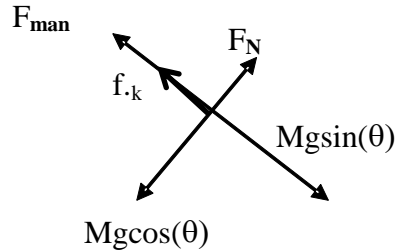


1. A man lowers a 330kg piano down a 28° incline as shown. He pushes parallel to the plane and keeps the piano from moving too fast. The piano accelerates from rest to 3m/s while traveling 2.25m down the incline. The surface has a coefficient of kinetic friction of $\mu_k = 0.2$



- a) Draw a FBD of the piano (only show x and y components)



- b) Based on the Free body write an Equation for the sum of the forces in the x-direction and y-direction

$$\Sigma F_y = F_n - m_p \cdot g \cdot \cos(\theta_{inc}) \quad \Sigma F_x = F_{man} + f_k - m_p \cdot g \cdot \sin(\theta_{inc})$$

- c) Determine the acceleration in the X and Y directions

up is positive $v_{op} := 0 \frac{m}{s}$ $v_{fp} := -3 \frac{m}{s}$ $s_{inc} := -2.25m$

$$a_x := \frac{v_{fp}^2 - v_{op}^2}{2 \cdot s_{inc}} \quad \boxed{a_x = -2 \frac{m}{s^2}} \quad a_y := 0 \frac{m}{s} \quad (\text{no motion}) \quad \forall$$

- d) Find the magnitude of the force exerted by the man

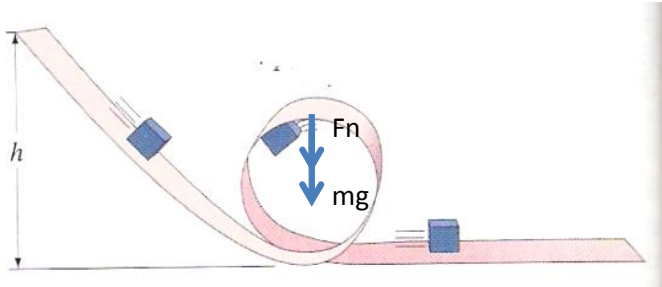
$$\Sigma F_y = F_n - m_p \cdot g \cdot \cos(\theta_{inc}) = m_p \cdot a_y \quad F_n := m_p \cdot g \cdot \cos(\theta_{inc}) \quad \boxed{F_n = 2.857 \times 10^3 \text{ N}}$$

$$f_k := \mu_k \cdot F_n \quad \boxed{f_k = 571 \text{ N}} \quad \Sigma F_x = F_{man} + f_k - m_p \cdot g \cdot \sin(\theta_{inc}) = m_p \cdot a_x$$

$$F_{man} := m_p \cdot a_x - f_k + m_p \cdot g \cdot \sin(\theta_{inc}) \quad \boxed{F_{man} = 288 \text{ N}}$$

2. A 5kg block released at rest, from a height of “h” meters above the ground, slides down a rough surfaced 30 degree incline. It reaches the bottom traveling at 10 m/s. The block then enters a frictionless vertical loop of radius 2m. The block performs one revolution and exits the loop. Although not correct we will assume the block performs uniform circular motion

- a) Draw the FBD of the block at the top of the circle



- b) Find the normal force at the top of the hoop

$$m_B := 5\text{kg} \quad V_h := 10 \frac{\text{m}}{\text{s}} \quad R_h := 2\text{m}$$

$$\text{at top} \quad a_R := \frac{V_h^2}{R_h} \quad a_R = 50 \frac{\text{m}}{\text{s}^2}$$

$$\boxed{\text{down is } +} \quad \Sigma F_y = F_{nT} + m_B \cdot g = m_B \cdot a_R \quad F_{nT} := m_B \cdot a_R - m_B \cdot g \quad \boxed{F_{nT} = 201 \text{ N}}$$

