A small hole of radius 0.1 mm is present at the bottom of a tumbler. Up to what maximum height may water be stored inside the tumbler so that no water leaks out through the whole? [given that the surface tension of water is 7.1 x 10^(-2) N/m]

Solution

We are given:

$$r = 0.1\ mm = 10^{-4} m$$

$$T = 7.1 * 10^{-2} N/m$$

Force of surface tension can be calculated as:

$$F_{tension} = 2\pi r * T$$

Force on water surface due to weight of the water in a tumbler is:

$$F_{weight} = p * \pi r^2$$

$$p = \rho * g * h$$

For maximum height:

$$F_{weight} = F_{tension}$$

$$2\pi r T = \rho g h_{max} \pi r^2$$

Thus:

$$h_{max} = \frac{2T}{\rho g r}$$

Calculation:

$$h_{max} = \frac{2T}{\rho g r} = \frac{2 * 7.1 * 10^{-2}}{1000 * 9.8 * 10^{-4}} \approx \mathbf{0.145\ m} = 14.5\ cm$$

Answer: **0.145 m**