Ch4 Q14. According to Newton's third law, each team in a tug of war pulls with equal force on the other team. What then, determines which team will win?

The friction force each feels from the ground, harder on the ground.

Ch4 Q19. A heavy crate rests on the bed of a flatbed truck. When the truck accelerates, the crate stays fixed on the truck, so it, too, accelerates. What force causes the crate to accelerate?

Friction between the bed of the truck and the crate.

Ch4 Q22. What would you bathroom scale read if you weighed yourself on an inclined plane? Assume the mechanism functions properly, even at an angle.

Less, specifically, cosθ times your weight.

Ch4 P20. A box weighing 77.0 N rests on a table. A rope tied to the box runs vertically upward over a pulley and a weight is hung from the other end. Determin the force the table exerts on the box if the weight hanging on the other sie of the pully weighs (a) 30.0 N (b) 60.0 N, and (c) 90.0N

We have that for the box

$$m_{\text{ box}}a_{\text{box}} = T_{\text{box}} - m_{\text{box}}g + n$$

and for the weight,

$$m_{\text{weight}}a_{\text{weight}} = T_{\text{weight}} - m_{\text{weight}}g$$

We have the the T's are the same. Since both are still, $a_{\text{box}} = a_{\text{weight}} = 0,$ so

$$n = m_{\text{box}}g - m_{\text{weight}}g$$

as we expect. So the normal forces felt are (a) 47.0N, (b) 17.0 N, and for (c), zero newtons since the box would now be accelerating upwards.

Ch4 P37. A force of 35.0 N is required to start a 6.0 Kg box moving acrosss a horizontal concrete floor. (a) What is the coefficient of static firction between the box and the floor? (b) If the 35.0 N force continues, the box accelerates at 0.60 m/s^2. What is the coefficient of kinetic friction?

We have that the normal force the box feels is 6.0Kg $\cdot g$ = 59N.Thus, the maximum static friction force must be

$$\begin{aligned} 35.0\,\text{N} &= \mu_s 59\text{N} \\ \Rightarrow \mu_s &= \frac{59\text{N}}{35.0\,\text{N}} \\ &= 0.60 \end{aligned}$$

Also, when pushing the box, we have that

$$\begin{aligned} 6.0\,\text{Kg}\cdot(0.6\,\text{m/s}^2) &= 35\text{N} - \mu_k 59\text{N} \\ \Rightarrow 35.0\text{N} - 3.6\text{N} &= \mu_k 59\text{N} \\ \Rightarrow \mu_k &= \frac{31.4\,\text{N}}{59\text{N}} \\ &= 0.53 \end{aligned}$$

Ch4 P50. A person pushes a 14.0 Kg lawn mower at a constant speed with a force of $F = 88.0$N directed at the handle which is at an angle of 45° to the horizontal. (a) Draw the free-body diagram showing all the forces acting on the mower. Calculate (b) the horizontal diction force on the mower, then (c) the normal force exerted vertically upward on the mower by the ground. (d) What force must the person exert on the lawn mower to accelerate it from to 1.5 m/s in 2.5 seconds, assuming the same friction force?

(a) do it. For (b), since it is moving at a constant speed, assume no net force. Thus,

$$\begin{aligned} 0 &= 88.0\text{N}\cos 45 - f \\ \Rightarrow f &= 88.0\text{N}\cos 45 \\ &= 62.2\,\text{N}. \end{aligned}$$

Since $\sin 45 = \cos 45 = 1/\sqrt{2}$. We have that vertically,

$$\begin{aligned} 0 &= f_n - 62.2\,\text{N} - 14.0\,\text{Kg}g \\ \Rightarrow f_n &= 62.2\,\text{N} + 137\text{N} \\ &= 199\,\text{N}. \end{aligned}$$

For it to accelerate from rest to 1.5 m/s in 2.5 second assuming constant acceleration,

$$\begin{aligned} a_x &= \frac{1.5}{2.5} \\ &= \frac{3}{5} \\ &= 0.6\,\text{m/s}^2. \\ \Rightarrow (14.0\,\text{Kg})0.6\text{m/s}^2 &= F - 62.2\text{N} \\ \Rightarrow &= 70.6\,\text{N}. \\ &= a\cos 45 \\ \Rightarrow a &= (\sqrt{2})70.6\,\text{N} \\ &= 99.8\,\text{N}. \end{aligned}$$

Ch4 P59. The crate shown in blah lies on a plane tilted at an angle of $\theta = 25.0$ ° to the horizontal, with $\mu_k = 0.19$. (a) Determine the acceleration of the crate as it slides down the plane. (b) If the crate starts from rest 8.15 m up along the plane from its base, what will the be the crate's speed when it reaches the bottom of the incline?

We have that, choosing a coordinate system along the plane,

$$\begin{aligned} m a_y &= f_n - m g \cos\theta \\ m a_x &= m g \sin\theta - \mu_k n. \end{aligned}$$

Since $m a_y = 0$, $f_n = m g \cos\theta$. Therefore,

$$\begin{aligned} m a_x &= m g \sin\theta - \mu_k m g \cos\theta \\ \Rightarrow a_x &= g \sin\theta - \mu_k g \cos\theta \\ &= g(\sin 25 - (0.19)\cos 25) \\ &= 2.5\,\text{m/s}^2 \end{aligned}$$

For (b), use basic kinematics

$$\begin{aligned} v_f^2 &= 0 + 2\,(2.5\,\text{m/s}^2)(8.15\,\text{m}) \\ &= 40.0(\,\text{m/s})^2 \\ \Rightarrow v_f &= 6.3\,\text{m/s}. \end{aligned}$$