

Question 5) The density of a solid ball is to be determined in an experiment. The diameter of the ball is measured with a screw gauge, whose pitch is 0.5 mm and there are 50 divisions on the circular scale. The reading on the main scale is 2.5 mm and that on the circular scale is 20 divisions. If the measured mass of the ball has a relative error of 2%, the relative percentage error in the density is

- (A) 0.9%
- (B) 2.4%
- (C) 3.1%
- (D) 4.2%

**Answer: (C) 3.1%**

**Solution:**

Least count of the screw gauge =  $0.5/50 = 0.01$  mm

Diameter of the ball,  $D = 2.5$  mm +  $20(0.01)$

=  $2.5 + 0.2 = 2.7$  mm

Density,  $\rho = M/\text{vol}$

$$= \frac{M}{\frac{4}{3}\pi\left(\frac{D}{2}\right)^3}$$

The relative percentage error in density

$$\frac{\Delta\rho}{\rho} = \left(\frac{\Delta M}{M} + \frac{3\Delta D}{D}\right)$$

$$= 2\% + (3(0.01/2.7) \times 100)$$

$$= 3.1\%$$