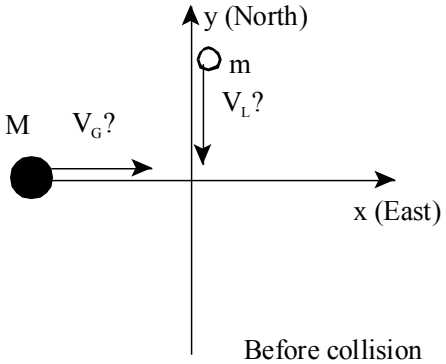
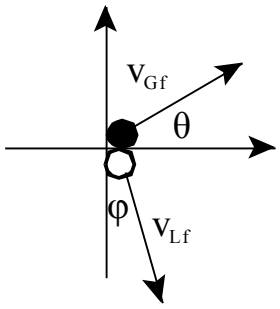
**Physics 1135 Homework for recitation 17: Linear Momentum and Impulse**

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 slide on a frozen pond. The pond surface is frictionless and horizontal. Gimli with mass *M* is originally moving **eastwards**. Legolas with mass *m* is originally sliding **southward**. They collide, and after the collision Gimli is moving with speed $\boldsymbol{v_{Gf}}$ at angle θ north of east (i.e. above the positive x-axis), while Legolas is moving with speed $\boldsymbol{v_{Lf}}$ at angle φ east of south (i.e.right from the negative y-axis), as shown in the figure.



Before collision

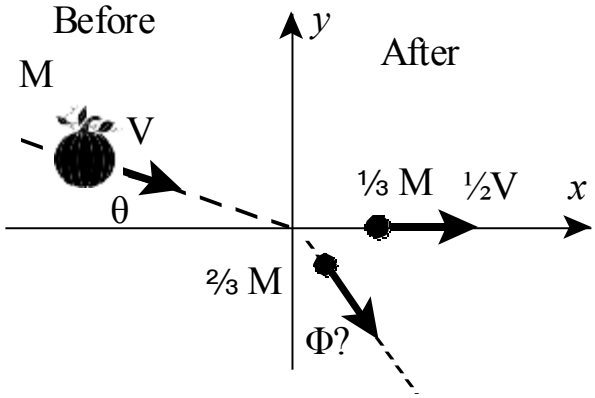


After collision

a) Derive expressions for the speeds of Gimli and Legolas, $V_G$ and $V_L$, respectively, **before** the collision, in terms of system parameters.

b) Derive an expression for the **impulse** delivered **to** Gimli **by** Legolas, in unit vector notation.
c) What is the impulse delivered to Legolas by Gimly in unit vector notation?

3. Students are experimenting with an explosives filled pumpkin. The pumpkin of total mass *M* moves with speed *V* on a frictionless horizontal table in a straight line that makes an angle θ with the *x*-direction, as shown in the diagram. It explodes and breaks up into two fragments of unequal masses. Fragment A of mass ⅓M moves with speed ½V in the positive *x*-direction.




Because of their excitement over the successful explosion, the students failed to record any information about the movement of the other fragment, B. The figure shows a top view of the table.

In terms of relevant system parameters, find the angle Φ the velocity of fragment B immediately after the explosion makes with the negative *y*-direction (see figure).

4. A helium nucleus, which is also called an *alpha particle*, of mass 4.0 u is moving along the positive *x*-axis and collides with a stationary oxygen nucleus of mass 16.0 u. After the collision, the oxygen nucleus moves with speed $1.2\times10^5$ m/s at angle θ=50º above the positive *x*-axis, and the alpha particle moves with speed at angle φ=60º below the positive *x*-axis. Find the speed of the alpha particle before and after the collision. (Hint: you do not need to convert u into kg!)