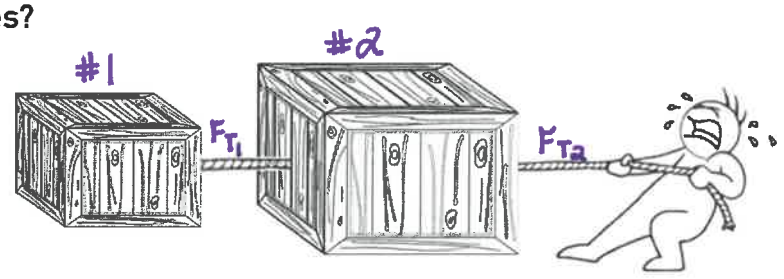
AP Physics

Objects in Equilibrium Name: Key

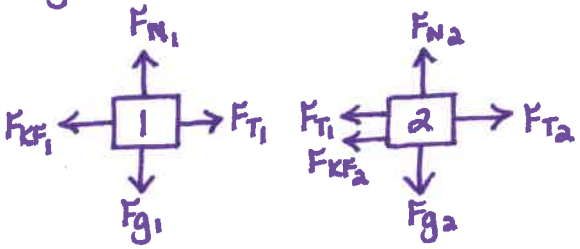
Two large boxes are connected by a rope, as shown below. The larger box is pulled by a second rope, held horizontally, so that the two boxes are moving at a constant speed. The larger box weighs 500 N and the smaller box weighs 200 N. The coefficient of kinetic friction between the floor and the boxes is 0.2. How much force does the person apply in pulling the boxes?



Given: $F_{g_2} = 500$ N
$F_{g_1} = 200$ N
$\mu_K = 0.2$
constant speed

Want: F_{T_2}

Figure:



$\mu_K F_{g_1} + \mu_K F_{g_2} = F_{T_2}$

$(0.2)(200) + (0.2)(500) = F_{T_2}$

$\boxed{F_{T_2} = 140 \text{ N}}$

Conclusion:
The person needs to apply 140 N of force to move the boxes at a constant speed.

Calculations:
constant speed ⇒ equilibrium
⇒ up forces = down forces
left forces = right forces

Box #1:
$F_{N_1} = F_{g_1}$

$F_{KF_1} = F_{T_1}$
$\mu_K F_{N_1} = F_{T_1}$ ← Kinetic Friction: $F_{KF} = \mu_K F_N$

Box #2:
$F_{N_2} = F_{g_2}$

$F_{T_1} + F_{KF_2} = F_{T_2}$
$F_{T_1} + \mu_K F_{N_2} = F_{T_2} \Rightarrow \mu_K F_{N_1} + \mu_K F_{g_2} = F_{T_2}$

$F_{N_1} = F_{g_1}$ (from Box #1 equation)