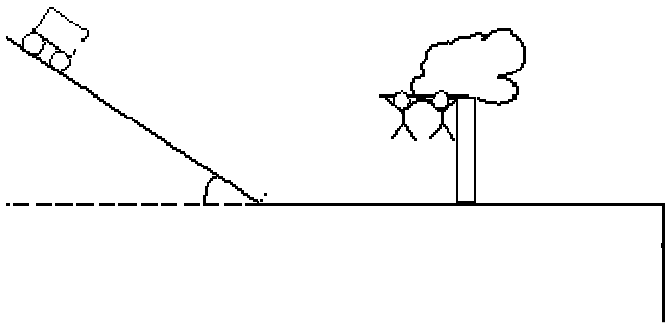
Physics 211 Week 7 Momentum: Lone Ranger

A wagon with two boxes of gold and having a total mass of 300 kg is cut loose from the horses by an outlaw when the wagon is at rest 50m up a 6^o slope. The outlaw plans to have the wagon roll down the slope and then across 50m of level ground before finally falling over a cliff into a canyon where his confederate waits. But, unknown to the outlaws, the Lone Ranger (mass of 80 kg) and Tonto (mass of 60kg) are waiting in a tree 40m from the cliff. They time their fall so that they drop vertically into the wagon just as the wagon passes beneath them. They require 5.0s to grab the gold and jump out of the wagon. Will they make it before the wagon goes over the cliff?



To know whether Tonto and the Lone Ranger make it out of the wagon before it goes over the cliff, we have to know the wagon's velocity. The velocity of the wagon changes after they fall into it because it is an inelastic collision and momentum is conserved. The velocity that the wagon has before the collision is a result of the conservation of energy from the top of the slope to the bottom. Beginning from the top of the slope, the wagon at rest has gravitational potential energy. All of the gravitational potential energy becomes kinetic energy by the time the wagon reaches the bottom of the slope. You can find the velocity of the wagon, then, using its mass, find its momentum. Use conservation of momentum to find the velocity of the wagon with Tonto and the Lone Ranger in it after the collision. The new velocity can be used with the known distance to the edge of the cliff to find the time available to Tonto and the Lone Ranger to grab the gold and jump out of the wagon. The wagon will go over the cliff 5.8 seconds after they jump in it. They only need 5 seconds, so they will have a little less than one second to spare!