1. **(25 points)** A block (mass $m_1$) lying on a frictionless inclined plane is connected to a mass $m_2$ by a massless cord passing over a pulley, as shown in the figure.

   a. **(10 pts)** Express the acceleration of the system in terms of $m_1$, $m_2$, $\theta$, and $g$.

   b. **(5 pts)** What condition apply to masses $m_1$ and $m_2$ for the acceleration to be in one direction (say, $m_1$ down the plane)?

   c. **(5 pts)** If $m_1 = 1.00 \text{ kg}$ and $\theta = 30^\circ$, and the system remains at rest, what must the mass $m_2$ be?

\[ F_{\text{T}} \]
\[ F_{\text{T}} \]
\[ F_{\text{N}} \]
\[ m_2 g \]
\[ m_1 g \]
\[ \theta \]
\[ x \]
\[ y \]

\[ \text{FBD 1 point/each force} \]
\[ 5 \text{ points in total} \]

\[ (a) \quad \text{From Newton's 2nd law:} \]
\[ \begin{align*}
   &2 \text{ pts} \quad m_1 g \sin \theta - F_{\text{T}} = m_1 a \\
   &2 \text{ pts} \quad F_{\text{T}} - m_2 g = m_2 a \\
   \end{align*} \]

\[ \text{Eliminate } F_{\text{T}}: \]
\[ m_1 g \sin \theta - m_2 g = (m_1 + m_2) \sin \theta \]

\[ 1 \text{ pt} \quad \boxed{a = \frac{m_1 \sin \theta - m_2 \sin \theta}{m_1 + m_2} g} \]

\[ (b) \quad m_1 \text{ down the plane} \rightarrow a > 0 \]
\[ \boxed{m_1 \sin \theta - m_2 > 0} \]

\[ 3 \text{ pts} \quad \boxed{m_2 = (1.00 \text{ kg}) \sin 30^\circ = 0.5 \text{ kg}} \]

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