

ERROR & MEASUREMENT

- The pitch and the number of divisions, on the circular scale, for a given screw gauge are 0.5 mm and 100 respectively. When the screw gauge is fully tightened without any object, the zero of its circular scale lies 3 divisions below the mean line.
The readings of the main scale and the circular scale, for a thin sheet, are 5.5 mm and 48 respectively, the thickness of this sheet is :
(1) 5.755 m (2) 5.725 mm
(3) 5.740 m (4) 5.950 mm
- The diameter and height of a cylinder are measured by a meter scale to be 12.6 ± 0.1 cm and 34.2 ± 0.1 cm, respectively. What will be the value of its volume in appropriate significant figures ?
(1) 4260 ± 80 cm³
(2) 4300 ± 80 cm³
(3) 4264.4 ± 81.0 cm³
(4) 4264 ± 81 cm³
- The least count of the main scale of a screw gauge is 1 mm. The minimum number of divisions on its circular scale required to measure $5\mu\text{m}$ diameter of wire is :
(1) 50 (2) 100 (3) 200 (4) 500
- In a simple pendulum experiment for determination of acceleration due to gravity (g), time taken for 20 oscillations is measured by using a watch of 1 second least count. The mean value of time taken comes out to be 30 s. The length of pendulum is measured by using a meter scale of least count 1 mm and the value obtained is 55.0 cm. The percentage error in the determination of g is close to :-
(1) 0.7% (2) 0.2%
(3) 3.5% (4) 6.8%
- The area of a square is 5.29 cm². The area of 7 such squares taking into account the significant figures is :-
(1) 37 cm² (2) 37.0 cm²
(3) 37.03 cm² (4) 37.030 cm²
- In the density measurement of a cube, the mass and edge length are measured as (10.00 ± 0.10) kg and (0.10 ± 0.01) m, respectively. The error in the measurement of density is :
(1) 0.10 kg/m³ (2) 0.31 kg/m³
(3) 0.07 kg/m³ (4) 0.01 kg/m³

SOLUTION1. **Ans. (2)**

$$LC = \frac{\text{Pitch}}{\text{No. of division}}$$

$$LC = 0.5 \times 10^{-2} \text{ mm}$$

$$+ve \text{ error} = 3 \times 0.5 \times 10^{-2} \text{ mm}$$

$$= 1.5 \times 10^{-2} \text{ mm} = 0.015 \text{ mm}$$

$$\text{Reading} = \text{MSR} + \text{CSR} - (+ve \text{ error})$$

$$= 5.5 \text{ mm} + (48 \times 0.5 \times 10^{-2}) - 0.015$$

$$= 5.5 + 0.24 - 0.015 = 5.725 \text{ mm}$$

2. **Ans. (1)**

$$\frac{\Delta V}{V} = 2 \frac{\Delta d}{d} + \frac{\Delta h}{h} = 2 \left(\frac{0.1}{12.6} \right) + \frac{0.1}{34.2}$$

$$V = 12.6 \times \frac{\pi}{4} \times 314.2$$

3. **Ans. (3)**

$$\text{Least count} = \frac{\text{Pitch}}{\text{Number of division on circular scale}}$$

$$5 \times 10^{-6} = \frac{10^{-3}}{N}$$

$$N = 200$$

4. **Ans. (4)**

$$\text{Sol. } T = \frac{30 \text{ sec}}{20}$$

$$\Delta T = \frac{1}{20} \text{ sec.}$$

$$L = 55 \text{ cm}$$

$$\Delta L = 1 \text{ mm} = 0.1 \text{ cm}$$

$$g = \frac{4\pi^2 L}{T^2}$$

percentage error in g is

$$\frac{\Delta g}{g} \times 100\% = \left(\frac{\Delta L}{L} + \frac{2\Delta T}{T} \right) 100\%$$

$$= \left(\frac{0.1}{55} + \frac{2 \left(\frac{1}{20} \right)}{\frac{30}{20}} \right) 100\% \approx 6.8\%$$

5. **Ans. (2)**

$$\begin{aligned} \text{Sol. Total Area} &= A_1 + A_2 + \dots + A_7 \\ &= A + A + \dots + 7 \text{ times} \\ &= 37.03 \text{ m}^2. \end{aligned}$$

Addition of 7 terms all having 2 terms beyond decimal, so final answer must have 2 terms beyond decimal (as per rules of significant digits.)

6. **Allen Answer (Bonus)****Final Ans. by NTA (2)**

$$\text{Sol. } \rho = \frac{m}{v}$$

maximum % error in S will be given by

$$\frac{\Delta \rho}{\rho} \times 100\% = \left(\frac{\Delta m}{m} \right) \times 100\% + 3 \left(\frac{\Delta L}{L} \right) \times 100\% \dots (i)$$

which is only possible when error is small which is not the case in this question.

Yet if we apply equation (i), we get

$$\Delta \rho = 3100 \text{ kg/m}^3$$

Now, we will calculate error, without using approximation.

$$\rho_{\min} = \frac{m_{\min}}{v_{\max}} = \frac{9.9}{(0.11)^3} = 7438 \text{ kg/m}^3$$

$$\& \rho_{\max} = \frac{m_{\max}}{v_{\min}} = \frac{10.1}{(0.09)^3} = 13854.6 \text{ kg/m}^3$$

$$\Delta \rho = 6416.6 \text{ kg/m}^3$$

No option is matching.

Therefore this question should be awarded bonus