- c) Find the time for mass to go once around

$$V_h = \frac{2 \cdot \pi \cdot R_h}{T_h} \quad T_h := \frac{2 \cdot \pi \cdot R_h}{V_h} \quad \boxed{T_h = 1.26\text{s}}$$

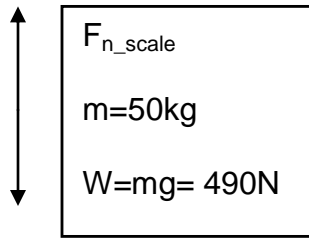
3. A 50kg person stands on a scale placed in a elevator. As an elevator passes the 49th floor it is traveling at a speed of 6m/s. The elevator uniformly slows down requiring 16m to eventually stop at the 55th floor..

- a) Find the acceleration of the elevator

$$\text{up is } + \quad V_f := 0 \frac{\text{m}}{\text{s}} \quad V_0 := 6 \frac{\text{m}}{\text{s}} \quad \Delta y := 16\text{m}$$

$$a := \frac{V_f^2 - V_0^2}{2 \cdot \Delta y} \quad \boxed{a = -1.125 \frac{\text{m}}{\text{s}^2}}$$

- b) Draw the FBD of the person and use it to write an expression for the sum of the forces acting on the person



$$\Sigma F = F_{N_Scale} - W_p$$

- c) Find the reading of the scale

$$\Sigma F = F_{N_Scale} - W_p = m_p \cdot a \quad F_{n_scale} := m_p \cdot a + W_p \quad \boxed{F_{n_scale} = 434 \text{ N}}$$

4. A balloon rises at a constant speed of 10 m/s. At an altitude of 36.1 m a ball is thrown out of the balloon with a velocity of 20 m/s at an angle of 30 degrees above the horizontal. It strikes the ground a little time later.

- a) Populate the tables with only the given information

a_x	V_{fx}	V_{0x}	Δx	Δt
0		17.3		

a_y	V_{fy}	V_{0y}	Δy	Δt
-9.8		20	-36.1	

up is positive $V_B := 10 \frac{m}{s}$ $V_{ball_O_B} := 20 \frac{m}{s}$ $\theta_{ball_O_B} := 30deg$

$$V_{ball_O_x} := V_{ball_O_B} \cdot \cos(\theta_{ball_O_B}) \quad V_{ball_O_x} = 17.3 \frac{m}{s}$$

$$V_{ball_O_Y} := V_{ball_O_B} \cdot \sin(\theta_{ball_O_B}) + V_B \quad V_{ball_O_Y} = 20 \frac{m}{s}$$

- b) Find the average velocity of the ball for the entire trip

$$V_{\text{ball_fy}} := -\sqrt{V_{\text{ball_O_Y}}^2 + 2 \cdot a_{\text{by}} \cdot \Delta y_{\text{b}}} \quad V_{\text{ball_fy}} = -33 \frac{\text{m}}{\text{s}}$$

$$V_{\text{ave_x}} := \frac{V_{\text{ball_O_x}} + V_{\text{ball_F_x}}}{2} \quad V_{\text{ave_x}} = 17 \frac{\text{m}}{\text{s}}$$

$$V_{\text{ave_y}} := \frac{V_{\text{ball_O_Y}} + V_{\text{ball_fy}}}{2} \quad V_{\text{ave_y}} = -7 \frac{\text{m}}{\text{s}}$$

$$V_{\text{ave}} := \sqrt{V_{\text{ave_x}}^2 + V_{\text{ave_y}}^2} \quad V_{\text{ave}} = 18.5 \frac{\text{m}}{\text{s}}$$

$$\theta_{\text{ave}} := \text{atan} \left(\frac{V_{\text{ave_y}}}{V_{\text{ave_x}}} \right)$$

$$\theta_{\text{ave}} = 21 \text{ deg}$$

4th Quadrant