Physics 271, Section ... Thursday, Sep 25, 2014
Quiz #3 Force & Motion [I]

Name: **[5 pts]**

1) Consider three masses as shown in the fig. 1, the masses m_1 and m_2 at a horizontal plane, connected over a pulley to a mass M on an inclined plane with an angle θ. Use numerical values $m_1 = 2$ kg, $m_2 = 3$ kg, $M = 5$ kg, and $\theta = \sin^{-1}(12/13)$, if you want.

a) Say you hold the mass m_2 with a force F so that the system is at equilibrium. Find F and the tension forces of both strings. **[3 pts]**
b) You let the system go. How are the accelerations of these masses related to each other? Show the acceleration vectors on the figure. **[2 pts]**
c) Write down the equations of motion for each mass. **[4 pts]**
d) Find the accelerations and tension forces. **[3 pts]**

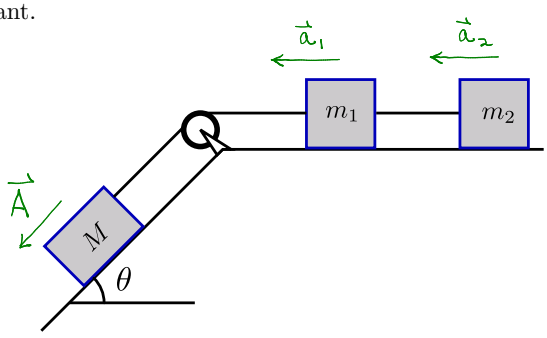
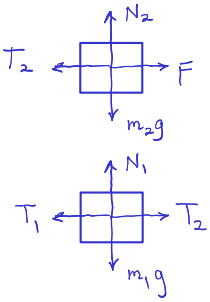


Figure 1: Three masses.

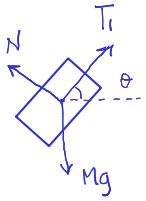
a) equilibrium or "$\sum F = 0$"

m_2: $\begin{cases} N_2 - m_2 g = 0 \\ T_2 - F = 0 \quad \text{(i)} \end{cases}$

m_1: $\begin{cases} N_1 - m_1 g = 0 \\ T_1 - T_2 = 0 \quad \text{(ii)} \end{cases}$



M: $\begin{cases} N - Mg\cos\theta = 0 \\ Mg\sin\theta - T_1 = 0 \quad \text{(iii)} \end{cases}$



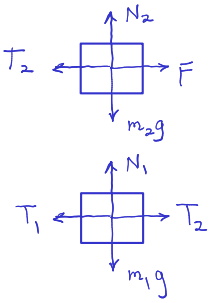
(i), (ii), & (iii) $\Rightarrow$ $\boxed{F = T_1 = T_2 = Mg\sin\theta}$.

b) $\vec{a}_1 = \vec{a}_2$, $|\vec{A}| = |\vec{a}_1| = |\vec{a}_2| =: a$ The length of the strings are constant.

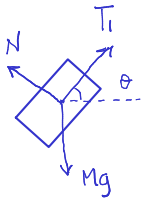
c) "$\sum F = ma$"

m_2: $\begin{cases} N_2 - m_2 g = 0 \\ T_2 = m_2 a \quad \text{(i)} \end{cases}$

m_1: $\begin{cases} N_1 - m_1 g = 0 \\ T_1 - T_2 = m_1 a \quad \text{(ii)} \end{cases}$



M: $\begin{cases} N - Mg\cos\theta = 0 \\ Mg\sin\theta - T_1 = Ma \quad \text{(iii)} \end{cases}$



d) (i), (ii), & (iii) $\Rightarrow$ $\boxed{a = \dfrac{Mg\sin\theta}{m_1 + m_2 + M}}$. $\rightarrow$ $\boxed{T_2 = \dfrac{m_2 Mg\sin\theta}{m_1 + m_2 + M}}$, $\boxed{T_1 = \dfrac{(m_1 + m_2) Mg\sin\theta}{m_1 + m_2 + M}}$.