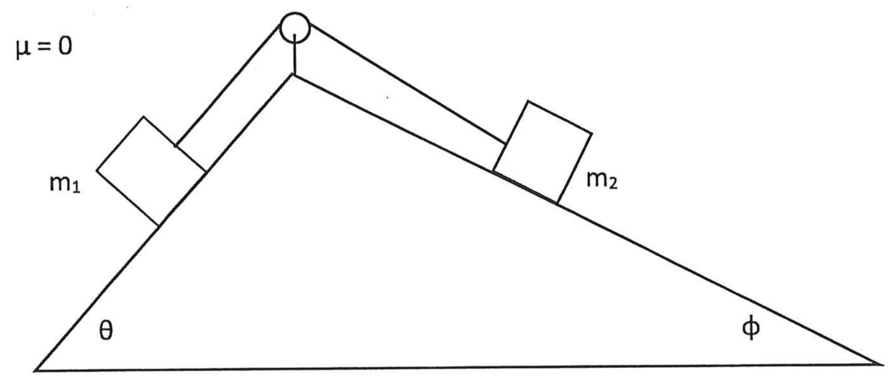
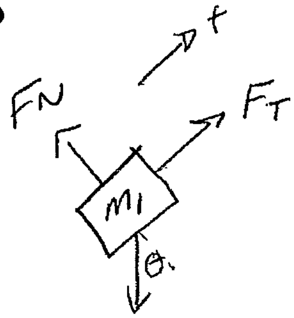
Double inclined plane - Physics 12 Dynamics Challenge question – ANSWER KEY

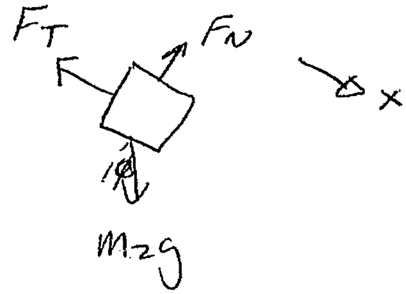
1. For the situation shown in the diagram below:
    a. Draw the fbd (free body diagram) for both m_1 and m_2 (remember to indicate your sign convention for direction). Remember that the two base angles are not equal to each other!
    b. Develop the Newton's second law equation for each mass ($\sum F = ma$)
    c. Develop the expression for the acceleration of the system
    d. In the form of an equation, state the condition for equilibrium
    e. In the form of an equation, state the condition that would cause the system to accelerate to the right



2. Now, assume that μ is greater than zero, and has the same value on both sides of the inclined plane. Assume that the system wants to accelerate to the right (i.e. the condition in 1(e) has been met).
    a. Draw the fbd (free body diagram) for both m_1 and m_2 (remember to indicate your sign convention for direction).
    b. Develop the Newton's second law equation for each mass ($\sum F = ma$)
    c. Develop the expression for the acceleration of the system
    d. In the form of an equation, state the condition for equilibrium

1 (a)





(b) $\sum F_1 = m_1 a = F_T - m_1 g \sin\theta$

$\sum F_2 = m_2 a = m_2 g \sin\phi - F_T$

$$a(m_1 + m_2) = m_2 g \sin\phi - m_1 g \sin\theta$$

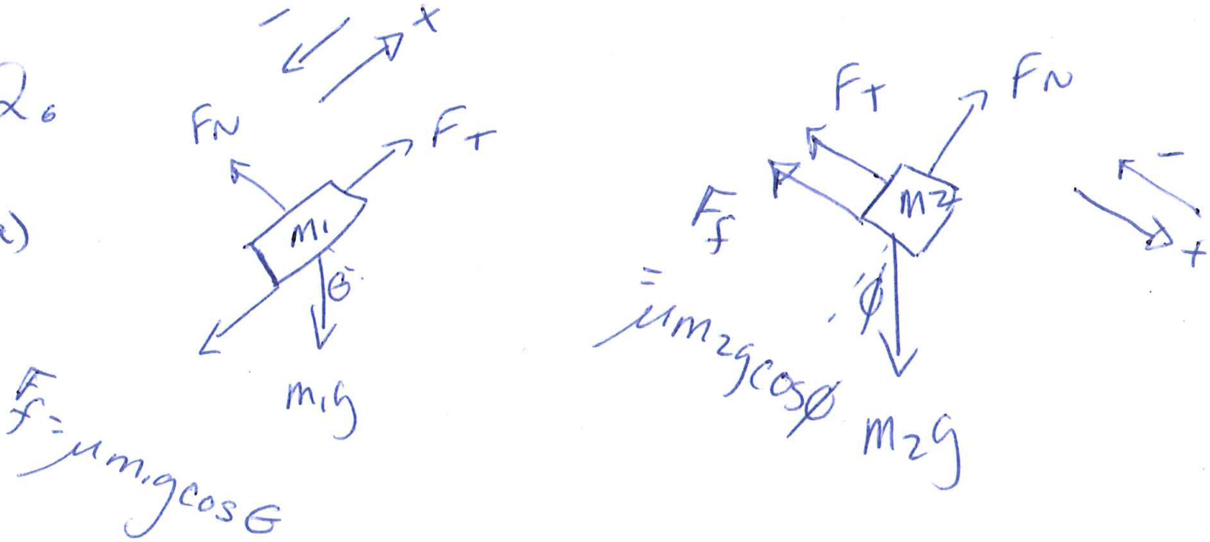
(c) $\boxed{a = \dfrac{g(m_2 \sin\phi - m_1 \sin\theta)}{m_1 + m_2}}$

(d) $\boxed{m_2 \sin\phi = m_1 \sin\theta}$

(e) $\boxed{m_2 \sin\phi > m_1 \sin\theta}$

2.

(a)



(b) $$\boxed{\begin{aligned}\Sigma F_1 &= m_1 a = F_T - \mu m_1 g\cos\theta - m_1 g\sin\theta \\ \Sigma F_2 &= m_2 a = m_2 g\sin\phi - \mu m_2 g\cos\phi - F_T\end{aligned}}$$

(c) $$(m_1+m_2)a = m_2 g\sin\phi - \mu m_2 g\cos\phi - \mu m_1 g\cos\theta - m_1 g\sin\theta$$

$$\boxed{a = g\,\frac{(m_2\sin\phi - \mu m_2\cos\phi - \mu m_1\cos\theta - m_1\sin\theta)}{m_1+m_2}}$$

(d) equilib. $\vec{a} = 0$

$$\therefore\; 0 = m_2\sin\phi - \mu m_2\cos\phi - \mu m_1\cos\theta - m_1\sin\theta$$