UNIT # 12 (PART - II)

PRACTICAL PHYSICS

EXERCISE -I

2. $K \propto mv^2 \Rightarrow \frac{\Delta K}{K} = \frac{\Delta m}{m} + \frac{\Delta v}{v}$

% error in kinetic energy = 2 + 2(3) = 8%

3. Density $\rho = \frac{m}{v} = \frac{m}{a^3} \Rightarrow \frac{\Delta\rho}{\rho} = \frac{\Delta m}{m} + 3\frac{\Delta a}{a}$

4. $X = \frac{ab^2}{c^3} \Rightarrow \frac{\Delta X}{X} = \left(\frac{\Delta a}{a} + 2\frac{\Delta b}{b} + 3\frac{\Delta c}{c}\right)$

5. $\because D = 2R \therefore \frac{\Delta D}{D} = \frac{\Delta R}{R}$

6. $\frac{\Delta(ABC)}{ABC} = \frac{\Delta A}{A} + \frac{\Delta B}{B} + \frac{\Delta C}{C} = a + b + c$

8. $T = 2\pi\sqrt{\frac{\ell}{g}} \Rightarrow g = \frac{4\pi^2\ell}{T^2}$

$\Rightarrow \frac{\Delta g}{g} = \frac{\Delta\ell}{\ell} + 2\frac{\Delta T}{T}$

10. $F = \frac{P}{A} = \frac{P}{\ell^2} \Rightarrow \frac{\Delta F}{F} = \frac{\Delta P}{P} + 2\frac{\Delta\ell}{\ell}$

11. Area(A) = $4\pi R^2$, Volume(V) = $\frac{4}{3}\pi R^3$

$\frac{\Delta A}{A} = 2\frac{\Delta R}{R}, \frac{\Delta V}{V} = 3\frac{\Delta R}{R}$

12. Average time period

$= \frac{2.63 + 2.56 + 2.42 + 2.71 + 2.80}{5}$

$= \frac{13.12}{5} = 2.624 = 2.62$ s

Average absolute error

$= \frac{0.01 + 0.06 + 0.20 + 0.09 + 0.18}{5} = \frac{0.54}{5}$

= 0.108 = 0.11s

15. $X = M^aL^bT^c$

$\Rightarrow \frac{\Delta X}{X} = a\left(\frac{\Delta M}{M}\right) + b\left(\frac{\Delta L}{L}\right) + c\left(\frac{\Delta T}{T}\right) = a\alpha + b\beta + c\gamma$

16. Circumference $\ell = 2\pi R = \pi D \Rightarrow \ell \propto D$

17. $\rho = \frac{m}{\pi r^2\ell} \Rightarrow \frac{\Delta\rho}{\rho} = \frac{\Delta m}{m} + 2\frac{\Delta r}{r} + \frac{\Delta\ell}{\ell} \Rightarrow \frac{\Delta\rho}{\rho}$ 100

$= \frac{0.003}{0.3}$ 100+2 $\frac{0.005}{0.5} + \frac{0.06}{6} \times 100 = 4\%$

18. $V = \pi r^2 h = \frac{\pi D^2 h}{4} \Rightarrow \frac{\Delta V}{V} = \frac{2\Delta D}{D} + \frac{\Delta h}{h}$

$\frac{\Delta V}{V} \times 100 = \left[2 \times \left(\frac{0.01}{2.00}\right) + \left(\frac{0.1}{5.0}\right)\right] \times 100 = 3\%$

19. Volume of 25 spheres = 25 1.76 = 44.00

20. $T = 2\pi\sqrt{\frac{\ell}{g}} \Rightarrow g = \frac{4\pi^2\ell}{T^2}$

$\Rightarrow \frac{\Delta g}{g} = \frac{\Delta\ell}{\ell} + 2\frac{\Delta T}{T} = 2x + y$

21. $R = \frac{V}{I} \Rightarrow \frac{\Delta R}{R} \times 100 = \frac{\Delta V}{V} \times 100 + \frac{\Delta I}{I} \times 100$

$= \frac{5}{100} \times 100 + \frac{0.2}{10} \times 100 = 7\%$

22. $\because V = \ell bt \therefore \frac{\Delta V}{V} = \frac{\Delta\ell}{\ell} + \frac{\Delta b}{b} + \frac{\Delta t}{t}$

$V = (10.0)\ (1.00)\ (0.100) = 1.00\ cm^3$

$\Delta V = (1.00)\left[\frac{0.10}{10.0} + \frac{0.01}{1.00} + \frac{0.001}{0.100}\right] = 0.03 cm^3$

