

Chapter 30

Experimental Physics

1. The pitch of the screw gauge is 1 mm 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:

[JEE (Main)-2021]

- (1) 0.82 mm
(2) 1.64 mm
(3) 1.80 mm
(4) 0.90 mm
2. One main scale division of a vernier calipers 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 calipers in mm is:

[JEE (Main)-2021]

- (1) $\frac{10 a}{(n-1)}$
(2) $\frac{10 na}{(n-1)}$
(3) $\left(\frac{n-1}{10 n}\right)a$
(4) $\frac{10 a}{n}$
3. 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)

[JEE (Main)-2021]

- (1) 8.54 cm
(2) 8.36 cm
(3) 8.56 cm
(4) 8.58 cm

4. 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. [JEE (Main)-2021]

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 cm)

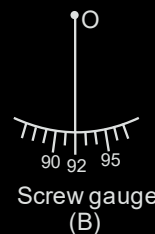
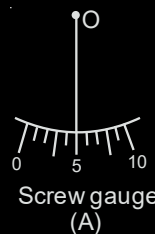
Least count for time = 0.1 s)

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. _____.

5. 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 _____. [JEE (Main)-2021]

[Figure shows position of reference 'O' when jaws of screw gauge are closed]

Given pitch = 0.1 cm.



6. 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.

[JEE (Main)-2021]

- (1) 5.20 mm
- (2) 5.00 mm
- (3) 5.25 mm
- (4) 5.15 mm

7. 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.

[JEE (Main)-2021]

8. In a Vernier callipers, each cm on the main scale is divided into 20 equal parts. If tenth vernier scale division coincides with ninth main scale division. Then the value of vernier constant will be $___ \times 10^{-2}$ mm.

[JEE (Main)-2022]

9. The vernier constant of Vernier callipers is 0.1 mm and it has zero error of (-0.05) cm. While measuring diameter of a sphere, the main scale reading is 1.7 cm and coinciding vernier division is 5. The corrected diameter will be $______ \times 10^{-2}$ cm.

[JEE (Main)-2022]

10. The one division of main scale of Vernier callipers reads 1mm and 10 divisions of Vernier scale is equal to the 9 division on main scale. When the two jaws of the instrument touch each other, the zero of the Vernier lies to the right of zero of the main scale and its fourth division coincides with a main scale division. When a spherical bob is tightly placed between the two jaws, the zero of the Vernier scale lies in between 4.1 cm and 4.2 cm and 6th Vernier division coincides with a main scale division. The diameter of the bob will be $___ \times 10^{-2}$ cm.

[JEE (Main)-2022]

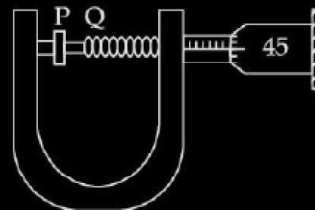
11. A travelling microscope has 20 divisions per cm on the main scale while its vernier scale has total 50 divisions and 25 vernier scale divisions are equal to 24 main scale divisions, what is the least count of the travelling microscope?

[JEE (Main)-2022]

- (1) 0.001 cm
- (2) 0.002 mm
- (3) 0.002 cm
- (4) 0.005 cm

12. In an experiment to find out the diameter of wire using screw gauge, the following observations were noted :

[JEE (Main)-2022]



- (A) Screw moves 0.5 mm on main scale in one complete rotation
- (B) Total divisions on circular scale = 50
- (C) Main scale reading is 2.5 mm
- (D) 45th division of circular scale is in the pitch line
- (E) Instrument has 0.03 mm negative error

Then the diameter of wire is :

- (1) 2.92 mm
- (2) 2.54 mm
- (3) 2.98 mm
- (4) 3.45 mm

13. The distance of the Sun from earth is 1.5×10^{11} m and its angular diameter is $(2000)''$ when observed from the earth. The diameter of the Sun will be :

[JEE (Main)-2022]

- (1) 2.45×10^{10} m
- (2) 1.45×10^{10} m
- (3) 1.45×10^9 m
- (4) 0.14×10^9 m

14. In a Vernier Calipers, 10 divisions of Vernier scale is equal to the 9 divisions of main scale. When both jaws of Vernier calipers touch each other, the zero of the Vernier scale is shifted to the left of zero of the main scale and 4th Vernier scale division exactly coincides with the main scale reading. One main scale division is equal to 1 mm. While measuring diameter of a spherical body, the body is held between two jaws. It is now observed that zero of the Vernier scale lies between 30 and 31 divisions of

main scale reading and 6th Vernier scale division exactly coincides with the main scale reading. The diameter of the spherical body will be

