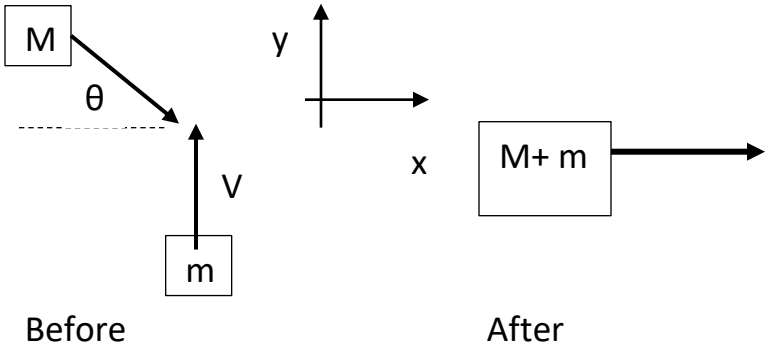
Phys 1135: Homework for Recitation #18: Momentum and energy

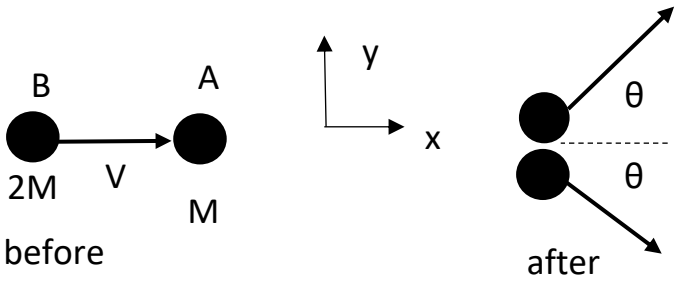
1. A bullet of mass 10g and unknown speed is shot horizontally into a block of mass 990g, initially at rest on a horizontal frictionless surface. The bullet embeds itself in the block, and the combined objects slide along the surface until they encounter a horizontal spring of spring constant 400N/m. The block, with the bullet in it, comes to momentarily rest when it has compressed the spring by 10 cm. Find the initial speed of the bullet.

2. A distracted professor is driving his car of mass *m* and speed *v* the wrong way out of the Physics Department parking lot, in the positive *y*-direction. At the same time, a student in her pickup truck of mass *M* is traveling at **unknown speed** on Pine Street which makes an angle θ with the *x*-axis. The car and the truck collide and stick together. The fused wreckage is skidding in the positive *x*-direction for some distance until it comes to a stop. The coefficient of kinetic friction between wreckage and road is μ.
Derive an expression for the distance the wreckage skids before coming to rest, in terms of *m*, *M, v, μ* and constants. (No people have been harmed in the creation of this problem.)

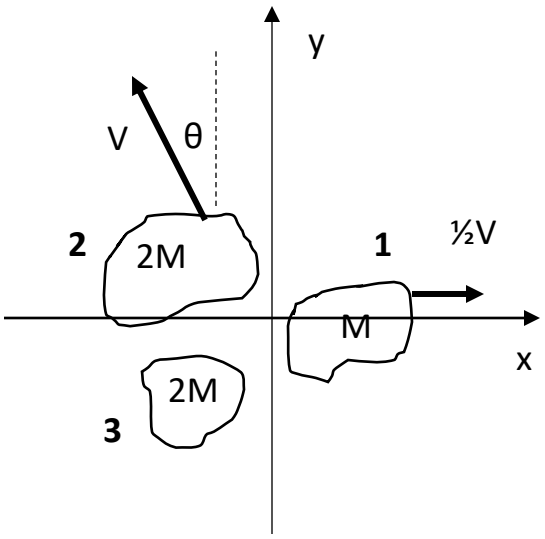


3. Object **A** of mass *M* is initially at rest on a flat, smooth frictionless surface. Object B, which has **twice** the mass of **A**, is traveling with speed *V* before it collides **elastically** with **A**. Immediately after the collision, both objects move off at angles θ>*0* with respect to the original direction of **B**.

Calculate the value of the angle θ. [Hint: Note that the collision is **elastic**.]



4. An UFO of mass 5*M* and zero speed is in deep space. Due to a communication problem between the alien crew members from different planets, the UFO explodes into three fragments when they are trying to start the engines. One fragment of mass *M* moves in the positive x-direction with speed ½*V*. The second fragment of mass 2*M* moves with speed *V* at an angle θ=30° left of the positive y-axis as shown in the figure. The third fragment has mass 2*M*.



Find the energy released in the explosion (Hint: you will need the speed of the third fragment). Simplify your expression as far as possible,

using $\sin 30^o = \frac{1}{2},\ \cos 30^o = \frac{1}{2}\sqrt{3}$.