Date - 04/08/2021 | 1st Unit Test | Time - 1hr.

Q1→ (a) (i) Pressure = Energy per unit volume

(b) The dimensional formula of angle is and its S.I. unit is radian.

(c) ~~f = kv^2~~ Speed v ⇒ $P = kv^2$

$k = ?$

$[MLT^{-2}] = [k][LT^{-1}]^2$

$[k] = [MLT^{-2}][L^{2}T^{-2}]$

$[k] = [ML^{-1}]$

(d) $P = \frac{M}{V}$

$= \frac{5.74}{1.2}$

$= 4.78333\, g/cm^3$

∴ There are two significant figures

Density = $4.8 g/cm^3$

(e) Two limitations of dimensional formula are -

(i) The method does not give any information about the dimensionless constant k.

(ii) It fails when a physical quantity depends on more than three quantities.

Q.2 → $v^2 = u^2 + 2as$

Given,

$v^2 = u^2 + 2as$ —— (1)

We know

$v \rightarrow$ velocity $[v] = [M^0L^1T^{-1}]$

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

a → acceleration $[a] = [M^0 L^1 T^{-2}]$
s → displacement $[s] = [M^0 L^1 T^0]$
2 is a pure number, so it is dimensionless.
$[2] = [M^0 L^0 T^0]$

Putting them in eq. (1)

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

∴ Each term of $v^2 = u^2 + 2as$ is having same dimensional formula so the equation $v^2 = u^2 + 2as$ must be correct by ppl. of homoginity.

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

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

$[a] = \left[\frac{Force}{Area} \times (volume)^2\right]$

$[a] = \left[\frac{MLT^{-2} \times L^6}{L^2}\right]$

$[a] = [ML^5T^{-2}]$

(c) (i) Significant figures = 3
(ii) Significant figures = 3
(iii) Significant figures = 4
(iv) Significant figures = 1

(d) $A = \frac{a^2 b^3}{c\sqrt{d}}$

less

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

$$\% A = (2 \times 1 + 3 \times 3 + 2 \times 1 + \frac{1}{2} \times 2)$$

$$= (2 + 9 + 2)$$

$$= 13\%$$

Q3→ ① $\nu \propto l^a T^b m^c$

$$\nu = k l^a T^b m^c = k l^{-1/2} T^{1/2} m^{-1/2}$$

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

$b + c = 0 \Rightarrow a + 1/2 = 0$

$a + b = 0 \Rightarrow a = -1/2$

$-2b = -1$

$b = 1/2$

$$\nu = k\sqrt{\frac{T}{mL}}$$

$$\nu \propto \sqrt{\frac{T}{mL}}$$

(b) Average length = l_0

Here,

$l_1 = 2.48m$, $l_2 = 2.46m$, $l_3 = 2.49m$

$l_4 = 2.50m$, $l_5 = 2.52m$, $l_6 = 2.43m$

$$l_0 = \frac{l_1 + l_2 + l_3 + l_4 + l_5 + l_6}{5}$$

$$= \frac{2.48 + 2.46 + 2.49 + 2.50 + 2.52 + 2.43}{5}$$

$$= \frac{14.88}{5}$$

$$\boxed{l_0 = 2.976}$$

Absolute error

~~$|\Delta l_1| \Rightarrow (l_0 - l_1) = (2.48 - 2$~~

$|\Delta l_1| \Rightarrow (l_0 - l_1) = (2.976 - 2.48) = 0.496$

$|\Delta l_2| \Rightarrow (l_0 - l_2) = (2.976 - ~~0.516~~ 2.46) = 0.516$

$|\Delta l_3| \Rightarrow (l_0 - l_3) = (2.976 - 2.49) = 0.486$

$|\Delta l_4| \Rightarrow (l_0 - l_4) = (2.976 - 2.50) = 0.476$

$|\Delta l_5| \Rightarrow (l_0 - l_5) = (2.976 - 2.52) = 0.456$

$|\Delta l_6| \Rightarrow (l_0 - l_6) = (2.976 - 2.43) = 0.546$

$\therefore$ Percentage error = $\frac{|\Delta l_0|}{l_0} \times 100$

$$\Delta l_0 = \frac{0.496 + 0.516 + 0.486 + 0.476 + 0.456 + 0.546}{5}$$

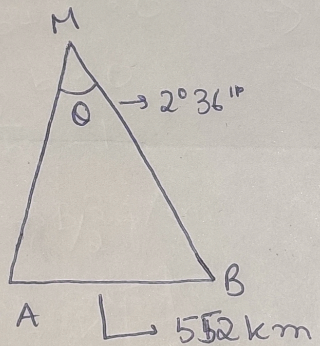
$\Delta l_0 = 0.5952$

$\frac{\Delta l_0}{l_0} \times 100$

$$\Rightarrow \frac{\Delta l_0}{l_0} \times 100 = \frac{0.5952}{2.48} \times 100$$

$$= 24\%$$

(c) The Parallactic angle is the angle made between the great circle passing through between the celestial object and zenith and the hour circle of the object.



We know that

$$\theta = \frac{b}{D}$$

$$1^\circ = 60'$$

$$60' + 36' = 96'$$

$$1' = 2.91 \times 10^{-4} \text{ rad}$$

$$96 \times 2.91 \times 10^{-4} \text{ rad}$$

$$96 \times \frac{1}{60} \times \frac{\pi}{180}$$

$$= \frac{1.6 \times \pi}{180}$$

$$= \frac{1.6 \times 22/7}{180}$$

$= 1.62 \times \frac{3.142}{180}$

$= 1.62 \times 0.01745$

$= 0.027$

$\theta = \frac{b}{D}$

$0.027 = \frac{552}{D}$

$D = \frac{552}{0.027}$

$\boxed{D = 20444.44}$

(Q) Given,

Time period T

$T \propto p^a d^b E^c$

$T = k p^a d^b E^c \longrightarrow (1)$

where k is a constant of proportionality and dimensionless quantity.

Inserting the dimensions of Time pressure, density and energy in equation (1) we get

$[T] = [ML^{-1}T^{-2}]^a [ML^{-3}]^b [ML^2T^{-2}]^c$

Equating powers of M, L, T on both sides

$0 = a + b + c \longrightarrow (2)$

$0 = -a - 3b + 2c \longrightarrow (3)$

$1 = -2a - 2c \longrightarrow (4)$

Solving (2), (3), & (4)

$a = \frac{-5}{6}, \; b = \frac{1}{2} \; \& \; c = \frac{1}{3}$