

1 Undo Formulas for Center of Mass (Algebra)

(Straightforward algebra) Purpose: Discover the change of variables that allows you to go from the solution to the reduced mass system back to the original system. Practice solving systems of two linear equations.

For systems of particles, we used the formulas

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

to switch from a rectangular coordinate system that is unrelated to the system to coordinates adapted to the center-of-mass. After you have solved the equations of motion in the center-of-mass coordinates, you may want to transform back to the original coordinate system. Find the inverse transformation, 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**.