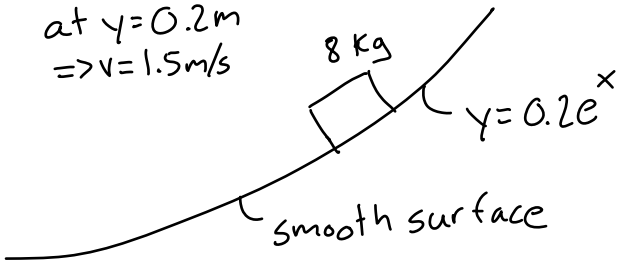
Kinetics of a Particle: Force and Acceleration

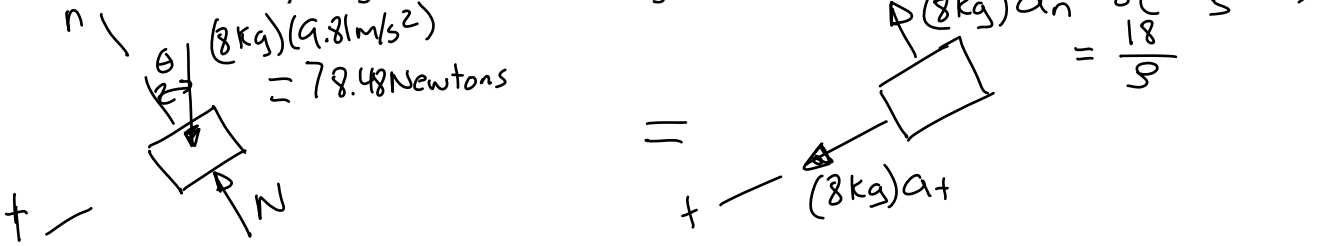
Problem Statement: The normal force and the rate of increase in speed at y = 0.2m.



1.) Determine the coordinate system.

Normal and Tangental Coordinates

2.) Draw the Free-Body Diagram and Kinetic Diagram.



3.) Apply F = ma.

$+\swarrow \sum F_t = ma_t$

$(78.48 \text{ Newtons})(\sin\theta) = 8a_t$

$+\uparrow \sum F_n = ma_n$

$N - (78.4 \text{ Newtons})(\cos\theta) = \frac{18}{\rho}$

4.) Apply kinematics to solve for additional unknowns.

$$\rho = \frac{\left[1+\left(\frac{dy}{dx}\right)^2\right]^{3/2}}{\left|\frac{d^2y}{dx^2}\right|}$$

$\frac{dy}{dx} = 0.2e^x$ $\quad \frac{d^2y}{dx^2} = 0.2e^x$

@ $y = 0.2m$ $\quad 0.2m = 0.2e^x$

$x = 0$

$\left.\frac{dy}{dx}\right|_{x=0} = 0.2$, $\left.\frac{d^2y}{dx^2}\right|_{x=0} = 0.2$

$$\rho = \frac{\left[1+(0.2)^2\right]^{3/2}}{0.2} = \boxed{5.3\text{ m}}$$

$\frac{dy}{dx} = \tan\theta$ $\quad \boxed{\theta = 11.31^\circ}$

$(78.48)(\sin 11.31^\circ) = 8a_t$ $\quad$ $a_t = 1.92\ m/s^2$

$N - (78.48)(\cos 11.31^\circ) = \frac{18}{5.3}$ $\quad$ $N = 80.35$ Newtons