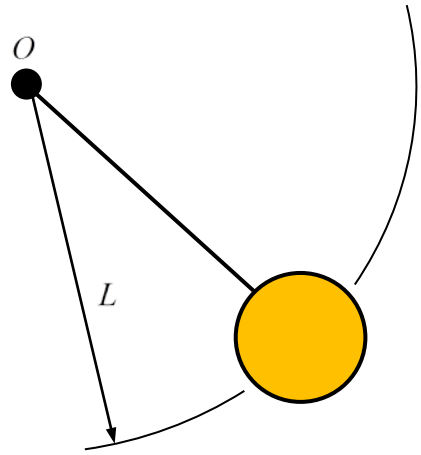
2-38. The sphere rotates in a horizontal circular path while attached to point *O* by a cable. When $L = 1\,\text{m}$, the tangential speed of the sphere is normally distributed $v_1 \sim N(0.5, 0.05^2)\,\text{m/s}$. Then the cable is pulled in at the constant rate of $r = 0.1\,\text{m/s}$. Determine the distribution of tangential speed of the sphere in 2 seconds.



Solution: Since no force acts on the sphere along the tangent of the path, the angular momentum is conserved about point *O*.

$$(\mathbf{H}_O)_1 = (\mathbf{H}_O)_2$$

$$L_1 m v_1 = L_2 m v_2$$

$$v_2 = \frac{L_1 v_1}{L_2} = \frac{L v_1}{L - rt}$$

$$\mu_{v_2} = \frac{L\mu_{v_1}}{L - rt} = \frac{1(0.5)}{1 - 0.1(2)} = 0.63\,\text{m/s}$$

$$\sigma_{v_2} = \frac{L\sigma_{v_1}}{L - rt} = \frac{1(0.05)}{1 - 0.1(2)} = 0.06\,\text{m/s}$$

Therefore, $v_2 \sim N(0.63, 0.06^2)\,\text{m/s}$. **Ans.**