a) The acceleration of the system is just the sum of the external forces acting on the system, which is just $F$.

\[
\sum F = F = (m_1 + m_2)a \rightarrow a = \frac{F}{(m_1 + m_2)} = 1 \text{ m/s}^2
\]
c) We need to calculate the sum of the x and the y components acting on the block. The sum of the x components will be equal to \( m_1a \) because it is accelerating in the x direction while the sum of the y components will be 0 since it experiences no accelerating.

\[
\sum F_x = F_{\text{friction}}^x + F_{\text{normal}}^x = -F_{\text{friction}} \cos \theta + F_{\text{normal}} \sin \theta = m_1a
\]

\[
\sum F_y = F_{\text{friction}}^y + F_{\text{normal}}^y + F_{\text{gravity}}^y = F_{\text{friction}} \sin \theta + F_{\text{normal}} \cos \theta - m_1g = 0
\]

Since we want friction, we need to get rid of the normal force. We can do this by multiplying the 1st equation by \(-\cos \theta\) and the 2nd equation by \(\sin \theta\) and then add the equations.

\[
F_{\text{friction}} \cos^2 \theta - F_{\text{normal}} \sin \theta \cos \theta = -m_1a \cos \theta
\]

\[
F_{\text{friction}} \sin^2 \theta + F_{\text{normal}} \cos \theta \sin \theta - m_1g \sin \theta = 0
\]

By adding we get

\[
F_{\text{friction}} (\cos^2 \theta + \sin^2 \theta) - m_1g \sin \theta = -m_1a \cos \theta
\]

\[
F_{\text{friction}} = -m_1a \cos \theta + m_1g \sin \theta = 40.33 \text{ N}
\]
d) Looking at the solution for the \( F_{\text{friction}} = -m_1 a \cos \theta + m_1 g \sin \theta \), we notice increasing \( F \) will increase \( a \). An increase in \( a \) will decrease the force of friction. Thus, a minimum applied force is necessary so \( F_{\text{friction}} \leq \mu F_{\text{Normal}} \) which is the condition required for no slipping.

a) We can use the Kinetic Energy Work Theorem \( \Delta KE = W_{\text{net}} \)

We know the kinetic energy at points A and B and know that gravity does positive total work on the object because the object goes down.

\[
\frac{1}{2} m v_f^2 - \frac{1}{2} m v_i^2 = mgh + W_{\text{friction}}
\]

\[
\frac{1}{2} 133(10)^2 - \frac{1}{2} 133(15)^2 - 133 \times 9.8 \times (2.5 \times 12 - 2 \times 12)
\]

\[
= W_{\text{friction}} = -16133 \text{ J}
\]

Or this can also be interpreted as energy lost to friction \( \rightarrow 16133 \text{ J} \)
b) To experience weightlessness at B, the normal force must be 0. This means that the only centripetal acceleration towards the center is due to gravity.

\[ m \frac{v^2}{R} = mg \]

\[ v = \sqrt{gR} = 10.8 \frac{m}{s} \]
2) $x \rightarrow x_t \rightarrow x = \frac{F}{k}$

Initially $F = kx$ and $E_i = \frac{1}{2}kx^2$

After $F$ removed, $E_f = \frac{1}{2}mv^2$

$E_i = E_f \Rightarrow \frac{1}{2}kx^2 = \frac{1}{2}mv^2$.

Use $x^2 = \frac{E^2}{k^2}$

$k \left( \frac{E^2}{k^2} \right) = mv^2 \Rightarrow k = \frac{E^2}{mv^2}$
Given: \(1F_1\) N \(\Delta t = 2s\) \(\vec{v}_i = 20^2\) kg m/s

\(1F_2\) N \(\Delta t = 2s\) \(\vec{v}_i = 10^2\) kg m/s

\[
\frac{dp}{dt} = \vec{F}_{net} \quad \vec{p}_x = \vec{F}_{net} \cdot \Delta \vec{t} \quad \vec{p}_y = \vec{F}_{net} \cdot \Delta \vec{t} \\
p_{fx} = F_x \Delta t + p_{xi} \\
p_{fy} = F_y \Delta t + p_{yi} \\
p_{fx} = \alpha \\
p_{fy} = 0 \\
\Rightarrow p_{px} = 1F_1 \cos \theta \Delta t + p_{xi} \quad p_{py} = -1F_1 \sin \theta \Delta t
\]
4) a) Draw a free body diagram

\[ T = m a_c \]

FBD of the block, side view to show ALL the forces acting on it

b) Find the tension \( T \)

From the above FBD, it is clear that

\[ T = m a_c = m \frac{v^2}{R} \]

\[ \therefore T = m \frac{v^2}{R} \]

**Version A**

\[ T = (0.10 \text{ kg}) \frac{(0.70 \text{ m/s})^2}{(0.40 \text{ m})} = 0.12 \text{ N} \]

**Version B**

\[ T = (0.10 \text{ kg}) \frac{(0.40 \text{ m/s})^2}{(0.70 \text{ m})} = 0.023 \text{ N} \]