1. A triangular block is wedged between a wall and the ground. On top rests a square block held stationary by friction between it and the triangular block. On top of the square block lies a trapezoidal block held stationary by a rope attached to an immovable wall. The square block has mass \(2m\) while both the triangular and trapezoidal block have mass \(m\). Friction is present only between the surface of the square and triangular block. (a) Treating each block as a point particle, draw a free-body-diagram for all three blocks. Scale each force vector relative to each other. (b) Identify all Newton's third law force pairs. (c) Find an expression, in terms of the wedge angle \(\theta\), for the coefficient of friction that would just barely keep the square block from sliding. (d) Find an expression for the tension in the cable as a function of \(\theta\) and \(m\). (e) What is the normal force of the ground on the triangular block? (f) What is the normal force of the wall acting on the triangular block.

\[
\begin{align*}
\text{Block 1} &= \text{Trapezoid} ; & \text{Block 2} &= \text{Square} ; & \text{Block 3} &= \text{Triangle} \\
\text{FBD 1} & & \text{FBD 2} & & \text{FBD 3} \\
\text{(a) +4} & & \text{(b) Force Pairs: } \vec{F}_{21}^N = -\vec{F}_{12}^N ; \quad \vec{F}_{23}^N = -\vec{F}_{23}^N ; \quad \vec{F}_F^N = -\vec{F}_F^N & & \text{Block 3} \\
\text{(b) Force Pairs} & & \text{(c) Trapezoid:} & & \\
\text{Block 2} \quad (\vec{F}_{R1})_x - (\vec{F}_{E1})_x &= m\omega_x^2 & & \text{Block 3} \quad (\vec{F}_{R1})_y - (\vec{F}_{E1})_y &= m\omega_y^2 \\
\text{Block 2} \quad |\vec{F}_{R1}^N| &= mg \cos \theta & & \text{Block 3} \quad |\vec{F}_{23}^N| &= mg \cos \theta
\end{align*}
\]
c) Square:

\[ \sum F_x = 2m a_x \]

\[ (F_{32})_x - (F_{E2})_x = 2ma_x^0 \]

\[ |F_{32}^f| = 2mg \sin \theta \]

\[ (|F_{32}^f|) = M_3 |F_{32}^N| \]

\[ 2mg \sin \theta = M_3 (3mg \cos \theta) \]

\[ M_3 = \frac{2}{3} \tan \theta \]

\[ \sum F_y = 2ma_y \]

\[ (F_{32}^N)_y - (F_{E2}^N)_y = 2ma_y^0 \]

\[ |F_{32}^N| = |F_{12}^N| - 2mg \cos \theta = 0 \]

\[ (|F_{12}^N|) = |F_{12}^N| \]

\[ |F_{32}^N| = mg \cos \theta + 2mg \cos \theta = 3mg \cos \theta \]

(d) Found in part (c): \[ |F_{R1}^T| = mg \sin \theta + 1 \]

(e) and (f)

Triangle:

\[ \sum F_x = ma_x \]

\[ (F_{a3}^N)_x - (F_{w3}^N)_x - (F_{23}^N)_x = 3ma_x^0 \]

\[ |F_{a3}^N| \sin \theta - |F_{w3}^N| - |F_{23}^N| \cos \theta = 0 \]

\[ (|F_{23}^N| = |F_{32}^N| = 3M_3 mg \cos \theta) \]

\[ (3mg \cos \theta) \sin \theta - |F_{w3}^N| - 3M_3 mg \cos^2 \theta = 0 \]

\[ |F_{w3}^N| = 3mg \cos \theta (\sin \theta - M_3 \cos \theta) \]

\[ |F_{E3}^N| = ma_y(1 + 3 \cos^2 \theta + 3M_3 \cos \theta \sin \theta) \]

\[ |F_{E3}^N| = ma_y(1 + 3 \cos^2 \theta + 3M_3 \cos \theta \sin \theta) \]