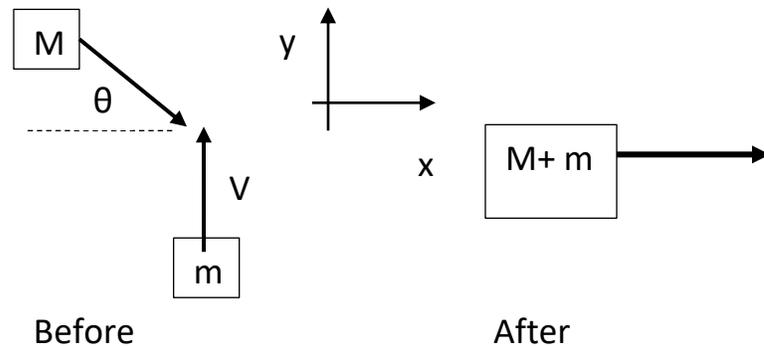


Phys 1135: Homework for Recitation #18: Momentum and energy

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 10cm . Find the initial speed of the bullet.

2. During the St. Pat's celebrations, for reasons we will not discuss, a person is driving a 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 law-abiding citizen in a 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 along the horizontal road surface for a distance D until it comes to a stop.

Derive an expression **for the coefficient of kinetic friction, μ** , between wreckage and road, in terms of m, M, v, D, θ and constants. You may use, without proof, that the normal force magnitude is equal to the weight magnitude. (No people have been harmed in the creation of this test problem.)

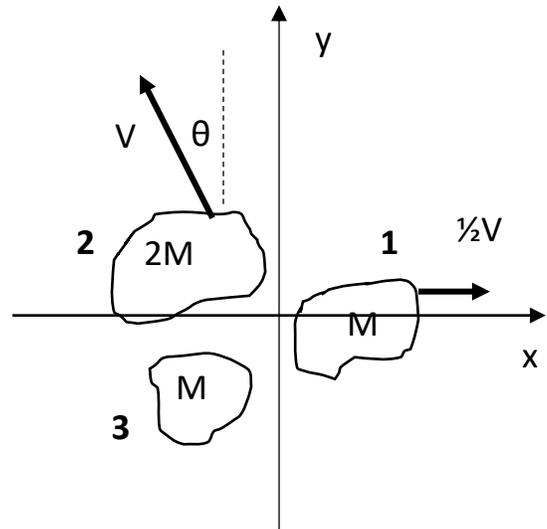


3. In a lecture demonstration – which you should watch on the course website if you have not seen it in class - a small ball of mass m is held directly above a large ball of mass M with a small space between them, and the two balls are dropped simultaneously from height H . (The height is much larger than the radius of each ball, so you may neglect the radius.) The large ball bounces **elastically** off the floor and the small ball bounces **elastically** off the large ball.

a) For which value of the mass m , in terms of M , does the large ball stop when it collides with the small ball?

b) What final height, in terms of H , does the small ball reach?

4. An UFO of mass $4M$ 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 $\frac{1}{2}V$. The second fragment of mass $2M$ moves with speed V at an angle $\theta=30^\circ$ left of the positive y -axis as shown in the figure. The third fragment has mass 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 $\sin 30^\circ = \frac{1}{2}$, $\cos 30^\circ = \frac{1}{2}\sqrt{3}$.