UNITS, DIMENSIONS & VECTORS TUTORIAL.

Pg 1 — 1, 3, 7, 10, 11

Pg 2 — 16, 18, 20, 21, 23, 25

Pg 3 — 28, 35, 38

Pg 4 — 41, 44, 47, 51

Pg 5 — 4

Pg 6 — 6, 7

Pg 7 — 15, 16, (18)

Pg 9 — Comp 1.

Pg 10 — Comp 4

1) $P_{wr} = F \times s$ D) X.

$P = \frac{F}{A}$ C) X.

$\text{Stress} = \frac{F}{A}$ ✓ $\text{Strain} = \frac{\Delta L}{L}$ B) X.

A) $P = \frac{F}{A}$ $\text{Stress} = \frac{F}{A}$ ✓

3) Momentum $= mv$ ✓ A) ✓

Force $= ma$

Change in momentum $= \frac{mv}{t} = ma$.

Torque $= F \times d = mv^2$

Impulse $= F \times t = ma \times t = mv$ ✓

7)

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

$$\dim(P) = \dim\left(\frac{a}{V^2}\right)$$

$$\dim(a) = \dim(P)\dim(V^2)$$

$$= [MLT^{-2}L^{-2}][(L^3)^2]$$

$$= ML^5T^{-2}$$

(A)

(8) $y = A \sin \omega\left(\frac{x}{v} - b\right)$

$\downarrow$

$\dim(\omega) = \frac{1}{T}$

$\dim\left(\omega\left(\frac{x}{v} - b\right)\right) =$ none.

$\dim\left(\left(\frac{x}{v} - b\right)\right) = T$

$\dim(b) = T$

(10) 3.

(11) $L = 2.331$ cm $\quad B = 2.1$ cm

$L + B$

$$\begin{array}{r} 2.331 \\ 2.1 \\ \hline 4.431 \end{array}$$

$\downarrow$

4.4 cm.

(16) $MLT^{-2} = M^{-1}L^{3} \times \frac{1}{D}$

$M^{2}L^{-2}T^{-2}$

(C)

(18) $s = a + bt + ct^2$

$\dim(s) = \dim(ct^2)$

$\therefore \dim(c) = \dfrac{\dim(s)}{\dim(t^2)}$

$= \dfrac{L}{T^2}$

$= LT^{-2}$

$= ms^{-2}$ (D)

20) ~~Extra~~ Energy $= Fs\cos\theta$

$\%(\text{Energy}) = 4F \times 4s$

$= 16Fs$

(C)

(21) $f = Cm^x k^y$

$\dim(f) = \dim(m)^x \dim(k)^y$

$\dfrac{1}{T} = \left(\dfrac{M}{\cancel{\quad}}\right)^x \times \cancel{\left(\dfrac{M}{\cancel{\quad}}\right)^y} \left(MT^{-2}\right)^y$.

$K = \dfrac{F}{L}$

$0 = (M)^{x+y}$

$x + y = 0$

$T^{-1} = M^{x+y} T^{-2y}$.

$x + y = 0$

$-2y = -1$

$y = 1/2$

$x = -1/2$

(23)

$$F = -\eta A \frac{\Delta v}{\Delta z}$$

$$\dim[\eta] = \dim\left[\frac{F}{A \times \text{velocity gradient}}\right]$$

$$= \left[\frac{MLT^{-2}}{(L^2)(LT^{-1}/L)}\right]$$

$$= \left[\frac{MLT^{-2}}{L^2 T^{-1}}\right]$$

$$= [MLT^{-2} \times L^{-2} T^{1}]$$

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

(25) velocity of light $= LT^{-1} = c$

Gravitational Const $= M^{-1}L^3T^{-2} = G$

Planck's Const $= ML^2T^{-1} = h$

$$F = \frac{G M_1 M_2}{R^2}$$

$$M = c^x G^y h^z$$

$$M = (LT^{-1})^x (M^{-1}L^3T^{-2})^y (ML^2T^{-1})^z$$

$$E = \frac{hc}{\lambda}$$

$$h = \frac{E\lambda}{c}$$

$$1 = -y + z \Rightarrow 1 = -2y \Rightarrow y = -1/2$$

$$0 = -x - 2y - z \quad x = -2y - z \rightarrow x = 1/2$$

$$0 = x + 3y + 2z \rightarrow 0 = y + z \quad z = \frac{1}{2}$$

$$M = c^{1/2} G^{-1/2} h^{1/2}$$

$$= \frac{ML^2T^{-2}K}{LT^{-1}} = ML^2T^{-1}$$

(c)

