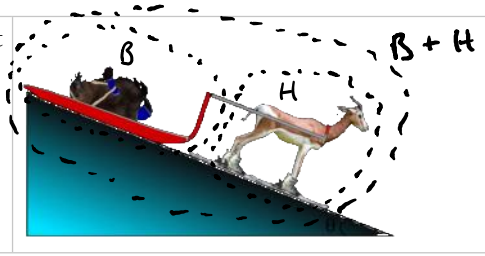
Week 7 Quiz

Thursday, November 12, 2020 1:32 PM

After Benny Beaver takes a fall in the World Skiing Championships, he is rescued by Hope, the taupe antelope. Hope, on their skis, slides down the mountain with Benny, tied on top of a sled, sliding behind, as pictured. Connecting Hope to Benny and the sled is a metal pole that is parallel to the surface of the mountain. The metal pole is attached in such a way that it can only exert forces parallel to the mountain surface. The coefficient of kinetic friction between the sled and the surface of the snow is 0.08, while the coefficient of kinetic friction between Hope's skis and the surface of the snow is 0.16. Together, Benny and the sled have the same mass as Hope. The slope of the mountain is 30 degrees with respect to the horizontal.

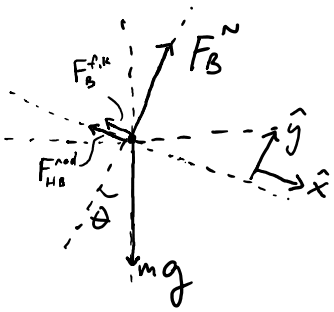
(a) What is the magnitude of their acceleration? Find a numerical answer that does not depend on the mass of Hope or Benny and the sled.

(b) Are Benny and the sled pushing down the incline on Hope, or pulling up the incline on Hope? Explain your reasoning thoroughly using any combination of words, math, pictures, etc.

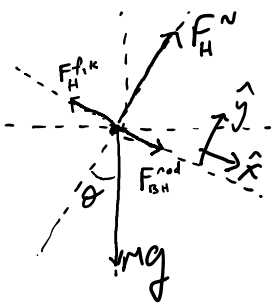


(a)

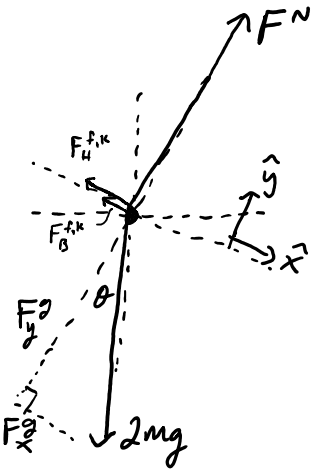
FBD (Benny + sled)



FBD (H)



FBD (H+B+Sled)



Constraints

$\vec{a}_B = \vec{a}_H \equiv \vec{a}$

$M_{B+S} = M_H \equiv M$

$F^{f,k} = \mu_K F^N$

To find Friction forces, need Normal forces

[H] $\Sigma F_y = M a_y^{\to 0}$

$F_H^N - Mg\cos\theta = 0$

$F_H^N = Mg\cos\theta$

$F_H^{f,k} = \mu_{K_H} F_H^N$

$= \mu_{K_H} Mg\cos\theta$

w/ $M_B = M_H$, $F_B^N = F_H^N$

+ w/ $\mu_{K_H} = 2\mu_{K_B}$

$F_H^{f,k} = 2F_B^{f,k}$

[H+B+sled] $\Sigma F_x = Ma_x \Rightarrow F_x^a - F_B^{f,k} - F_H^{f,k} = (M_{B+S} + M_H)a_x$

$2Mg\sin\theta - \mu_{K_H} Mg\cos\theta - \mu_{K_B} Mg\cos\theta = 2Ma_x$

$a_x = g\sin\theta - \frac{2}{2}\cos\theta(\mu_{K_H} + \mu_{K_B})$

$a_x = 3.88\ m/s^2$

(b) w/ $m_B = m_H$, + no other forces ⊥ to incline, $F_B^N = F_H^N$

then w/ $\mu_{k_B} < \mu_{k_H}$, $F_B^{f,k} < F_H^{f,k}$ .... Benny would slide more easy.

Benny pushes on Hope Down the incline

Rubric

~~ Part (a) - 8.5 points ~~ 2 pts - FBD's 1 pt - Acceleration constraint 0.5 pt - Friction force equals coefficient times normal force equation 2 pts - 2nd Law analysis 1 pt - Finding normal force 1.5 pts - Finding acceleration down the incline - application and algebra 0.5 pt - correct answer and units	~~ Part (b) - 1.5 pts ~~ 1 pt - explanation 0.5 pt - answer