[JEE (Main)-2022]

- (1) 3.02 cm (2) 3.06 cm
(3) 3.10 cm (4) 3.20 cm

15. In an experiment of determine the Young's modulus of wire of a length exactly 1 m, the extension in the length of the wire is measured as 0.4 mm with an uncertainty of ± 0.02 mm when a load of 1 kg is applied. The diameter of the wire is measured as 0.4 mm with an uncertainty of ± 0.02 mm when a load of 1 kg is applied. The diameter of the wire is measured as 0.4 mm with an uncertainty of 0.01 mm. The error in the measurement of Young's modulus (ΔY) is found to be $x \times 10^{10} \text{ Nm}^{-2}$. The value of x is ____.

(Take $g = 10 \text{ ms}^{-2}$)

[JEE (Main)-2022]

16. A travelling microscope is used to determine the refractive index of a glass slab. If 40 divisions are there in 1 cm on main scale and 50 Vernier scale divisions are equal to 49 main scale divisions, then least count of the travelling microscope is _____ $\times 10^{-6} \text{ m}$.

[JEE (Main)-2022]

17. A screw gauge of pitch 0.5 mm is used to measure the diameter of uniform wire of length 6.8 cm, the main scale reading is 1.5 mm and circular scale reading is 7. The calculated curved surface area of wire to appropriate significant figures is :

[Screw gauge has 50 divisions on its circular scale]

[JEE (Main)-2022]

- (1) 6.8 cm^2
(2) 3.4 cm^2
(3) 3.9 cm^2
(4) 2.4 cm^2



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1. Answer (1)

$$LC = 0.01 \text{ mm}$$

$$\text{Zero Error} = 0.08 \text{ mm}$$

$$\text{Diameter} = 1.72 - 0.08 = 1.64 \text{ mm}$$

$$\Rightarrow \text{Radius} = \frac{1.64}{2} \text{ mm} = 0.82 \text{ mm}$$

2. Answer (4)

$$1 \text{ VSD} = \frac{(n-1) \times (a \text{ cm})}{n}$$

$$\therefore \text{Least count} = 1 \text{ MSD} - 1 \text{ VSD}$$

$$= a - \frac{(n-1)a}{n}$$

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

$$= \frac{a}{n} \text{ cm}$$

$$= \frac{a}{n} \times 10 \text{ mm}$$

3. Answer (1)

$$e = +0.2 \text{ mm} = +0.02 \text{ cm}$$

$$\text{Measured value} = 8.5 + 6 \times LC$$

$$= 8.5 + 6 \times 0.01$$

$$= 8.56 \text{ cm}$$

$$\therefore \text{Correct measured value} = 8.56 - 0.02 \\ = 8.54 \text{ cm}$$

4. Answer (1)

$$T = \frac{t}{n} = 2\pi \sqrt{\frac{l}{g}}$$

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

$$\Rightarrow \frac{\Delta g}{g} \times 100 = \frac{\Delta l}{l} \times 100 + 2 \frac{\Delta T}{T} \times 100$$

$$= \left(\frac{\Delta l}{l} + \frac{2\Delta T}{nT} \right) 100\%$$

$$E_1 = \frac{20}{64} \%$$

$$E_2 = \frac{30}{64} \%$$

$$E_3 = \frac{19}{18} \%$$

5. Answer (13)

$$\begin{aligned} \text{Difference in CSR} &= (100 - 92) + 5 \\ &= 8 + 5 \\ &= 13 \end{aligned}$$

6. Answer (4)

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

$$\text{Zero error} = 5 \times 0.01 = 0.05 \text{ mm (positive)}$$

$$\text{True reading} = \text{Reading} - \text{Zero error}$$

$$= 5 \text{ mm} + 20 \times 0.01 - 0.05$$

$$= 5 + 15 \times 0.01$$

$$= 5.15 \text{ mm}$$

7. Answer (52)

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

$$\begin{aligned} \text{Diameter} &= \text{Reading} - \text{Zero error} \\ &= 10.4 \text{ mm} \end{aligned}$$

$$\text{Radius} = 5.2 \text{ mm}$$

8. Answer (5)

$$LC = \frac{1 \text{ MSD}}{\text{VSD}} = \frac{\frac{1}{20} \text{ cm}}{10}$$

$$= \frac{1}{200} \text{ cm}$$

$$= 5 \times 10^{-2} \text{ mm}$$

9. Answer (180)

Since zero error is negative, we will add 0.05 cm.

$$\begin{aligned} \Rightarrow \text{Corrected reading} &= 1.7 \text{ cm} + 5 \times 0.1 \text{ mm} + 0.05 \text{ cm} \\ &= 180 \times 10^{-2} \text{ cm} \end{aligned}$$

