Homework 10:

Suppose we have two particles each of mass M. One of the particles is at rest (in your rest frame) and the other is traveling with a speed of v_0. Suppose the two particles crash and stick together to form a new particle.

a. Show that the total energy of the systems (which is the sum of the energies of the two particles) is
$$E = Mc^2\left(1 + \frac{1}{\sqrt{1 - \frac{v_0^2}{c^2}}}\right).$$

b. Show that the magnitude of the total momentum is
$$p = M\frac{v_0}{\sqrt{1 - \frac{v_0^2}{c^2}}}.$$

c. Show that the mass of the new particle is
$$M_{new} = M\sqrt{2\left(1 + \frac{1}{\sqrt{1 - \frac{v_0^2}{c^2}}}\right)}.$$

d. Show that the speed of the new particle is
$$\frac{v_0}{\sqrt{1 - \frac{v_0^2}{c^2}} + 1}.$$