(28) $\frac{1}{20} = \frac{5}{100} = 0.0500$ (A)

(35) $d = \frac{m}{V}$

$$\frac{\Delta d}{d} \times 100 = \frac{\Delta m}{m} \times 100 + \frac{\Delta V}{V} \times 100$$

$$= \frac{1}{22.42} + \frac{10}{4.7}$$

$$= \frac{228.4}{105.374}$$

$$= 2.167\ \%$$

$$= B$$

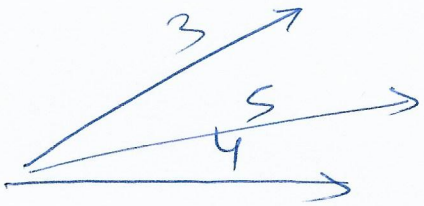
(38) $X = M^a L^{-b} T^{-c} k^d$

$$= \frac{M^a k^d}{L^b T^c}$$

$$= a\alpha\% + d\delta\% + b\beta\% + c\gamma\%$$

(C)

41)



$pi = \pi = 180^\circ$

$$5 = \sqrt{3^2+4^2+2(3)(4)\cos\theta}$$

$$25 = 25 + 24\cos\theta$$

$$\cos\theta = 0 \implies \theta = 90^\circ = \frac{\pi}{2}$$

(B)

44) $0.2\hat{i} + 0.6\hat{j} + a\hat{k}$

$$1 = \sqrt{0.2^2+0.6^2+a^2}$$

$$1 = 0.04 + 0.36 + a^2$$

$$a^2 = 0.6$$

$$a = \sqrt{0.6} \quad (C)$$

47) Least count = ~~number~~ value of 1 division on the main scale / no. of div. of Vernier Scale

$= 1\,MSD - 1\,VSD$

$= a - \frac{N}{N+1}a = \frac{a}{N+1} = \frac{a}{N+1}$ (A)

$(N+1)VSD = N\,MSD$

$1\,VSD = \frac{N}{N+1}MSD$

(5) $1\,MSD = \frac{1}{10} = 0.1$ cm.

$L.C = 0.005$ cm.

$L.C = \frac{1\ MSD.}{\text{Number of vernier scale Div.}}$

$0.005 = \frac{0.1}{x}$ $\quad x = \frac{0.1}{0.005} = 20$ div.

(B)

Pg 5

(4) $Y = 2A \sin\left(\frac{2\pi c t}{\lambda}\right) \cos\left(\frac{2\pi x}{\lambda}\right)$

A) ✓ $\dim(ct) = \dim(\lambda)$

B) ✓ $\dim(x) = \dim(\lambda)$

C) ✗

D) ✓ $\dim\left(\frac{2\pi c}{\lambda}\right) = \frac{1}{\dim(t)}$

Pg 6.

6) i) $v' = \frac{\alpha^2}{\beta} v$ $\quad$ ii) $a' = (\alpha\beta)a$

iii) $F' = \frac{1}{\alpha\beta} F$

$F' = m'a' \Rightarrow m' = \frac{F'}{a'} = \frac{F}{\alpha\beta(\alpha\beta)a} = \left(\frac{F}{a}\right)\frac{1}{\alpha^2\beta^2}$

$v' = \frac{a't'}{t'}$ $\quad t' = \frac{v'}{a'} = \frac{\alpha^2 v}{\beta \alpha\beta a} = \frac{\alpha}{\beta^2}\left(\frac{v}{a}\right)$

$m' = \frac{1}{\alpha^2\beta^2} m$ $\quad$ B) ✓

$x' = \frac{\alpha}{\beta^2} t$ $\quad$ C) ✓

$$p' = m'v'$$

$$= \frac{1}{\alpha^2\beta^2} m \cdot \frac{\alpha^2}{\beta} v$$

$$= \frac{1}{\beta^3} mv = \frac{1}{\beta^3} p$$ D) ✓

$$L' = v't' = \frac{\alpha^2}{\beta} v \cdot \frac{\alpha}{\beta^2} t$$

$$= \frac{\alpha^3}{\beta^3} vt = \frac{\alpha^3}{\beta^3} L$$ A) ✓

7) $V = a^3$

2.3×4.35 → 2 S.F.

