Rigid Body Drawing for Appendix D PhL 10.24.16

I thought this was trivial, but now I see that I really have to solve the whole problem before I can draw the vectors. So I will now solve the problem. This is the problem with no string.

Paradox: I solve the problem below and the result is a contradiction . Watch:

Force on m_1 is $\mathbf{F_1} = m_1\mathbf{g} + \mathbf{R_1}$ where $\mathbf{R_1} = \mathbf{N_1} + \mathbf{T_{12}}$.

Force on m_2 is $\mathbf{F_2} = m_2\mathbf{g} + \mathbf{R_2}$ where $\mathbf{R_2} = \mathbf{N_2} - \mathbf{T_{12}}$.

Both $\mathbf{F_1}$ and $\mathbf{F_2}$ must point along the ramp.

Both masses have the same acceleration so $\mathbf{a_1} = \mathbf{a_2}$ which means $\mathbf{F_1}/m_1 = \mathbf{F_2}/m_2$ or $m_2\mathbf{F_1} = m_1\mathbf{F_2}$.

Aside: Does this give some preliminary contradiction?

$$m_2(m_1\mathbf{g} + \mathbf{R_1}) = m_1(m_2\mathbf{g} + \mathbf{R_2})$$

or

$$m_2\mathbf{R_1} = m_1\mathbf{R_2}$$

This does seem odd, it says that the constraint forces point in the same direction ! Keep going:

$$m_2(\mathbf{N_1} + \mathbf{T_{12}}) = m_1(\mathbf{N_2} - \mathbf{T_{12}})$$

$$m_2\mathbf{N_1} - m_1\mathbf{N_2} = -(m_1+m_2)\mathbf{T_{12}}$$

More contradiction! Since both normal forces are perp to the ramp, this says $\mathbf{T_{12}}$ must be perp to the ramp.

So I can stop right here, no need to do algebra below, already have the Paradox.

Resolution: In the case I have described, there is no tension/compression in the stick. Both balls natrually accelerate down the ramp at the same acceleration which is $g\sin\theta$. So $\mathbf{T_{12}} = 0$. Then there is no contradiction, and $\mathbf{N_1} = \mathbf{R_1}$ and $\mathbf{N_2} = \mathbf{R_2}$. So that must be why I added the string!