a) Circular motion, so at the bottom $F_{net} \uparrow \rightarrow ac \uparrow$
\[ \Sigma F_R = N - mg \rightarrow \Sigma F_R = 0.5mg \]
\[ \rightarrow N = 1.5mg \]
At the top, \[ \Sigma F_R = mg - N = 0.5mg \]
\[ \rightarrow N = 0.5mg \]

b) \[ \Sigma F_R = m\frac{v^2}{R} = 0.5mg \]
\[ V = \sqrt{0.5gR} \]

(c) Scale reads 0 \[ \rightarrow N = 0 \] at top
\[ \Sigma F_R = mg - N = m\frac{v^2}{R} \]
\[ V_{max} = \sqrt{gR} \]

If this speed is exceeded, \[ \Sigma F_R > mg \], so \[ N < 0 \] the rider will experience "air time" and should wear a restraint.
a) \[ E_0 = E_H \]
\[ \frac{1}{2} m V_0^2 = m g H \]
\[ H = \frac{V_0^2}{2g} \]

Alternatively, note that \( V_0^2 \) at bottom of ramp is converted to 0 at the final point.

\[ V_0^2 = V_f^2 + 2 g \Delta y \]
\[ V_0^2 = 2 g \sin \theta \frac{H}{\sin \theta} \]
\[ \frac{V_0^2}{2g} = H \]

I believe energy is an easier/better problem-solving tool here.

b) \[ E_0 = E_H + W_f \]
\[ \frac{1}{2} m V_0^2 = m g H + M_k m g D + M_k m g \cos \theta \frac{H}{\sin \theta} \]
\[ \frac{1}{2} V_0^2 = g H + M_k g D + M_k g \cot \theta H \]

\[ \frac{V_0^2}{2g} - M_k D = M_k g \cot \theta H + H \]
\[ H = \frac{V_0^2}{2g} - M_k D \]
\[ \frac{1}{1 + M_k \cot \theta} \]

Kinematics approach requires you to see \( \bar{a}_{\text{ric}} = -M_k g \) for flat part D
\( \bar{a}_{\text{ric}} = -M_k g \cot \theta \) for ramp \( \frac{H}{\sin \theta} \)
Problem 3

a) \[ m_1 \sum F_y = N_1 - m_1 g \cos \theta = 0 \]
\[ \Rightarrow N_1 = m_1 g \cos \theta \]
\[ m_2 \sum F_y = N_2 - N_1 - m_2 g \cos \theta = 0 \]
\[ \Rightarrow N_2 = (m_1 + m_2) g \cos \theta \]

b) \[ m_1 \sum F_x = m_1 a = m_1 g \sin \theta - T \]
\[ m_2 \sum F_x = -m_2 a = -T + m_2 g \sin \theta \]
\[ \Rightarrow T = m_2 (a + \frac{m_1}{m_2} g \sin \theta) \]
\[ a = m_1 g \sin \theta - m_2 a - m_2 g \sin \theta \]
\[ a = \frac{(m_1 - m_2) g \sin \theta}{m_1 + m_2} \]
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\[ T = m_2 (a + \frac{g}{2} \sin \theta) \]
\[ \Rightarrow a = 0 \]
\[ \frac{d}{dt} \left( \frac{m_2}{m_1} \right) = m_2 g \sin \theta \]

Therefore, \[ T = m_2 g \sin \theta \]