$

$c=-\frac{1}{2}$

$\rightarrow a=-1$

$a=\frac{1}{2}$

$\therefore \quad v = K\, T^{a} M^{b} L^{c}$

$v = K\, T^{\frac{1}{2}} M^{-\frac{1}{2}} L^{-\frac{1}{2}}$

$v = K\, T^{\frac{1}{2}} \left(\frac{1}{ML}\right)^{\frac{1}{2}}$

$v = K \sqrt{\frac{T}{LC}}$

Ans