2) We have $\vec{R} = \frac{m_1\vec{r}_1 + m_2\vec{r}_2}{m_1+m_2}$ and $\vec{r} = \vec{r}_1 - \vec{r}_2$

first equation gives $(m_1+m_2)\vec{R} = m_1\vec{r}_1 + m_2\vec{r}_2$ ☆

Second equation: $\vec{r}_2 = \vec{r}_1 - \vec{r}$. Substitute in:

$$(m_1+m_2)\vec{R} = m_1\vec{r}_1 + m_2(\vec{r}_1 - r)$$
$$(m_1+m_2)\vec{R} = m_1\vec{r}_1 + m_2\vec{r}_1 - m_2\vec{r}$$
$$(m_1+m_2)\vec{r}_1 = (m_1+m_2)R + m_2\vec{r}$$
$$\vec{r}_1 = \frac{(m_1+m_2)}{(M_1+m_2)}\vec{R} + \frac{m_2}{m_1+m_2}\vec{r}$$

$$\boxed{\vec{r}_1 = \vec{R} + \frac{m_2}{m_1+m_2}\vec{r} = \vec{R} + \frac{m_2}{M}\vec{r}}$$

Substituting in $\vec{r}_1 = \vec{r}+\vec{r}_2$ gives $(m_1+m_2)\vec{R} = m_1\vec{r} + m_1\vec{r}_2 + m_2\vec{r}_2$

$$\Rightarrow (m_1+m_2)\vec{r}_2 = (m_1+m_2)R - m_1\vec{r}$$

$$\Rightarrow \boxed{\vec{r}_2 = \vec{R} - \frac{m_1}{m_1+m_2}\vec{r} = \vec{R} - \frac{m_1}{M}\vec{r}}$$