23. Thickness of the wall

$= (4.23 \pm 0.01) - (3.89 \pm 0.01) = (0.34 \pm 0.02)$ cm

24. Area of disk

$= \pi R^2 = (3.14)\ (1.2)^2 = 4.5216 = 4.5 cm^2$

25. $\because V = \ell bt \therefore \frac{\Delta V}{V} = \frac{\Delta\ell}{\ell} + \frac{\Delta b}{b} + \frac{\Delta t}{t}$

$\frac{\Delta V}{V} \times 100 = \left(\frac{0.01}{15.12} + \frac{0.01}{10.15} + \frac{0.01}{5.28}\right) \times 100$

= (0.066 + 0.098 + 0.189) %

= (0.07 + 0.10 + 0.19)% = 0.36%

26. $T = \frac{rhg}{2} \Rightarrow \frac{\Delta T}{T} = \frac{\Delta r}{r} + \frac{\Delta h}{h} + \frac{\Delta g}{g}$

$\frac{\Delta T}{T}$ 100 = $\left(\frac{0.01 \times 10^{-2}}{1.25 \times 10^{-2}} + \frac{0.01 \times 10^{-2}}{1.45 \times 10^{-2}} + \frac{0.01}{9.80}\right)$ 100

= 0.80 + 0.69+ 0.10 = 1.59% = 1.6%

27. $\frac{\Delta T}{T} \times 100 = \frac{1/5}{25} \times 100 = 0.8\%$

28. Area = 1.2 2.345 = 2.884 = 2.9 cm^2

29. 1 MSD – 1VSD = Vernier Constant

30. Least count = 1MSD – 1VSD

but 30 VSD = 29 MSD $\Rightarrow$ VSD = $\left(\frac{29}{30}\right)$MSD

Therefore L.C. = 1 MSD – $\frac{29}{30}$MSD

$= \frac{\text{MSD}}{30} = \frac{0.5°}{30} = \left(\frac{1}{60}\right)^{\circ} = 1'$

31. Reading = 2.30 mm

32. Least count = 1 MSD – 1 VSD

(N–1) MSD = N(VSD) $\Rightarrow$ VSD = $\left(1-\frac{1}{N}\right)$MSD

Least count = 1MSD – $\left(1-\frac{1}{N}\right)$MSD

= $\left(\frac{1}{N}\right)$(1mm)= $\frac{1}{10N}$ cm

33. $\because$ L.C. = 1 MSD – 1 VSD

$\therefore$ 0.02 = 0.1 – $\frac{m}{n}$ $\Rightarrow \frac{m}{n} = 0.08$

34. L.C. = 1MSD – 1VSD but (N) MSD = (N+M) (VSD)

$\Rightarrow$ L.C. = 1MSD – $\left(\frac{N}{N+m}\right)$MSD

= $\left(\frac{m}{N+m}\right) = \left(\frac{1}{\frac{N}{m}+1}\right)$MSD

For minimum least count, m should be minimum so m=1

35. Let 1 MSD = S & 1 VSD = V

Given, 10V = 9S or S = V...(i)

Also given (N S(+2 (S–V) = NS' + 2 (S'–V')

or (N+2) (S'-S) = 2 (V'-V)

or $S\alpha_1\Delta T = \frac{2}{N+2}(V\alpha_2\Delta T)$

or $\frac{\alpha_1}{\alpha_2} = \left(\frac{2}{N+2}\right)\times\frac{V}{S} = \frac{2}{N+2}\times\frac{9}{10} = \frac{1.8}{N+2}$

36. $\frac{X}{10} = \frac{90}{90} \Rightarrow X = 10\Omega$

$\Rightarrow \frac{10(1+\alpha_1\Delta T)}{10+\Delta\ell} = \frac{90(1+\alpha_2\Delta T)}{90-\Delta\ell}$

$\Rightarrow (1+\alpha_1\Delta T)\left(1+\frac{\Delta\ell}{10}\right)^{-1} = (1+\alpha_2\Delta T)\left(1-\frac{\Delta\ell}{90}\right)^{-1}$

$\Rightarrow (1+\alpha_1\Delta T)\left(1-\frac{\Delta\ell}{10}\right) = (1+\alpha_2\Delta T)\left(1+\frac{\Delta\ell}{90}\right)$

$\Rightarrow 1+\alpha_1\Delta T - \frac{\Delta\ell}{10} = 1+\alpha_2\Delta T + \frac{\Delta\ell}{90}$

