

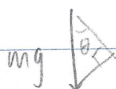
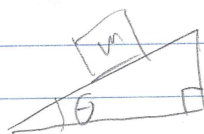
20-P-MOM-04-24

A $m = 0.1 \text{ kg}$ marble starts from rest and rolls down a rail in the shape of a cylindrical helix. The helix has a radius $r = 5 \text{ cm}$ and descends 5 cm for every revolution. Determine the magnitude of the velocity of the marble at time $t = 4 \text{ s}$. Assume the rails are frictionless.

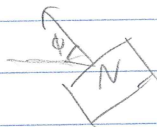


Solution: For $5 \text{ cm} \downarrow \quad 2\pi(5) \text{ cm} \rightarrow$

$$\theta = \tan^{-1}\left(\frac{5}{2\pi(5)}\right) = 9.043^\circ$$



$$N = mg \cos \theta$$



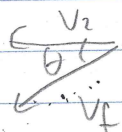
$$\cos \phi = \sin \theta$$

$N \sin \theta = \text{force in circular direction}$

$$m v_2 + \int M dt = m v_2$$

$$0 + \int_0^4 N \sin \theta (0.05) dt = m v_2$$

$$v_2 = \frac{0.05 N \sin \theta (4)}{m} = 0.305 \frac{\text{m}}{\text{s}} \text{ in tangent}$$



$$v_f = \frac{v_2}{\cos \theta} = 0.30877 \frac{\text{m}}{\text{s}}$$