A rod is arranged at an angle of $30^\circ$ from the horizontal. Attached to the rod with two strings is the mass $m$, as shown. The rod is rotaed, maintaining its direction in space, so that $m$ travels in a circular path. The strings are of equal length, and make angles of $60^\circ$ with the rod as shown. Take the length of the strings as $L$.

(a) Draw clear free body and force diagrams for the situation where the mass is directly above the rod (dotted line in the drawing).

(b) Calculate the minimum value of the tangential speed of the mass such that the string with tension $T_2$ does not become slack when the mass is directly above the rod.

(c) Calculate the value of $T_1$ for the situation in (b).
(b) along X:

\[ T_1 \sin 30^\circ = T_2 \sin 30^\circ + mg \sin 30^\circ \]

along Y:

\[ \frac{(T_1 + mg + T_2) \cos 30^\circ}{m} = a_r = \frac{v^2}{r} \]

1. \[ T_1 = T_2 + mg \],

let \( T_2 = 0 \), \( T_1 = mg \)

2. \[ v^2 = r \cdot \left[ \frac{T_1 + mg + T_2}{m} \right] \cos 30^\circ \]

\[ = r \left[ \frac{2mg}{m} \right] \cos 30^\circ \]

\[ r = l \cos 30^\circ \]

\[ v^2 = l \cos^2 30^\circ \cdot 2g \]

\[ v = \cos 30^\circ \sqrt{2gL} = \frac{\sqrt{3}}{2} \sqrt{2gL} \]

(c) \quad T_1 = mg