$\Rightarrow (\alpha_1-\alpha_2)\Delta T = \frac{\Delta\ell}{9} \Rightarrow \Delta\ell = 9(\alpha_1-\alpha_2)\Delta T$

37. Deflection is zero for 324 so value of unknown resistance = $\frac{324}{100}$ = 3.24 Ω

Comprehension

1. Least count = $\frac{0.5}{50}$ = 0.01 mm

2. ID = 321 + 7(0.5) + 17(0.01) = 324.67 mm

3. Zero error = –(50–41) (0.01) =–0.09 mm

Subjective Questions

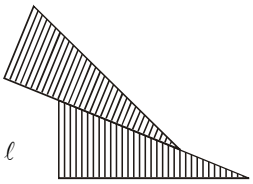
1. Least count = 1MSD – 1VSD

= 0.5 – $\frac{9}{10}$ (0.5) =0.05 mm

2. Least count = 1MSD – IVSD

= $\frac{\ell}{\cos\theta} - \ell$

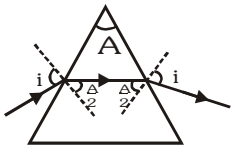
= $\left(\frac{1-\cos\theta}{\cos\theta}\right)\ell$



3. Zero error = –(50 – 44) $\left(\frac{1\text{mm}}{50}\right)$ = –0.12 mm

Thickness of plate = 3+26 $\frac{1}{50}$ +0.12mm=3.64mm

4. $\frac{100}{0.45\ell} = \frac{1110}{400} \Rightarrow \ell$ = 40m



5. $\theta = 2i - 2r = 2i - A$

$\Rightarrow i = \frac{\theta+A}{2} = \frac{60°+30°}{2}$ =45

But $\sin i = \mu\sin\frac{A}{2}$

$\Rightarrow \sin\left(\frac{\theta+A}{2}\right) = \mu\sin\frac{A}{2} \Rightarrow \mu = \sqrt{2}$

$\mu = \frac{\sin\left(\frac{\theta+A}{2}\right)}{\sin\frac{A}{2}}$

$$\Rightarrow \Delta\mu = \left(\text{cosec}\,\frac{A}{2}\right)\cos\left(\frac{\theta + A}{2}\right)\left(\frac{\Delta\theta}{2}\right)B$$

$$= (\text{cosec } 30°)\cos 45°\left(\frac{1°}{2}\right) = \frac{1}{\sqrt{2}}\left(\frac{\pi}{180°}\right)$$

$$\frac{\Delta\mu}{\mu}\times 100 = \left\{\left(\frac{\pi}{\sqrt{2}(180)}\right)\frac{1}{\sqrt{2}}\right\}100 = \frac{5\pi}{18}\%$$

6. Index (Bench) error

= observed distance – Actual distance

$= (x_L - x_o) - 10$ cm $= -0.2$ cm

$u = (x_L - x_o) - (-0.2) = 10.8 - (-0.2) = 11$ cm

$v = (x_L - x_o) - (0.2) = 22.5 - 11.4 - 0.2 = 10.9$ cm

$$\frac{1}{f} = \frac{1}{v} - \frac{1}{u} = \frac{1}{10.9} - \frac{1}{-11} \Rightarrow f = 5.5 \text{ cm} \quad \text{and}$$

$$\frac{\Delta f}{f^2} = \frac{\Delta u}{u^2} + \frac{\Delta v}{v^2} \Rightarrow \Delta f = \left[\frac{0.1}{(11)^2} + \frac{0.1}{(10.9)^2}\right][5.5]^2 = 0.05$$

$\Rightarrow f = (5.5 \pm 0.05)$ cm

7. $S = x\cos\theta = (2)\cos 53 = (2)\left(\frac{3}{5}\right) = 1.2$

$$\frac{\Delta S}{S} = \frac{\Delta x}{x} + \frac{\Delta(\cos\theta)}{\cos\theta} = \frac{\Delta x}{x} + (\tan\theta)\,\Delta\theta \Rightarrow \Delta S = 1.2$$

$$\left[\frac{0.2}{2} + \left(\frac{4}{3}\right)\left(2\times\frac{\pi}{180}\right)\right] = 0.12 + 0.06 = 0.18$$

$\Rightarrow S = (1.2 \pm 0.18)$ cm

EXERCISE -2(A)

