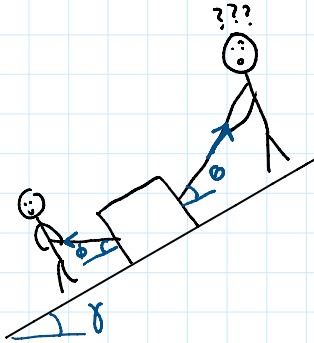
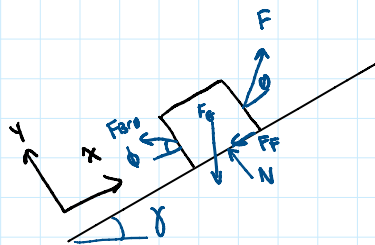


20-R-WE-DK-19 Intermediate Power and Efficiency

Inspiration: None



For a sports day event, you are partnered with your little brother in order to pull a **10 kg** box up a hill angled at **gamma = 30 degrees** with a coefficient of kinetic friction of **mu_k = 0.25**. The event is a race and you really want to win so you apply a force at an angle **theta = 20 degrees**. Your brother misheard the instructions so he applies a force **F_bro = 5 N** at an angle **phi = 15 degrees** in the opposite direction. You estimate the box must have a constant velocity **v = 4 m/s** up the hill to win. What is the power you must exert?



$$\begin{aligned} \sum F_x &= F \cos \theta - F_f - mg \sin \gamma - F_{bro} \cos \phi = 0 \\ \sum F_y &= F \sin \theta + F_{bro} \sin \phi - mg \cos \gamma + N = 0 \end{aligned}$$

$$F \cos 20 = 0.25N + (10)(9.81) \sin 30 + 5 \cos 15$$

$$N = (10)(9.81) \cos 30 - 5 \sin 15 - F \sin 20$$

$$F(\cos 20 + 0.25 \sin 20) = 0.25(10)(9.81) \cos 30 - 5(0.25) \sin 15 + (10)(9.81) \sin 30 + 5 \cos 15$$

$$F = 72.95703211$$

$$P = \vec{F} \cdot \vec{v} = F v \cos \theta = (72.95703211)(4) \cos 20 = \boxed{274.2247386 \text{ W}}$$