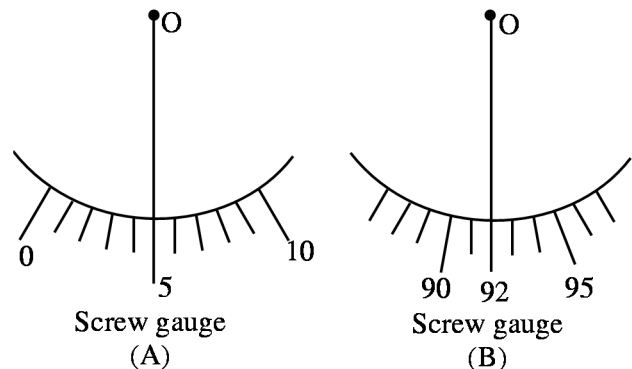


ERROR & PRACTICAL PHYSICS

- The period of oscillation of a simple pendulum is $T = 2\pi\sqrt{\frac{L}{g}}$. Measured value of 'L' is 1.0 m from meter scale having a minimum division of 1 mm and time of one complete oscillation is 1.95 s measured from stopwatch of 0.01 s resolution. The percentage error in the determination of 'g' will be :
 (1) 1.13% (2) 1.03%
 (3) 1.33% (4) 1.30%
- The pitch of the screw gauge is 1mm and there are 100 divisions on the circular scale. When nothing is put in between the jaws, the zero of the circular scale lies 8 divisions below the reference line. When a wire is placed between the jaws, the first linear scale division is clearly visible while 72nd division on circular scale coincides with the reference line. The radius of the wire is:
 (1) 1.64 mm (2) 0.82 mm
 (3) 1.80 mm (4) 0.90 mm
- One main scale division of a vernier callipers is 'a' cm and nth division of the vernier scale coincide with (n - 1)th division of the main scale. The least count of the callipers in mm is :
 (1) $\frac{10na}{(n-1)}$ (2) $\frac{10a}{(n-1)}$
 (3) $\left(\frac{n-1}{10n}\right)a$ (4) $\frac{10a}{n}$
- The resistance $R = \frac{V}{I}$, where $V = (50 \pm 2)V$ and $I = (20 \pm 0.2)A$. The percentage error in R is 'x' %. The value of 'x' to the nearest integer is _____.
- In order to determine the Young's Modulus of a wire of radius 0.2 cm (measured using a scale of least count = 0.001 cm) and length 1m (measured using a scale of least count = 1 mm), a weight of mass 1kg (measured using a scale of least count = 1g) was hanged to get the elongation of 0.5 cm (measured using a scale of least count 0.001 cm). What will be the fractional error in the value of Young's Modulus determined by this experiment ?
 (1) 0.14% (2) 0.9%
 (3) 9% (4) 1.4%

- The vernier scale used for measurement has a positive zero error of 0.2 mm. If while taking a measurement it was noted that '0' on the vernier scale lies between 8.5 cm and 8.6 cm, vernier coincidence is 6, then the correct value of measurement is _____ cm.
 (least count = 0.01 cm)
 (1) 8.36 cm (2) 8.54 cm
 (3) 8.58 cm (4) 8.56 cm
- The time period of a simple pendulum is given by $T = 2\pi\sqrt{\frac{\ell}{g}}$. The measured value of the length of pendulum is 10 cm known to a 1mm accuracy. The time for 200 oscillations of the pendulum is found to be 100 second using a clock of 1s resolution. The percentage accuracy in the determination of 'g' using this pendulum is 'x'. The value of 'x' to the nearest integer is:-
 (1) 2% (2) 3% (3) 5% (4) 4%
- In the experiment of Ohm's law, a potential difference of 5.0 V is applied across the end of a conductor of length 10.0 cm and diameter of 5.00 mm. The measured current in the conductor is 2.00 A. The maximum permissible percentage error in the resistivity of the conductor is :-
 (1) 3.9 (2) 8.4 (3) 7.5 (4) 3.0
- The radius of a sphere is measured to be (7.50 ± 0.85) cm. Suppose the percentage error in its volume is x. The value of x, to the nearest x, is _____.
- Student A and Student B used two screw gauges of equal pitch and 100 equal circular divisions to measure the radius of a given wire. The actual value of the radius of the wire is 0.322 cm. The absolute value of the difference between the final circular scale readings observed by the students A and B is _____. [Figure shows position of reference 'O' when jaws of screw gauge are closed]
 Given pitch = 0.1 cm.



11. **Assertion A :** If in five complete rotations of the circular scale, the distance travelled on main scale of the screw gauge is 5 mm and there are 50 total divisions on circular scale, then least count is 0.001 cm.

