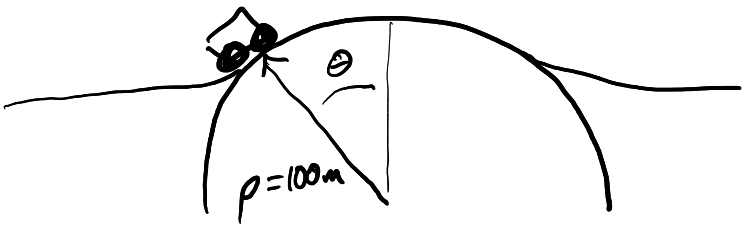
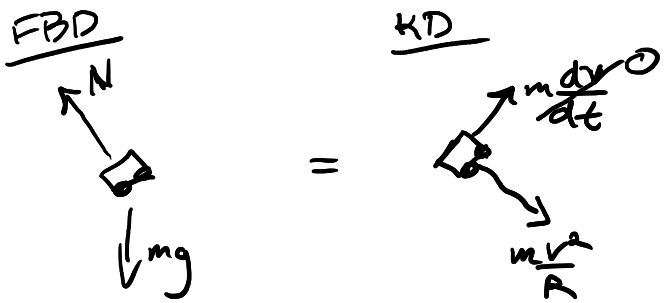


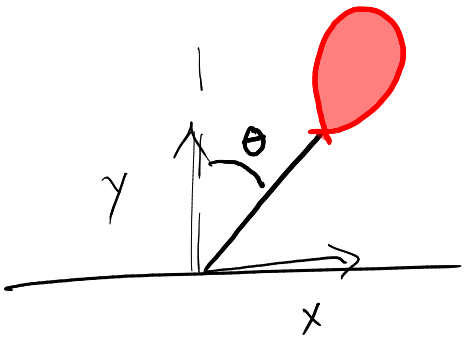

$\theta << 1$

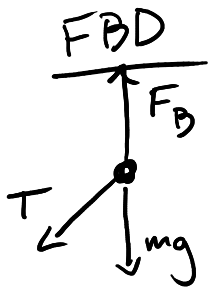
$\cos\theta \sim 1$

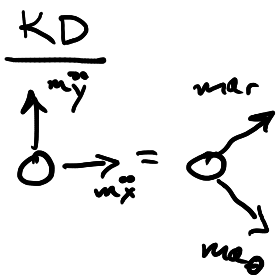
$$mg\cos\theta - N = \frac{mv^2}{R}$$

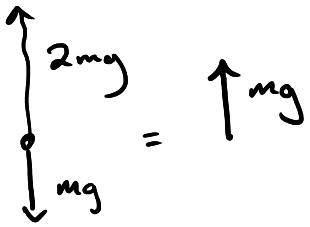
$$-\frac{mv^2}{R} + mg\cos\theta = N \geq 0$$

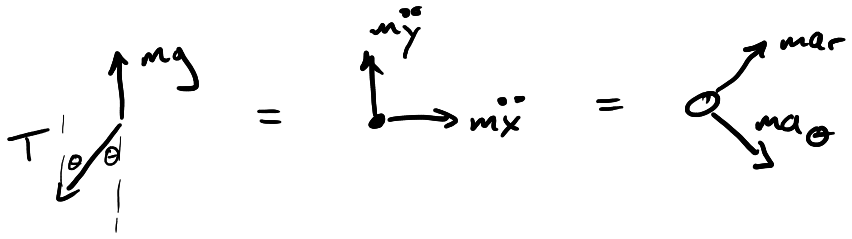
$$\frac{v^2}{R} = g\cos\theta$$




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

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

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

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

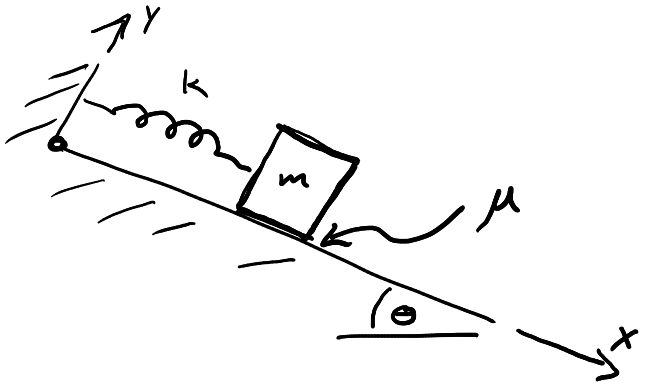
$$\frac{d}{dt}(r^2) = 0 = \frac{d}{dt}(x^2 + y^2) = 2x\dot{x} + 2y\dot{y}$$

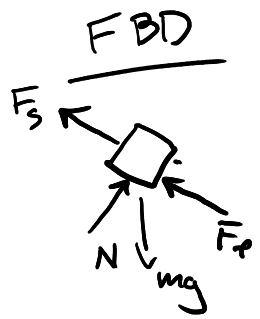
$$\frac{d}{dt}(2x\dot{x} + 2y\dot{y}) = 2\dot{x}^2 + 2\dot{y}^2 + 2x\ddot{x} + 2y\ddot{y} = 0$$

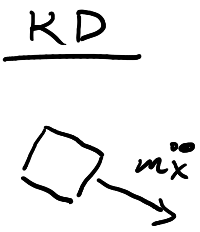
$\hat{e}_r \rightarrow$ $-T + mg\cos\theta = m(-r\dot{\theta}^2)$

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

$$\ddot{\theta} = \frac{-g}{r}\sin\theta$$ eom




$$F_s = kx$$

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

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

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

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

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

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

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

$$\frac{k}{m} \cdot P = g\sin\theta \Rightarrow \boxed{P = \frac{mg\sin\theta}{k}} \quad \text{eqbm soln}$$

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

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

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