10. Answer (412)

$$1 \text{ MSD} = 1 \text{ mm}$$

$$10 \text{ VSD} = 9 \text{ MSD}$$

$$LC = \frac{1}{10} \text{ mm}$$

$$0 + 4\left(\frac{1}{10}\right) \text{ mm} = 0.4 \text{ mm}$$

$$\begin{aligned}\text{Reading} &= 41 + 6\left(\frac{1}{10}\right) \\ &= 41 + 0.6 \\ &= 41.6 \text{ mm}\end{aligned}$$

$$\begin{aligned}\text{True reading} &= 41.2 \text{ mm} \\ &= 412 \times 10^{-2} \text{ cm}\end{aligned}$$

11. Answer (3)

$$1 \text{ MSD} = \frac{1}{20} \text{ cm}$$

$$1 \text{ VSD} = \frac{24}{25} \times \frac{1}{20} \text{ cm}$$

$$\therefore \text{Least count} = 1 \text{ MSD} - 1 \text{ VSD}$$

$$= \frac{1}{20} \left(1 - \frac{24}{25}\right) \text{ cm}$$

$$= \frac{1}{20} \times \frac{1}{25} \text{ cm}$$

$$= 0.002 \text{ cm}$$

12. Answer (3)

$$\text{L.C.} = \frac{0.5}{50} \text{ mm} = 0.01 \text{ mm}$$

$$\begin{aligned}d &= (2.5 + 45 \times 0.01 + 0.03) \text{ mm} \\ &= 2.98\end{aligned}$$

13. Answer (3)

$$\text{Diameter} = r \times \delta$$

$$= 1.5 \times 10^{11} \times (2000) \times \left(\frac{1}{3600}\right) \times \left(\frac{\pi}{180}\right)$$

$$= 1.45 \times 10^9 \text{ m}$$

14. Answer (C)

$$10 \text{ VSD} = 9 \text{ MSD}$$

$$\Rightarrow \text{LC} = \frac{1}{10} \text{ MSD} = 0.01 \text{ cm}$$

$$\text{Negative error} = (0.1 - 0.04) \text{ cm} = 0.06 \text{ cm}$$

$$\begin{aligned}\text{Reading} &= (3.0 \text{ cm}) + 6(0.01) \text{ cm} + 0.06 \text{ cm} \\ &= 3.12 \text{ cm}\end{aligned}$$

$$\text{Closer to } 3.10 \text{ cm}$$

15. Answer (2)

$$\frac{F/A}{l/L} = Y, A = \pi D^2$$

$$\frac{\Delta Y}{Y} = \frac{\Delta F}{F} + \frac{2\Delta D}{D} + \frac{\Delta l}{l} + \frac{\Delta L}{L}$$

$$= 2 \times \frac{0.01}{0.4} + \frac{0.02}{0.4}$$

$$= \frac{0.04}{0.4} = \frac{1}{10}$$

$$Y = \frac{Fl}{A\Delta l}$$

$$= \frac{10 \times 1}{\pi(0.1 \text{ mm})^2 \times 0.4 \text{ mm}}$$

$$= 1.988 \times 10^{11}$$

$$\approx 2 \times 10^{11}$$

$$\frac{\Delta y}{y} = \frac{1}{10}$$

$$\Delta y = \frac{y}{10} = 2 \times 10^{10}$$

16. Answer (5)

$$40 \text{ M} = 1 \text{ cm}$$

$$\Rightarrow \text{M} = 0.025 \text{ cm} \dots\dots\dots(1)$$

$$\text{Also, } 50 \text{ V} = 49 \text{ M}$$

$$\Rightarrow \text{Least count} = \text{M} - \text{V} = \text{M} - \frac{49}{50} \text{ M}$$

$$= \frac{\text{M}}{50}$$

$$\Rightarrow \text{LC} = \frac{0.025}{50} \text{ cm}$$

$$= \frac{250}{50} \times 10^{-6} \text{ m}$$

$$\Rightarrow \text{LC} = 5 \times 10^{-6} \text{ m}$$

17. Answer (2)

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

$$\therefore \text{Diameter, } d = 1.5 \text{ mm} + 7 \times 0.01 = 1.57 \text{ mm}$$

$$\begin{aligned}\therefore \text{Surface area} &= (2\pi r) \times l \\ &= \pi dl\end{aligned}$$

$$= 3.142 \times \frac{1.57}{10} \times 6.8 \text{ cm}^2$$

$$= 3.354 \text{ cm}^2 = 3.4 \text{ cm}^2$$