

Your friend has just been in a traffic accident and is trying to negotiate with the insurance company of the other driver to pay for fixing her car. She believes that the other car was speeding and therefore that the accident was the other driver's fault. She knows that you are taking Physics 111, so she asks you for help in proving her conjecture. She takes you out to the scene and describes what happened.

She was traveling north when she entered the fateful intersection. There was no stop sign, so she looked in both directions and did not see another car approaching. It was a bright, sunny, clear day. When she reached the center of the intersection, her car was struck by the other car which was traveling east. The two cars remained joined together after the collision and skidded to a stop. The speed limit on both roads entering the intersection was 80 km/hr. From the skid marks still visible on the street, you determine that after the collision the cars skidded 17m at an angle of  $30^\circ$  north of east before stopping. She has a copy of the police report which gives the year and make of each car. At the library you determine that the weight of her car was 1200kg and that of the other car was 1000kg, including the weight of the driver in each case. The coefficient of kinetic friction for a rubber tire skidding on dry pavement is 0.80. It is not enough to prove that the other driver was speeding to convince the insurance company. She must also show that she was under the speed limit. How do you advise her?

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The first part of the problem is an inelastic collision: momentum is conserved. The initial momentum in each direction can be used to find the momentum components for the combined mass of the crashed cars. After the cars collide the force of friction slows and stops their motion. Here, the work energy theorem applies. Friction is the only force that does work on the system, so the kinetic energy must all be dissipated in the work done by friction. By setting the kinetic energy equal to the work done by friction and using the given distance and coefficient of friction, you should be able to find the velocity of the crashed cars immediately after the collision. Using this velocity, the given masses, and the components of the final momentum that you found, you can find the initial speed of each of the cars in the collision. The speeds you find will be in  $m/s$  while the speed limit is given in  $km/hr$ . Convert the units and you will find that the speed limit is  $22.2 m/s$ , the other car was going  $31.12 m/s$ , and your friend was going  $14.97 m/s$ . In  $km/hr$ , your friend was going  $53.89 km/hr$  and the other driver's speed was  $112.03 km/hr$ . Whichever units you use, you find that the other driver was speeding and that your friend was not.

