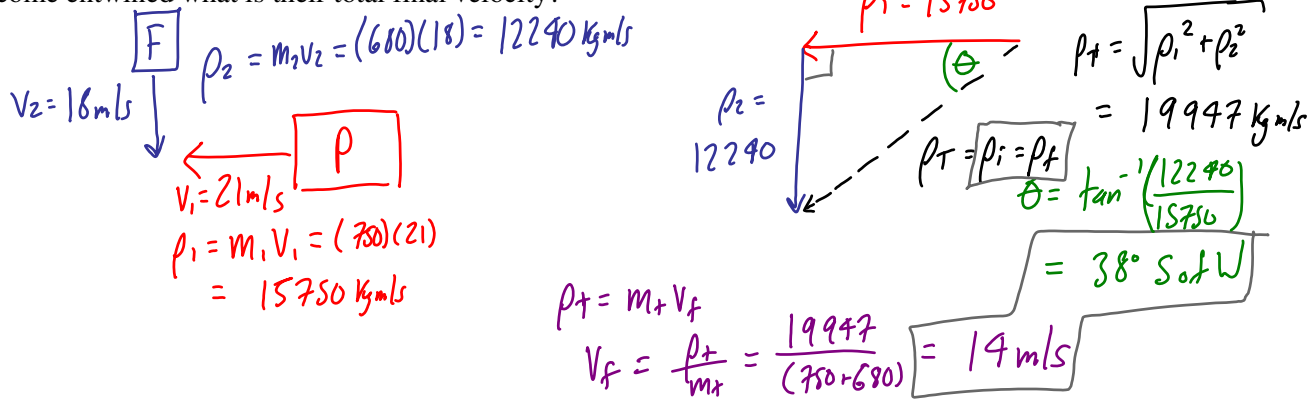
Work, Energy and Momentum Notes

4 – Collisions in 2-D

When dealing with collisions in 2-dimensions it is important to remember that momentum is a vector with magnitude and direction. When finding the **total momentum** we have to do: vector addition

Collisions at 90°:

A 750 kg Peugeot travelling at 21 m/s West collides with a 680 kg Fiat travelling at 18 m/s South. If the two cars become entwined what is their total final velocity?

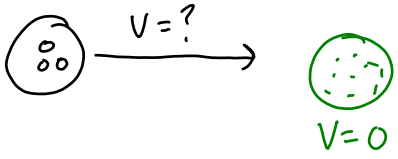


Remember that it is momentum that is conserved, so we need to add the momenta **NOT** velocities

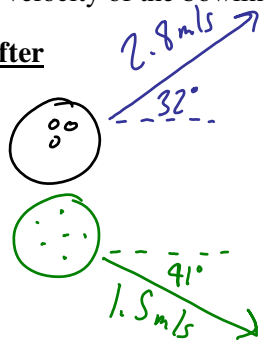
Collisions not at 90° (because life is never that easy…):

A 4.0 kg bowling ball is moving east at an unknown velocity when it collides with a 6.1 kg frozen cantaloupe at rest. After the collision, the bowling ball is traveling at a velocity of 2.8 m/s 32° N of E and the cantaloupe is traveling at a velocity of 1.5 m/s 41° S of E. What was the initial velocity of the bowling ball?

Before

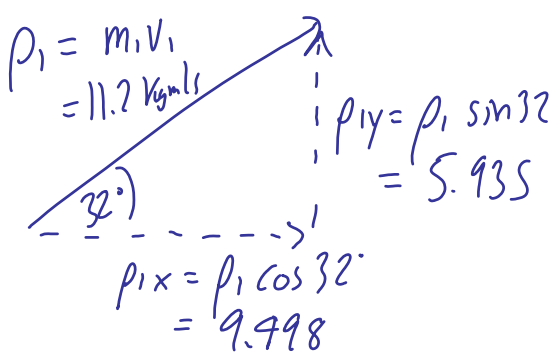


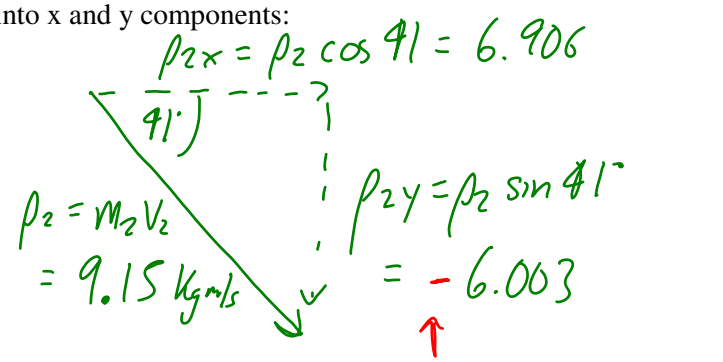
After



Component Method

We need to break the final momenta of the two objects into x and y components:





Remember: when using components to include +/- signs.

We then add the **individual x** and the **individual y** components to find our total momentum.

$\Sigma p_x = p_{1x} + p_{2x} =$ $9.498 + 6.906 = 16.404$ kg m/s

$\Sigma p_y = p_{1y} + p_{2y} =$ $5.935 + (-6.003) = -0.068$ kg m/s $\simeq 0$

Notice that the total momentum is all in the x direction ! This should be no surprise since the bowling ball was initially only moving in the x direction.

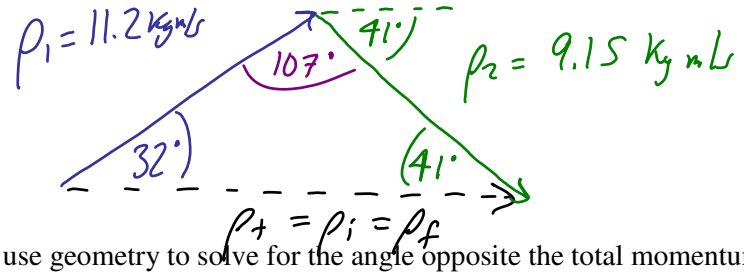
Don't forget to solve for the initial velocity (magnitude and direction):

$p_t = p_x = 16.404$ kg m/s

$p_i = m_1 v_{1i}$ $\quad v_{1i} = \frac{p_i}{m_1} = \frac{16.404}{4.0} =$ **4.1 m/s East**

Vector Addition:

Simply add the vectors and solve with the sine or cosine law. Notice that the total momentum is either the initial or the final because momentum is conserved.



First we need to use geometry to solve for the angle opposite the total momentum.

And then, start hammering:

$\frac{p_t}{\sin 107} = \frac{11.2}{\sin 41}$ $\quad p_t = 11.2 \frac{\sin 107}{\sin 41}$

$= 16.33$ kg m/s

$v_i = \frac{p_i}{m_1} = \frac{16.33}{4.0} =$ **4.1 m/s**