Center of Mass

Center of mass of a system is defined as:

$$\vec{R} = \frac{m_1\vec{r}_1 + m_2\vec{r}_2 + \ldots m_n\vec{r}_n}{m_1 + m_2 + \ldots m_n}$$

Here r_i and m_i are positions and masses of a particle "*i*".
By this definition, the velocity of center of mass is related to the total momentum:

$$\vec{V}_{cm} = \frac{m_1\vec{v}_1 + m_2\vec{v}_2 + \ldots m_n\vec{v}_n}{m_1 + m_2 + \ldots m_n} = \frac{\vec{P}_{total}}{m_{total}}$$

This means that when total momentum is conserved (no external forces), center of mass moves with constant velocity (or stays at the same point)

$$\vec{V}_{cm} = const$$

Homework

A Musketeer and a Beautiful lady are sitting inside of a carriage in front of each other. Their centers of masses are at positions x=1 m and x=-1m with respect to the center of the carriage. They both have the same mass, m=70 kg (the standards of women's beauty were different 300 years ago). The carriage has mass M=200 kg.

a) What is the x coordinate of center of mass of the whole system: carriage + both people?
b) Now the musketeer moves to the lady's side and sits next to her. How much the carriage will move with respect to outside witness? There is no horse, and no friction.