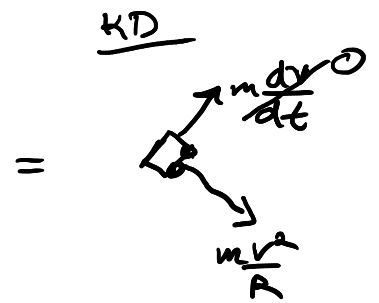
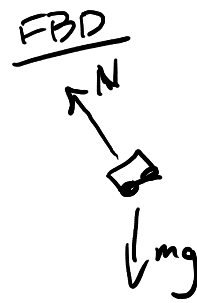


$$\theta \ll 1$$

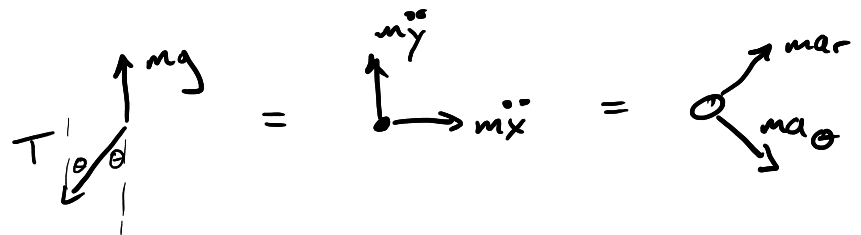
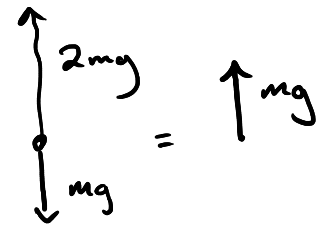
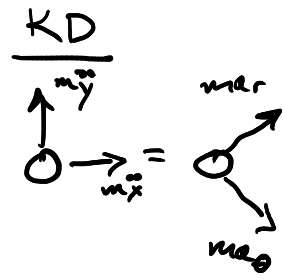
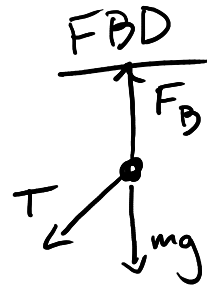
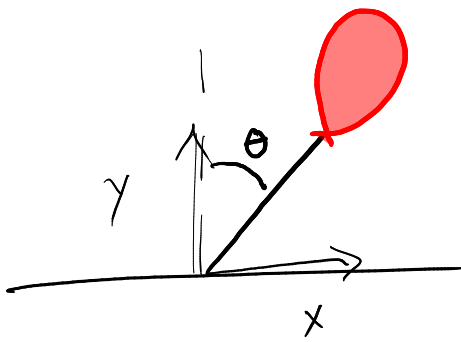
$$\cos \theta \sim 1$$



$$mg \cos \theta - N = \frac{mv^2}{R}$$

$$-\frac{mv^2}{R} + mg \cos \theta = N \geq 0$$

$$\frac{v^2}{R} = g \cos \theta$$



$$x \rightarrow \textcircled{1} -T \sin \theta = m \ddot{x}$$

$$y \rightarrow \textcircled{2} -T \cos \theta + mg = m \ddot{y}$$

$$\tan \theta = \frac{y}{x}$$

$$r^2 = x^2 + y^2$$

$$\frac{d}{dt}(r^2) = 0 = \frac{d}{dt}(x^2 + y^2) = 2x\dot{x} + 2y\dot{y}$$

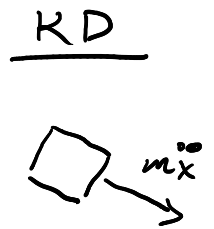
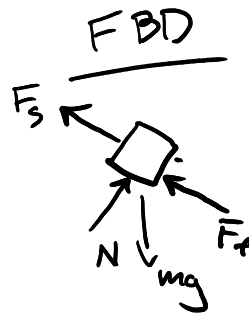
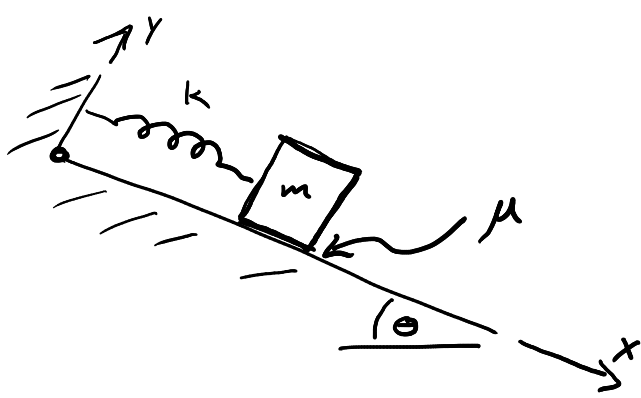
$$\frac{d}{dt}(2x\dot{x} + 2y\dot{y}) = 2\dot{x}^2 + 2\dot{y}^2 + 2x\ddot{x} + 2y\ddot{y} = 0$$



$$\hat{e}_r \rightarrow -T + mg \cos \theta = m(-r\dot{\theta}^2)$$

$$\hat{e}_\theta \rightarrow -mg \sin \theta = m(r\ddot{\theta})$$

$$\ddot{\theta} = -\frac{g}{r} \sin \theta \quad \underline{\underline{\text{com}}}$$



$$F_s = kx$$

$$F_f = \mu N \cdot \frac{v}{|v|} = \mu N \frac{\dot{x}}{|\dot{x}|}$$

$$m\ddot{x} = -F_s - F_f + mg \sin \theta$$

$$m\ddot{x} = -kx - \mu mg \cos \theta \cdot \frac{v}{|v|} + mg \sin \theta$$

$$\ddot{x} + \frac{k}{m}x = -\mu g \cos \theta \frac{\dot{x}}{|\dot{x}|} + g \sin \theta$$

$$x = x_H + x_p = \underbrace{A \cos \omega t + B \sin \omega t}_{x_H} + \underbrace{P}_{x_p}$$

$$\textcircled{1} \quad \ddot{x}_H + \frac{k}{m}x_H = 0 \quad \leftarrow \quad \omega^2 = \frac{k}{m}$$

$$\textcircled{2} \quad \ddot{x}_p + \frac{k}{m}x_p = g \sin \theta$$

$$\frac{k}{m} \cdot P = g \sin \theta \Rightarrow$$

$$P = \frac{mg \sin \theta}{k} \quad \begin{array}{l} \text{eqbm} \\ \text{sol'n} \end{array}$$

$$x(t) = A \cos \sqrt{\frac{k}{m}}t + B \sin \sqrt{\frac{k}{m}}t + \frac{mg \sin \theta}{k}$$

$$x(0) = x_0 = A + \frac{mg \sin \theta}{k}$$

$$\dot{x}(0) = v_0 = B \cdot \sqrt{\frac{k}{m}}$$