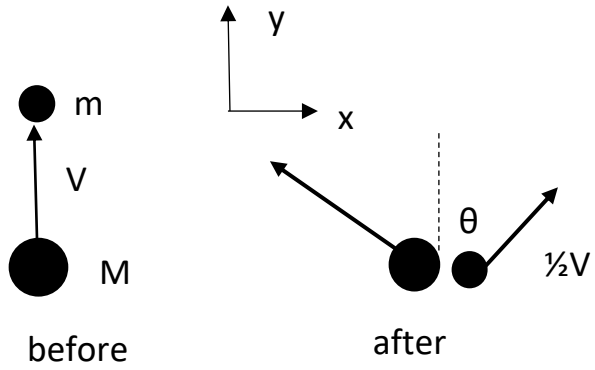
Physics 1135 Homework #17: Linear Momentum and Impulse

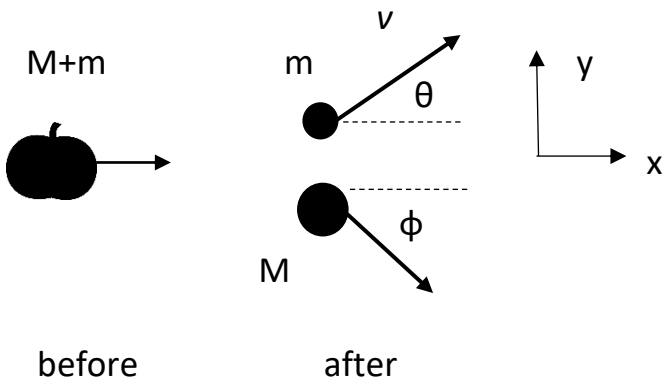
1. A baseball of mass 0.145kg is moving at 40m/s in the negative *x*-direction. After being hit by the bat, it moves with speed 50m/s at an angle 30° above the positive *x*-axis. The ball is in contact with the bat for 2 ms.
Calculate the impulse delivered to the ball by the bat and the average force exerted on the ball by the bat and express them in unit vector notation.

2. Gimli and Legolas are on a frozen pond. The pond surface is frictionless and horizontal. Legolas of mass *m* is originally standing still, gazing into the distance to look out for Orcs. Gimli with mass *M* is originally moving in the positive y-direction with speed *V*. He collides with Legolas.
After the collision Legolas is moving with speed ½*V* at angle θ from the positive y-direction, as shown in the figure, while Gimli is moving at an unknown speed in some unknown direction.



a) Derive an expression for Gimli's speed after the collision, in terms of system parameters.
b) Derive an expression for the **impulse** delivered **to** Legolas **by** Gimly in unit vector notation.

3. Students are testing their physics understanding by filling a pumpkin with an explosive material. The pumpkin of total mass *M*+*m* moves on a frictionless horizontal table in a straight line in the positive x-direction. It explodes and breaks up into two fragments of mass *M* and *m*, respectively. The figure shows a top view of the table. Immediately after the explosion, the fragment of mass *m* moves with speed ***v*** at an angle θ above the positive *x*-direction; the fragment of mass *M* moves at an angle φ below the positive *x*-direction. Startled by the explosion, the students failed to record the initial speed of the pumpkin and the final speed of the fragment of mass *M*.



Derive an expression for the speed of the pumpkin before the explosion, in terms of system parameters.

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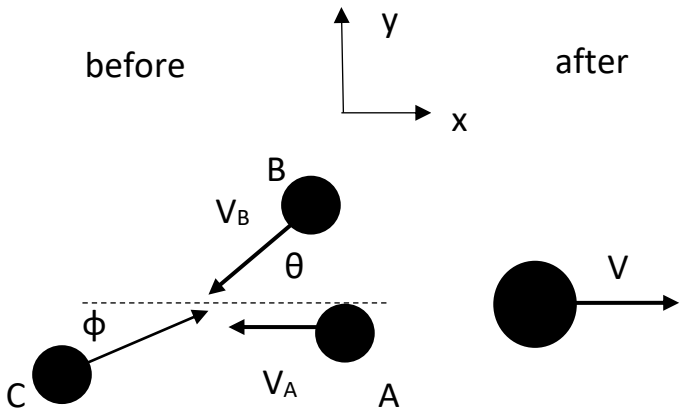
4. Three spheres, each of mass M, are sliding on a frictionless table towards the origin. Sphere A is moving at speed v_A in the negative *x*-direction. Sphere B is moving at speed v_B at an angle θ with respect to the x-axis, as shown in the figure. Sphere C moves with unknown speed at some (unknown) angle Φ with respect to the *x*-axis, as shown in the figure. The spheres undergo a perfectly inelastic collision. They stick together and end up moving at speed *V* in the positive x-direction.



Derive an expression for the angle Φ at which sphere C was approaching the origin before the collision.