$= 7.203 \times 7.203 \times 7.203$ → 4 S.F.

373.71475 → $373.7\ cm^3$ A)

$6a^2$

$= 6(7.203 \times 7.203) = 311.299$

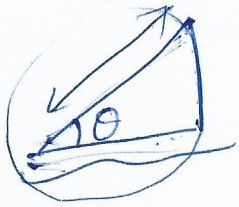
$= 311.3\ cm^2$ C) ✗

B) ✗ D) ✗

15) $r = \sqrt{6^2+8^2+2(6)(8)\cos\theta}$

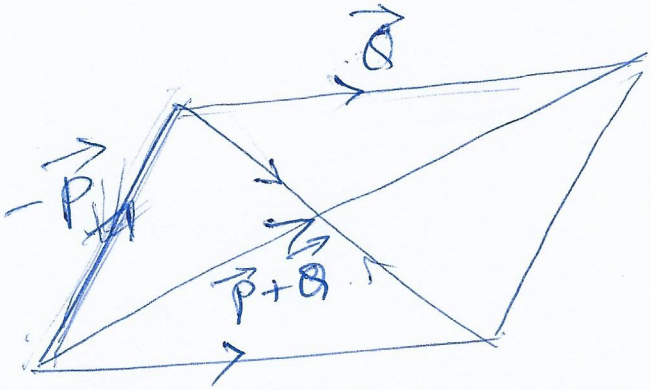
$= \sqrt{100+96\cos\theta}$

2 — 14



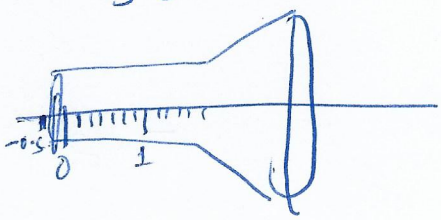
ABC) ~ (1)

16



$\vec{P}+\vec{\theta}$ $\vec{P}-\vec{\theta}$

18) $L.C = \frac{\text{pitch}}{\text{No. of CSD}} = \frac{0.5\text{ mm}}{50} = 0.01\text{ mm}$



$-0.5 + 45 \times LC$

$-0.5 + 45 \times 0.01 = -0.5 + 0.45$

$= -0.05\text{ mm}$. Zero Error

Zero correction $= +0.05\text{ mm}$.

$2 \times 0.5 + 20 \times 0.01$

$1 + 0.2 = 1.2\text{ mm}$.

Comp 1

① $E = ML^2T^{-2}$

$= \alpha\beta^2\gamma^{-2}$

$1\,cal = 4.2\,J$

$= (4.2)\,\alpha\beta^2\gamma^{-2}$

② $T = \sigma^x \rho^y \gamma^z$

$= \left[\frac{F}{L}\right]^x \left[\frac{M}{V}\right]^y L^z$

$T = \left[MT^{-2}\right]^x \left[ML^{-3}\right]^y L^z$

$1 = -2x \Rightarrow x = -1/2$

$0 = x + y \Rightarrow y = 1/2$

$0 = -3y + z \Rightarrow z = 3/2$

$T = \sigma^{-1/2} \rho^{1/2} \gamma^{3/2}$

$= \sqrt{\frac{\rho\gamma^3}{\sigma}}$ (C)

(8) $E = m^x f^y A^z$

$ML^2T^{-2} = M^x T^{-y} L^z$

$x = 1 \quad z = 2 \quad mf^2A^2$ (D)

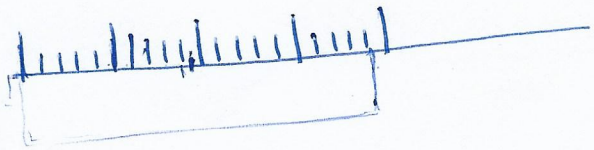
$y = 2$

Comp 4

$1\,MSD = \frac{10mm}{20} = 0.5mm.$

$L.C = \frac{1\,MSD}{N} = \frac{0.5mm}{20} = 0.025mm.$

10 VSD 9 MSD.



Zero Error $= -0.5 + 10 \times LC$

$= -0.5 + 10 \times 0.025$

$= -0.5 + 0.25$

$= -0.25.$

Zero correction $= \underline{+0.25}$ (A)

10) (C)

11) $(31)(0.5) + 4LC = 15.5 + 0.1 = 15.6mm$

Ans $= 15.6 + 0.25$

$= 15.85mm.$