Reason R :

$$\text{Least Count} = \frac{\text{Pitch}}{\text{Total divisions on circular scale}}$$

In the light of the above statements, choose the most appropriate answer from the options given below :

- (1) **A** is not correct but **R** is correct.
 (2) Both **A** and **R** are correct and **R** is the correct explanation of **A**.
 (3) **A** is correct but **R** is not correct.
 (4) Both **A** and **R** are correct and **R** is NOT the correct explanation of **A**.

12. A physical quantity 'y' is represented by the

$$\text{formula } y = m^2 r^{-4} g^x l^{-\frac{3}{2}}$$

If the percentage errors found in y, m, r, l and g are 18, 1, 0.5, 4 and p respectively, then find the value of x and p.

- (1) 5 and ± 2 (2) 4 and ± 3
 (3) $\frac{16}{3}$ and $\pm \frac{3}{2}$ (4) 8 and ± 2
13. Three students S_1 , S_2 and S_3 perform an experiment for determining the acceleration due to gravity (g) using a simple pendulum. They use different lengths of pendulum and record time for different number of oscillations. The observations are as shown in the table.

Student No.	Length of pendulum (cm)	No. of oscillations (n)	Total time for n oscillations	Time period (s)
1.	64.0	8	128.0	16.0
2.	64.0	4	64.0	16.0
3.	20.0	4	36.0	9.0

(Least count of length = 0.1 m
 least count for time = 0.1 s)

If E_1 , E_2 and E_3 are the percentage errors in 'g' for students 1, 2 and 3 respectively, then the minimum percentage error is obtained by student no. _____.

14. In a Screw Gauge, fifth division of the circular scale coincides with the reference line when the ratchet is closed. There are 50 divisions on the circular scale, and the main scale moves by 0.5 mm on a complete rotation. For a particular observation the reading on the main scale is 5 mm and the 20th division of the circular scale coincides with reference line. Calculate the true reading.
- (1) 5.00 mm (2) 5.25 mm
 (3) 5.15 mm (4) 5.20 mm

15. If the length of the pendulum in pendulum clock increases by 0.1%, then the error in time per day is:

- (1) 86.4 s (2) 4.32 s
 (3) 43.2 s (4) 8.64 s

16. The acceleration due to gravity is found upto an accuracy of 4% on a planet. The energy supplied to a simple pendulum to known mass 'm' to undertake oscillations of time period T is being estimated. If time period is measured to an accuracy of 3%, the accuracy to which E is known as%

17. The diameter of a spherical bob is measured using a vernier callipers. 9 divisions of the main scale, in the vernier callipers, are equal to 10 divisions of vernier scale. One main scale division is 1 mm. The main scale reading is 10 mm and 8th division of vernier scale was found to coincide exactly with one of the main scale division. If the given vernier callipers has positive zero error of 0.04 cm, then the radius of the bob is _____ $\times 10^{-2}$ cm.

18. A student determined Young's Modulus of elasticity using the formula $Y = \frac{MgL^3}{4bd^3\delta}$. The value of g is taken to be 9.8 m/s², without any significant error, his observation are as following.

Physical Quantity	Least count of the Equipment used for measurement	Observed value
Mass (M)	1 g	2 kg
Length of bar (L)	1 mm	1 m
Breadth of bar (b)	0.1 mm	4 cm
Thickness of bar (d)	0.01 mm	0.4 cm
Depression (δ)	0.01 mm	5 mm

Then the fractional error in the measurement of Y is :

- (1) 0.0083 (2) 0.0155
 (3) 0.155 (4) 0.083
19. Two resistors $R_1 = (4 \pm 0.8) \Omega$ and $R_2 = (4 \pm 0.4) \Omega$ are connected in parallel. The equivalent resistance of their parallel combination will be :
- (1) $(4 \pm 0.4) \Omega$ (2) $(2 \pm 0.4) \Omega$
 (3) $(2 \pm 0.3) \Omega$ (4) $(4 \pm 0.3) \Omega$

SOLUTION

1. Official Ans. by NTA (1)

Sol. $T = 2\pi \sqrt{\frac{\ell}{g}}$
 $g = \frac{4\pi^2 \ell}{T^2}$
 $\frac{\Delta g}{g} = \frac{\Delta \ell}{\ell} + \frac{2\Delta T}{T}$
 $\frac{\Delta g}{g} = \frac{1 \times 10^{-3}}{1} + 2 \times \frac{0.01}{1.95}$
 $\frac{\Delta g}{g} = 0.0113$ or 1.13%

option (1) is correct

2. Official Ans. by NTA (2)

Sol. Least count = $\frac{1\text{mm}}{100} = 0.01\text{mm}$
 zero error = $+ 8 \times \text{LC} = + 0.08 \text{ mm}$
 True reading (Diameter)
 = $(1 \text{ mm} + 72 \times \text{LC}) - (\text{Zero error})$
 = $(1 \text{ mm} + 72 \times 0.01 \text{ mm}) - 0.08 \text{ mm}$
 = $1.72 \text{ mm} - 0.08 \text{ mm}$
 = 1.64 mm
 therefore, radius = $\frac{1.64}{2} = 0.82 \text{ mm}$.

