1 Undo Formulas for Center of Mass (Algebra)

For systems of particles, we used the formulas

$$\begin{aligned} \vec{R}_{cm} &= \frac{1}{M}\left(m_1\vec{r}_1 + m_2\vec{r}_2\right) \\ \vec{r} &= \vec{r}_2 - \vec{r}_1 \end{aligned} \tag{1}$$

to describe the system of two objects in terms of the center of mass and relative position instead of the positions of each object. After solving for the equations of motion in the center-of-mass coordinates, you may want to transform back to the original coordinate system to examine the motion of each object.

Find the positions of the two objects in terms of the position of the center of mass and the relative position, i.e. solve for:

$$\vec{r}_1 = \tag{2}$$

$$\vec{r}_2 = \tag{3}$$

Hint: The system of equations (1) is *linear*, i.e. each variable is to the first power, even though the variables are vectors. In this case, you can use all of the methods you learned for solving systems of equations while keeping the variables vector valued, i.e. you can safely ignore the fact that the $\vec{r}$s are vectors while you are doing the algebra **as long as you don't divide by a vector**.