
Herman the Horse is feeling motivated after successfully taking his rider, Justin, to his friend's place. In order to achieve his long-time aspirations to be one of Santa's reindeers, he decides to demonstrate his strength to impress Santa's scouts hidden among the trees and shrubs. He begins loading weights into the sleigh with Justin so that he can highlight his pulling strength. If Herman can exert a maximum pull force that is just slightly greater than $P_{max}$, what is the maximum total mass of the weights $m_{max}$ that he should load into the sleigh, assuming that he starts from rest, in order to demonstrate his great strength? Assume that Justin's mass and the sleigh's mass are negligible and that Herman has a mass of $m_H\,\mathrm{kg}$.

$+\uparrow \Sigma F_y = 0 \rightarrow N - m \cdot g = 0$

$\Rightarrow N = m \cdot g$

In order to move the sleigh, Herman has to exert a force greater than the maximum static friction force.

$F_{max} = \mu_s \cdot N = \mu_s \cdot m \cdot g$

$$+ \rightarrow \Sigma F_x = 0 \rightarrow P - F_{max} = 0$$
$$\Rightarrow P = \mu_s \cdot m \cdot g$$

Since $P$ is proportional to $m$, maximum mass $m_{max}$ occurs at $P_{max}$

$$m_{max} = \frac{P_{max}}{\mu_s \cdot g}$$

After the sleigh begins sliding and reaches a speed of $s$ m/s, Herman eases up and exerts a force of $P_{steady}$ to keep the sleigh sliding at constant speed. Find the kinetic coefficient of friction between the surface and the sleigh.

$$+ \rightarrow \Sigma F_x = 0 \rightarrow P_{steady} - \mu_k \cdot m_{max} \cdot g = 0$$
$$\Rightarrow \mu_k = \frac{P_{steady}}{m_{max} \cdot g}$$