3. Diameter = M.S.R. + C.S.R L.C. + Z.E. = 3 + 35 (0.5/50) + 0.03 = 3.38 mm

4. Least count of vernier callipers

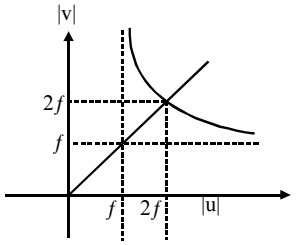
L.C. = 1MSD – 1VSD

But here 29 MSD = 30 VSD $\Rightarrow$ 1 VSD = $\frac{29}{30}$MSD

$$\Rightarrow \text{L.C.} = 1\text{MSD} - \frac{29}{30}\text{MSD} = = \frac{1}{30}\text{MSD} = \frac{1}{30}$$

$0.5 = \left(\frac{1}{60}\right)^\circ$ =1 minute.

5.



7. Least count = $\frac{1\text{mm}}{100}$ = 0.01 mm

Diameter of the wire = 0 + 52 0.01 mm = 0.52 mm = 0.052 cm

8. $1\text{VSD} = \frac{29}{30}\times 0.5° = \left(\frac{29}{60}\right)^\circ$ and

$1\text{MSD} = \left(\frac{1}{2}\right)^\circ = \left(\frac{30}{60}\right)^\circ$

Least count = 1MSD – 1VSD = $\left(\frac{1}{60}\right)^\circ$

Reading = 58.5 + 9x $\left(\frac{1}{60}\right)^\circ$ = 58.65

9. $R = \frac{V}{I} \Rightarrow \frac{\Delta R}{R} = \frac{\Delta V}{V} + \frac{\Delta I}{I} = 3\% + 3\% = 6\%$

EXERCISE -2(B)

1. $V = a^3 = (1.2 \quad 10^{-2})^3 = 1.728 \quad 10^{-6}\text{m}^3 = 1.7 \quad 10^{-6}\text{m}^3$

2. $\rho = \frac{m}{\pi r^2 \ell} \Rightarrow \frac{\Delta\rho}{\rho} = \frac{\Delta m}{m} + 2\frac{\Delta r}{r} + \frac{\Delta\ell}{\ell}$

$$\frac{\Delta\rho}{\rho}\times 100 = \frac{0.003}{0.3}\times 100 + 2\times\frac{0.005}{0.5} + \frac{0.06}{6}\times 100 = 4\%$$

4. $v = f\lambda = 2f(\ell_2 - \ell_1)$

$= 512 \quad 2\,(63.2 - 30.7) \quad 10^{-2} = 332.8\ \text{ms}^{-1}$

$$\frac{\Delta v}{v} = \left(\frac{\Delta\lambda}{\lambda}\right) = \left(\frac{\Delta\ell_2 + \Delta\ell_1}{\ell_2 - \ell_1}\right)$$

$$\Rightarrow \Delta v = v\left(\frac{\Delta\ell_2 + \Delta\ell_1}{\ell_2 - \ell_1}\right) = (332.8)\left(\frac{0.1 + 0.1}{32.5}\right) = 2.048\ \text{m/s}$$

5. From $\frac{1}{f} = \frac{1}{v} - \frac{1}{u} = \frac{1}{10} - \frac{1}{-10} = \frac{1}{5} \Rightarrow f = 5\text{cm}$

From graph $\Delta u = 0.1$ cm, $\Delta v = 0.1$ cm

But $\frac{\Delta f}{f^2} = \frac{\Delta v}{v^2} + \frac{\Delta u}{u^2}$

so $\Delta f = \left(\frac{0.1}{100} + \frac{0.1}{100}\right)(25) = 0.05$

$\Rightarrow f = (5 \pm 0.05)$ cm

6. $g = \frac{4\pi^2\ell}{T^2} \Rightarrow \frac{\Delta g}{g} = \frac{\Delta\ell}{\ell} + \frac{2\Delta T}{T}$ Here $T \simeq 2$ sec

For (A) $\frac{\Delta g}{g} = \frac{0.5}{1} + \frac{0.2(0.1)}{2} = 0.6$

For (B) $\frac{\Delta g}{g} = 0.5 + \frac{0.2}{2} = 0.6$

For (C) $\frac{\Delta g}{g} = 0.5 + \frac{0.02}{2} = 0.51$

For (D) $\frac{\Delta g}{g} = 0.1 + \frac{0.1}{2} = 0.15$

$\Rightarrow \frac{\Delta g}{g}$ is minimum for (D). Also number of observations are maximum in (D).

