1st Unit Test
Physics

Ans 1)a) We know,

~~Pressure~~
Dimensional formula of Pressure = $[ML^{-1}T^{-2}]$

Now,
In (i) Pressure = Energy per unit volume

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

$$= [ML^{-1}T^{-2}]$$

which is dimensionally ~~equal~~ equal to pressure. Hence,

(i) Pressure = Energy per unit volume is dimensionally correct.

Ans b) We know,

$$Angle = \frac{Arc}{radius} = \frac{[L]}{[L]} = [M^0L^0T^0]$$

Hence it does not have any dimension but it has been given a S.I unit i.e radian.

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Ans c) Given;

$$F = Kv^2$$

Taking dimensions of each term. we get

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

$$\Rightarrow [K] = [ML^{-1}]$$

Ans d) Density $\rho = M/V = 5.74/1.2$
$= 4.78333 \, g/cm^3$

As volume has least two significant figures so the answers must be expressed in two significant figures.

Thus density will be $4.8 \, g cm^{-3}$.

Ans 2/a) Given equation is $v^2 = u^2 + 2as$

$$LHS = v = [v]^2 = [M^0L^1T^{-1}]^2$$
$$= [M^0L^2T^{-2}] \text{ --- (1)}$$

$RMS = u^2 + 2as$, hence

$= [u]^2 + [a][s]$ ($\because$ 2 is a pure no. so it is dimensionless)

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

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

$= [M^0 L^2 T^{-2}]$ -- (2)

From (1) and (2)

$[LHS] = [RHS]$

—x—

Ans b) Vander Wall equation is given as,

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

The dimension of a is given as,

$a = PV^2$

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

The dimension of b is given as,

$b = V = [L^3]$

Thus the dimension of $a = [ML^5 T^{-2}]$, $b = [L^3]$

Ans c) 1) $0.00206 m^2$ have 3 significant figures.

2) $1.03 g cm^{-2}$ have 3 significant figures

3) 6.023×10^{23} Kg have 4 significant figures

4) 70000 J have 1 significant figures.

Ans d) Given,

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

Maximum fractional error of in A is given by

$$\frac{\Delta A}{A} = \pm\left[3\frac{\Delta a}{a} + 2\frac{\Delta b}{b} + \frac{1\Delta c}{2c} + \frac{\Delta d}{d}\right]$$

Putting the given value:

$= \frac{13}{100} = 0.13$

∴ Percentage error on $A = 13\%$

Ans 1) e) Two limitations of dimensional analysis:-

(I) Constant proportionality cannot be determined

(II) We cannot check, wheather an equation is numerically correct.

Ans 3) a) Let the relation be:

Frequency $v = K L^a f^b m^c$

where K is a dimensionless constant
The dimension of each quantity are:

$L = [M^0 L^1 T^0]$
$f = [M^1 L^1 T^{-2}]$
$m = [M^1 L^{-1} T^0]$
$v = [M^0 L^0 T^{-1}]$

Thus now equating the dimension on both side of the equation:

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

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

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

$a = -1$

Thus the formula

$\therefore$ Frequency $= K L^{-1} F^{1/2} M^{-1/2}$

$= \frac{K}{L} F^{1/2} M^{-1/2}$

Frequency $= \frac{K}{L} \sqrt{\frac{F}{M}}$

—x—

ms b) Average length,

$$= \frac{2.48 + 2.46 + 2.49 + 2.50 + 2.52 + 2.43}{6}$$

$= 2.48\ m$

Absolute error in different measurements are:

$\Delta L_1 = 2.48 - 2.48 = 0.00\ m$

$\Delta L_2 = 2.48 - 2.46 = 0.02\ m$

$\Delta L_3 = 2.48 - 2.49 = 0.01\ m$

$\Delta L_4 = 2.48 - 2.50 = 0.02$

$\Delta L_5 = 2.48 - 2.52 = 0.04$

$\Delta L_6 = 2.48 - 2.43 = 0.05$

Mean absolute error $= \frac{\Sigma|\Delta L|}{6}$

$= \frac{0.00+0.02+0.01+0.02+0.04+0.05}{6}$

$= 0.02$

∴ Correct length $= (2.48 \pm 0.02)$

Percentage error $= \frac{0.02}{2.48} \times 100$

$= 0.8\%$

Ans d) Given, time period T

$T \propto P^a \rho^b E^c$

$T = K P^a \rho^b E^c$ — (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

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

$M^0 L^0 T^1 \propto M^{a+b+c} L^{-a-3b+2c} T^{-2a}$

comparing powers of M, L, T

$a+b+c=0$ — (i)

$-a-3b+2c=0$ — (ii)

$-2a-2c=1$ — (iii)

From (iii)

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

in (i) we get

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

putting ~~the~~ value of b

$-a-3\left(\frac{1}{2}\right)+2c=0 \Rightarrow -a+2c$ — (iv)

From (ii)

$a+c=\frac{-1}{2}$ — (v)

$-a+2c=\frac{3}{2}$ — (vi)

Adding (v) (vi)

$3c=1 \Rightarrow c=\frac{1}{3}$

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

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$$a + \frac{1}{3} = -\frac{1}{2} \Rightarrow a = -\frac{5}{6}$$

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

~~Ans c) [illegible] is the ar~~

Ans c) Parallactic angle is the angle between the two limits of sight of a distant planet ~~on~~ or a star from the two observatories from the surface of the earth.