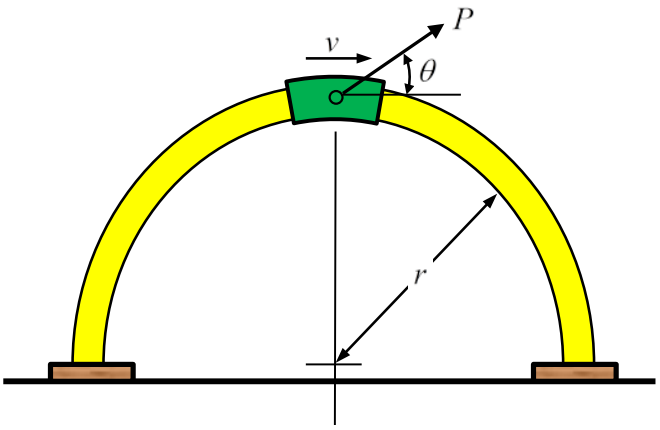
2-19. A collar is sliding along a smooth vertical guide rod. At this instant, the collar has a horizontal speed $v = 3\,\text{m/s}$ and a tangential acceleration $a_t = 2\,\text{m/s}^2$. If the mass of the collar follows a normal distribution $m \sim N(2, 0.1^2)\,\text{kg}$, determine the normal reaction of the guide rod on the collar at this instant. Assume $\theta = 45^\circ$ and $r = 0.2\,\text{m}$.



$$P\cos\theta = ma_t$$

$$P = \frac{ma_t}{\cos\theta}$$

$$N + mg - P\sin\theta = m\frac{v^2}{r}$$

$$N = P\sin\theta + m\frac{v^2}{r} - mg = \left(a_t\tan\theta + \frac{v^2}{r} - g\right)m$$

$$\mu_N = \left(a_t\tan\theta + \frac{v^2}{r} - g\right)\mu_m = 74.38\ \text{N}$$

$$\sigma_N = \left(a_t\tan\theta + \frac{v^2}{r} - g\right)\sigma_m = 3.72\ \text{N}$$

Therefore, $N \sim N(74.38, 3.72^2)\,\text{N}$. **Ans.**