7. least count $= \frac{0.5}{50} = 0.01$ mm

Diameter of sphere
= 2 0.5 + (25 – 5) 0.01 = 1.2 mm

8. $Y = \frac{F\ell}{A\Delta\ell} = \frac{Mg\ell}{A\Delta\ell} = \frac{(1)(9.8)(2)}{\pi(0.2\times10^{-3})^2(0.8\times10^{-3})}$

= 1.95 10^{11} = 2.0 10^{11} Nm^{-2}

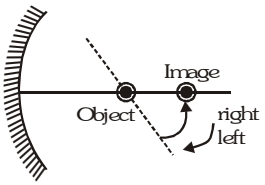
$\frac{\Delta Y}{Y} = \frac{\Delta(\Delta\ell)}{\Delta\ell} + 2\frac{\Delta r}{r} = \frac{0.05}{0.8} + 2\left(\frac{0.01}{0.4}\right)$

= 0.0625 + 0.05 = 0.1125

ΔY = (2.0 10^{11}) (0.1125) = 0.2 10^{11}

$\Rightarrow$ Y = (2 ± 0.2) 10^{11} Nm^{-2}

10. Since object and image move in opposite direction, the positioning should be as shown in the figure. Object lies between focus and centre of curvature f < x < 2f



11. 50 divisions = 2.45 cm

$\Rightarrow$ 1 division = $\frac{2.45}{50} = 0.049$cm

$\Rightarrow$ least count = 1 MSD –1VSD = 0.05 – 0.049
= 0.001 cm.

So vernier reading = 0.001 24 = 0.024 cm.
Therefore diameter of cylinder
= 5.10 + 0.024 = 5.124 cm.

12. $d = \frac{\lambda}{2\sin\theta}$

$\delta(d) = \left(\frac{\lambda}{2\sin^2\theta}\right)\cos\theta\delta\theta$ $\{\delta\theta = \text{constant}\}$

as θ increases, $\frac{\cos\theta}{\sin^2\theta}$ decreases so

Absolute error $|\delta(d)|$ decreases
Also fractional error

$$= \left|\frac{\delta(d)}{d}\right| = \frac{\left(\frac{\lambda\cos\theta}{2\sin^2\theta}\right)\delta\theta}{\frac{\lambda}{2\sin\theta}} = (\cot\theta)\delta\theta$$

as θ increases, cotθ decreases, so fractional error decreases

MCQ's

1. By using mirror formula $\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$

Set 1 $\rightarrow$ u = – 42 cm $\Rightarrow$ v = – 56 cm
Set 2 $\rightarrow$ u = – 48 cm $\Rightarrow$ v = – 48 cm
Set 3 $\rightarrow$ u = – 60 cm $\Rightarrow$ v = – 40 cm
Set 4 $\rightarrow$ u = – 66 cm $\Rightarrow$ v = – 37.7±0.2 ≠33 cm
Set 5 $\rightarrow$ u = – 78 cm $\Rightarrow$ v = – 34.67±0.2 ≠39cm

2. For a longer air column, absorption of energy is more. Due to end correction $\ell + e = \frac{\lambda}{4}$.

Subjective

1. Least count = 1MSD – 1VSD

Here n(MSD) = (n+1) (VSD) $\Rightarrow$ 1 VSD = $\frac{na}{n+1}$

$\Rightarrow$ Least count = a – $\frac{na}{n+1} = \frac{a}{n+1}$

2. $Y = \frac{F\ell}{\left(\frac{\pi D^2}{4}\right)\Delta\ell} = \frac{4F\ell}{\pi D^2\Delta\ell}$

$\frac{\Delta Y}{Y} = \frac{\Delta\ell}{\ell} + 2\frac{\Delta D}{D} + \frac{\Delta(\Delta\ell)}{\Delta\ell} = \frac{0.1}{110} + 2\left(\frac{0.001}{0.050}\right) + \frac{0.001}{0.125}$

Maximum percentage error

$\frac{\Delta Y}{Y}\times100 = \frac{1}{11} + 4 + 0.8 = 4.89\%$

4. Least count = $\frac{1\text{mm}}{100} = 0.01$ nn

Diameter D=1mm+(47) (0.01)mm=1.47mm
= 0.147 cm

Curved surface area = $2\pi r\ell = \pi D\ell$
= (3.14) (0.147) (5.6) = 2.6 cm^2

5. Least count ofverimer callipers

$= \left(1 - \frac{9}{10}\right)$ mm = 0.1 mm

Side of cube = 10mm + 1 0.1 mm
= 10.1 mm = 1.01 cm

Density $= \frac{2.736}{(1.01)^3} = 2.66$ g/cm^3