21-P-WE-AG-030

A human is pushing a *M*-kg box from rest with a force of $F = Bt + Mg\mu_s$. The coefficient of kinetic friction is μ_k and the coefficient of static friction is μ_s. What is the human's power output when the box reaches $V\frac{m}{s}$?

Do not assume that the values in this question are realistic

ANSWER:

First, we write down the equation for force in this system.

$$F = ma \rightarrow a = \frac{F}{m} = \frac{Bt + Mg\mu_s - Mg\mu_k}{M}$$

Then, we determine the time by using a kinematics equation and then rearranging to solve for time.

$$v_f = v_i + at = 0 + \frac{Bt + Mg\mu_s - Mg\mu_k}{M} \cdot t$$

$$\frac{B}{M}t^2 + (g\mu_s - g\mu_k) \cdot t - v_f = 0$$

$$t = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} = \frac{-(g\mu_s - g\mu_k) \pm \sqrt{(g\mu_s - g\mu_k)^2 - 4 \cdot \frac{B}{M} \cdot (-v_f)}}{2 \cdot \frac{B}{M}}$$

Then, we simply use the equation for power to determine the human's power output.

$$P = Fv = (B \cdot t + Mg\mu_s) \cdot V\frac{m}{s}$$