SCIENCE SCHOLARS ACADEMY

MEASUREMENTS & DIMENSIONS OF PHYSICAL QUANTITIES!

Lesson targets

→ Clear from syllabus book. ✓

Research: → Watch Youtube videos on how the different instruments work → the ones in the NOTES.

→ [Basic Qtys]

[mass] is M ✓

[length] is L ✓

[time] is T ✓

{Bold / Italics}

m = 3kg

L = 3m

t = 3s

M L T ✓

✓✓✓

SCIENCE SCHOLARS ACADEMY

→ [Derived Quantities] ✓

↳ obtained from M, L & T.

Recap: → [mass] = M {kg} ✓

[length] = L {metres} ✓

[time] = T {seconds} ✓

(a). Area → square metres → m^2 (m → length)

[Area] = L^2 ✓

Area → = rectangle

✓ Area = length × width → [radius] = L

circle: πr^2 → [radius] = L

π → $\frac{22}{7}$ {dimensional}

ms^{-1} → [velocity] = LT^{-1} ✓

(b). (speed) ✓

[Velocity] ✓ → $\frac{[\text{displacement}]}{[\text{time}]}$ → $\frac{L}{T^1}$ → LT^{-1}

displacement → distance ✓

M, L, T

$m^3 \rightarrow L^3$ ✓

(c). [Volume] $= \frac{[\text{mass}]}{[\text{density}]}$ → ?? *

$Kgm^{-3} \rightarrow ML^{-3}$ ✓

(d). $[\text{density}] = \frac{[\text{mass}]}{[\text{volume}]} = \frac{M}{L^3} = ML^{-3}$ ✓

$9.81\,ms^{-2}$

(e). [Acceleration] → $ms^{-2} \rightarrow LT^{-2}$

$\frac{[\text{velocity}]}{[\text{time}]} = \frac{LT^{-1}}{T^1} = LT^{-2}$ ✓

(f). [Force] → Newtons {N} → $kgms^{-2}$

[mass] × [acceleration]

kg, ms^{-2}

$M \times LT^{-2} = MLT^{-2}$ ✓

SCIENCE SCHOLARS ACADEMY

(g). [Work] (Workdone) → Joules

Work = force × distance

force → ma → $kgms^{-2}$; distance → m

→ $\{kgm^2s^{-2}\}$ → ✓

$= MLT^{-2} \times L \rightarrow ML^2T^{-2}$ ✓

$V = u + at$

(1). $[V] = [U] + [a][t]$

$[V] \rightarrow ms^{-1}$ ✓ ; $[U] \rightarrow ms^{-1}$; $[a] \rightarrow ms^{-2}$; $[t] \rightarrow s$; $[a][t] \rightarrow ms^{-1}$ ✓

$$LT^{-1} = LT^{-1} + (LT^{-2})(T)$$

$$LT^{-1} = LT^{-1} + LT^{-1}$$

Since [LHS] = [RHS]

Hence dimensionally consistent. ✓

(c). $v^2 = u^2 + 2aS$

$[v]^2 = [u]^2 + [2][a][S]$

$(LT^{-1})^2 = (LT^{-1})^2 + 1(LT^{-2})(L)$

$L^2T^{-2} = L^2T^{-2} + L^2T^{-2}$

Since $[LHS] \equiv [RHS]$ hence $v^2 = u^2 + 2aS$ is dimensionally consistent.

Assignment:

P1 1997/No 1a(ii)

(2). $F = \frac{mv^2}{r}$

- F → force
- m → mass
- v → velocity
- r → radius

P1 2005/No.1(b).

(3). $\frac{V}{t} = \frac{\pi r^4 p}{8\eta l}$

- V → Volume
- t → time
- π → constant
- r → radius
- p → pressure
- l → length
- η → co-efficient of viscosity with dimensions $ML^{-1}T^{-1}$.

Exceptional trial; → $P1_{2001}$ / No. 4a(ii)

$$F = K\eta r v$$

Show that K is dimensionless

Hint: → $K = \frac{F}{\eta r v}$

→ $[K] = \frac{[F]}{[\eta][r][v]}$

→ If $[K] = 1$

Case-2

$T \propto m$, $T \propto l$ & $T \propto g$

depends

$T \propto m^x l^y g^z$

= K

$$T = k m^{x} l^{y} g^{z}$$

$$[\text{Period}] = [k][m]^{x}[l]^{y}[g]^{z}$$

$$T = 1 (M)^{x} (L)^{y} (LT^{-2})^{z}$$

$$T = (M)^{x} (L)^{y+z} (T)^{-2z}$$

Equating Powers,

for M, $x = 0$

for T, $-2z = 1 \longrightarrow z = -\frac{1}{2}$

for L, $0 = y + \left(-\frac{1}{2}\right) \longrightarrow y = \frac{1}{2}$

$$\therefore T = k m^{0} l^{\frac{1}{2}} g^{-\frac{1}{2}}$$

$$T = k(1)(\sqrt{l})\left(\frac{1}{\sqrt{g}}\right)$$

$$\boxed{T = k\sqrt{\frac{l}{g}}}$$ is the equation.

②. $T \propto a^x \rho^y \gamma^z$

$= k$ ✓

$T = k a^x \rho^y \gamma^z$

- T → Period (time)
- k → ✓
- a → radius ✓
- γ → MT^{-2}
- ρ → density

Qn: Use dimensional analysis, find x, y & z.