3. Official Ans. by NTA (4)

Sol. $(n - 1)a = n(a')$
 $a' = \frac{(n - 1)a}{n}$
 $\therefore \text{L.C.} = 1 \text{ MSD} - 1 \text{ VSD}$
 = $(a - a')\text{cm}$
 = $a - \frac{(n - 1)a}{n} = \frac{na - na + a}{n}$
 = $\frac{a}{n} \text{ cm} = \left(\frac{10a}{n}\right) \text{ mm}$

4. Official Ans. by NTA (5)

Sol. $\frac{\Delta R}{R} \times 100 = \frac{\Delta V}{V} \times 100 + \frac{\Delta I}{I} \times 100$
 $\% \text{ error in } R = \frac{2}{50} \times 100 + \frac{0.2}{20} \times 100$
 $\% \text{ error in } R = 4 + 1$
 $\% \text{ error in } R = 5\%$

5. Official Ans. by NTA (4)

Sol. $Y = \frac{\text{Stress}}{\text{Strain}} = \frac{FL}{Al} = \frac{mg.L}{\pi R^2 . \ell}$
 $\frac{\Delta Y}{Y} = \frac{\Delta m}{m} + \frac{\Delta L}{L} + 2 \cdot \frac{\Delta R}{R} + \frac{\Delta \ell}{\ell}$
 $\frac{\Delta Y}{Y} \times 100 = 100 \left[\frac{1}{1000} + \frac{1}{1000} + 2 \left(\frac{0.001}{0.2} \right) + \frac{0.001}{0.5} \right]$
 $= \frac{1}{10} + \frac{1}{10} + 1 + \frac{1}{5} = \frac{14}{10} = 1.4\%$

6. Official Ans. by NTA (2)

Sol. Positive zero error = 0.2 mm
 Main scale reading = 8.5 cm
 Vernier scale reading = $6 \times 0.01 = 0.06 \text{ cm}$
 Final reading = $8.5 + 0.06 - 0.02 = 8.54 \text{ cm}$

7. Official Ans. by NTA (2)

Sol. $g = \frac{4\pi^2 \ell}{T^2}$
 $\frac{\Delta g}{g} = \frac{\Delta \ell}{\ell} + 2 \frac{\Delta T}{T} = \frac{0.1}{10} + 2 \left(\frac{1}{200} \right)$

$\frac{\Delta g}{g} = \frac{1}{100} + \frac{1}{50}$

$\frac{\Delta g}{g} \times 100 = 3\%$

8. Official Ans. by NTA (1)

Sol. $R = \frac{\rho \ell}{A} = \frac{V}{I}$
 $\rho = \frac{AV}{I\ell} = \frac{\pi d^2 V}{4I\ell} \quad \left(A = \frac{\pi d^2}{4} \right)$
 $\therefore \frac{\Delta \rho}{\rho} = \frac{2\Delta d}{d} + \frac{\Delta V}{V} + \frac{\Delta I}{I} + \frac{\Delta \ell}{\ell}$
 $\frac{\Delta \rho}{\rho} = 2 \left(\frac{0.01}{5.00} \right) + \frac{0.1}{5.0} + \frac{0.01}{2.00} + \frac{0.1}{10.0}$
 $\frac{\Delta \rho}{\rho} = 0.004 + 0.02 + 0.005 + 0.01$
 $\frac{\Delta \rho}{\rho} = 0.039$
 $\% \text{ error} = \frac{\Delta \rho}{\rho} \times 100 = 0.039 \times 100 = 3.90\%$

Ans. (1)

9. Official Ans. by NTA (34)

Sol. $\therefore v = \frac{4}{3}\pi r^3$

taking log & then differentiate

$$\frac{dV}{V} = 3 \frac{dr}{r}$$

$$= \frac{3 \times 0.85}{7.5} \times 100\% = 34\%$$

10. Official Ans. by NTA (13)

Sol. For (A)

Reading = MSR + CSR + Error

$$0.322 = 0.300 + \text{CSR} + 5 \times \text{LC}$$

$$0.322 = 0.300 + \text{CSR} + 0.005$$

$$\text{CSR} = 0.017$$

For B

Reading = MSR + CSR + Error

$$0.322 = 0.200 + \text{CSR} + 0.092$$

$$\text{CSR} = 0.030$$

$$\text{Difference} = 0.030 - 0.017 = 0.013 \text{ cm}$$

$$\text{Division on circular scale} = \frac{0.013}{0.001} = 13$$

11. Official Ans. by NTA (1)

Sol. Least count = $\frac{\text{Pitch}}{\text{total division on circular scale}}$

