This problem must be handed in on paper according to the rules for group homework problems.

Your friend has just been involved in a car accident and is trying to negotiate with the insurance company of the other driver to get them to pay for the cost of the repairs. Your friend knows that they will do that if he can prove that the other car was speeding (but that he was not) and he asks you for your help in making the case for him.

You visit the scene of the accident and see that it happened on a bright sunny day at a remote country intersection where there was no stop sign either way. Your friend was heading north through the intersection when he was hit in the middle of the intersection by the other car heading east. The two cars got locked together by the crash and together moved (according to the skid marks) a total distance of 66 ft after the collision in a direction 30° north of east before stopping. Knowing the makes of the two cars, you find out from the library that the other car has a mass of 1000kg and your friend's car is 1200kg, where you have included the drivers' weights as well. The coefficient of kinetic friction for a rubber tire skidding on a dry pavement is 0.80 and the speed limit on both roads was 45 mph. Using this information, what conclusions about the cars' speeds do you arrive at in order to advise your friend?

\[ m_{ot} = 1000 \text{ kg} \]
\[ m_{fr} = 1200 \text{ kg} \]
\[ \mu_k = 0.80 \]

Use conservation of momentum. Since \( \vec{p} \) is a vector, break it into \( x \) and \( y \) components.

\[ \vec{p}_i = \vec{p}_f \]

\[ (1) \quad p_{x,i} = p_{x,f} \Rightarrow m_{ot} v_{x,ot} = \frac{M}{m_{fr} + M} (v_{f,total} \cos 30°) \]

\[ (2) \quad p_{y,i} = p_{y,f} \Rightarrow m_{fr} v_{y,fr} = M (v_{f,total} \sin 30°) \]

\( v_{f,total} \) is the initial velocity after impact. We can use kinematics to get this:

\[ F = ma \Rightarrow f = Ma \Rightarrow \mu M g = Ma \Rightarrow a = \mu g = (0.80)(9.8 \text{ m/s}^2) = 7.84 \text{ m/s}^2 \]

Then

\[ \gamma_i^2 = \gamma_f^2 + 2a \Delta s \Rightarrow \gamma_i^2 = 2(7.84 \text{ m/s}^2)(66 \text{ ft})(\frac{1 \text{ m}}{3.28 \text{ ft}}) \]

\[ \Rightarrow \gamma_i = 17.8 \text{ m/s} \equiv v_{f,total} \]

So in (1):

\[ v_{x,ot} = \frac{MV_{f,total} \cos 30°}{m_{ot}} = \frac{(2200 \text{ kg})(17.8 \text{ m/s}) \cos 30°}{1000 \text{ kg}} \approx \frac{2.24 \text{ mi/hr}}{1 \text{ m/s}} = 75.7 \text{ mi/hr} \]

In (2):

\[ v_{y,fr} = \frac{MV_{f,total} \sin 30°}{m_{fr}} = \frac{(2200 \text{ kg})(17.8 \text{ m/s}) \sin 30°}{1200 \text{ kg}} \approx \frac{2.24 \text{ mi/hr}}{1 \text{ m/s}} = 36.5 \text{ mi/hr} \]

⇒ Get money from the insurance company!!!