In 5 revolution, distance travel, 5 mm

In 1 revolution, it will travel 1 mm.

$$\text{So least count} = \frac{1}{50} = 0.02$$

12. Official Ans. by NTA (3)

Sol. $\frac{\Delta y}{y} = \frac{2\Delta m}{m} + \frac{4\Delta r}{r} + \frac{x\Delta g}{g} + \frac{3}{2} \frac{\Delta \ell}{\ell}$

$$18 = 2(1) + 4(0.5) + xp + \frac{3}{2}(4)$$

$$8 = xp$$

By checking from options.

$$x = \frac{16}{3}, p = \pm \frac{3}{2}$$

13. Official Ans. by NTA (1)

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

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

$$\Delta T = \frac{\text{least count of time } (\Delta T_0)}{\text{number of oscillations}(n)}$$

$$\frac{\Delta g}{g} = \frac{\Delta \ell}{\ell} + \frac{2\Delta T_0}{nT}$$

As $\Delta \ell$ and ΔT_0 are same for all observations so

$\frac{\Delta g}{g}$ is minimum for highest value of ℓ , n and T

\Rightarrow Minimum percentage error in g is for student number-1

14. Official Ans. by NTA (3)

Sol. Least count (L.C) = $\frac{0.5}{50}$

$$\text{True reading} = 5 + \frac{0.5}{50} \times 20 - \frac{0.5}{50} \times 5$$

$$= 5 + \frac{0.5}{50}(15) = 5.15 \text{ mm}$$

Option (3)

15. Official Ans. by NTA (3)

Sol. $T = 2\pi\sqrt{\frac{\ell}{g}}$

$$\frac{\Delta T}{T} = \frac{1}{2} \frac{\Delta \ell}{\ell}$$

$$\Delta T = \frac{1}{2} \times \frac{0.1}{100} \times 24 \times 3600$$

$$\Delta T = 43.2$$

Ans. 3

16. Official Ans. by NTA (14)

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

$$E = mg\ell \frac{\theta^2}{2} = mg^2 \frac{T^2 \theta^2}{8\pi^2}$$

$$\frac{dE}{E} = 2 \left(\frac{dg}{g} + \frac{dT}{T} \right) = (4 + 3) = 14\%$$

17. Official Ans. by NTA (52)

Sol. 9 MSD = 10 VSD

$$9 \times 1 \text{ mm} = 10 \text{ VSD}$$

$$\therefore 1 \text{ VSD} = 0.9 \text{ mm}$$

$$\text{LC} = 1 \text{ MSD} - 1 \text{ VSD} = 0.1 \text{ mm}$$

$$\text{Reading} = \text{MSR} + \text{VSR} \times \text{LC}$$

$$10 + 8 \times 0.1 = 10.8 \text{ mm}$$

$$\text{Actual reading} = 10.8 - 0.4 = 10.4 \text{ mm}$$

$$\text{radius} = \frac{d}{2} = \frac{10.4}{2} = 5.2 \text{ mm} = 52 \times 10^{-2} \text{ cm}$$

18. Official Ans. by NTA (2)

Sol. $y = \frac{MgL^3}{4bd^3\delta}$

$$\frac{\Delta y}{y} = \frac{\Delta M}{M} + \frac{3\Delta L}{L} + \frac{\Delta b}{b} + \frac{3\Delta d}{d} + \frac{\Delta \delta}{\delta}$$

$$\frac{\Delta y}{y} = \frac{10^{-3}}{2} + \frac{3 \times 10^{-3}}{1} + \frac{10^{-2}}{4} + \frac{3 \times 10^{-2}}{4} + \frac{10^{-2}}{5}$$

$$= 10^{-3} [0.5 + 3 + 2.5 + 7.5 + 2] = 0.0155$$

Option (2)

19. Official Ans. by NTA (3)

Sol. $\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2}$

$$\frac{1}{R_{eq}} = \frac{1}{4} + \frac{1}{4} \Rightarrow R_{eq} = 2\Omega$$

Also $\frac{\Delta R_{eq}}{R_{eq}^2} = \frac{\Delta R_1}{R_1^2} + \frac{\Delta R_2}{R_2^2}$

$$\frac{\Delta R_{eq}}{4} = \frac{.8}{16} + \frac{.4}{16} = \frac{1.2}{16}$$

$$\underline{\Delta R_{eq}} = 0.3\Omega$$

$$R_{eq} = (2 \pm 0.3)\Omega$$

Option (3)