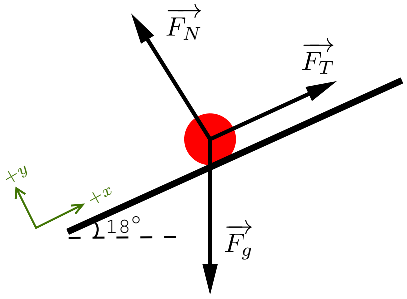
SPH4U: Dynamics Assignment

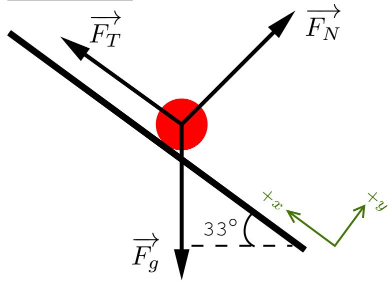
Q01.

(a) **Draw FBD(s).**

<u>m_1 FBD:</u>



<u>m_2 FBD:</u>



(b) **Find the magnitude of the tension in the cable.**

<u>m_1:</u>

$$\begin{aligned}
\vec{F_{net_{1x}}} &= 0 \\
0 &= \left|\vec{F_T}\right| - \vec{F_{g_x}} \\
0 &= \left|\vec{F_T}\right| - 380(9.81)\sin 18° \\
\left|\vec{F_T}\right| &= 380(9.81)\sin 18° \\
\left|\vec{F_T}\right| &= 1151.95 \text{ N} \\
\left|\vec{F_T}\right| &= 1200 \text{ N}
\end{aligned}$$

$\boxed{\therefore \text{ The magnitude of tension in the cable is } \mathbf{1200\ N}.}$

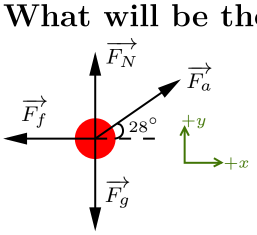
(c) **Calculate the mass of m_2 needed to keep the system in equilibrium.**

$$\begin{aligned}
\vec{F_{net_{2x}}} &= 0 \\
0 &= \vec{F_T} - \vec{F_{g_x}} \\
0 &= 1151.95 - m_2(9.81)\sin 33° \\
m_2 &= \frac{1151.95}{9.81\sin 33°} \\
m_2 &= 215.6 \text{ kg} \\
m_2 &= 220 \text{ kg}
\end{aligned}$$

$\boxed{\therefore \text{ The mass of the second box } (m_2) \text{ is } \mathbf{220\ kg}.}$

Q02.

(a) **What will be the horizontal acceleration of the bale?**



$$\begin{aligned}
\vec{F_{net_x}} &= \vec{F_{a_x}} - \vec{F_f} \\
&= 140\cos 28° - 55 \\
&= 68.81 \text{ N[forward]}
\end{aligned}$$

$$\begin{aligned}
\vec{F_{net_x}} &= m\vec{a} \\
68.81 &= 35\vec{a} \\
\vec{a} &= 1.96\text{m/s}^2\text{[forward]} \\
\vec{a} &= 2.0 \text{ m/s}^2\text{[forward]}
\end{aligned}$$

$\boxed{\therefore \text{ The horizontal acceleration of the bale will be } \mathbf{2.0\ m/s^2[forward]}.}$

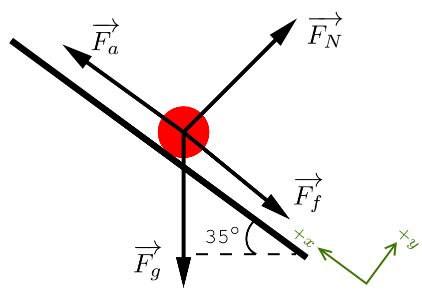
(b) **What is the coefficient of friction between the bale and the ground?**

$$\begin{aligned}
\vec{F_f} &= \mu_f \vec{F_N} \\
55 &= \mu_f(\vec{F_g} - \vec{F_{a_y}}) \\
\mu_f &= \frac{55}{\vec{F_g} - \vec{F_{a_y}}} \\
\mu_f &= \frac{55}{35(9.81) - 140\sin 28^\circ} \\
\mu_f &= 0.198 \\
\mu_f &= 0.20
\end{aligned}$$

$\therefore$ The coefficient of friction between the bale and ground is **0.20**.

Q03.

(a) **Draw an FBD showing a tilted coordinate system (label positive x-direction)**



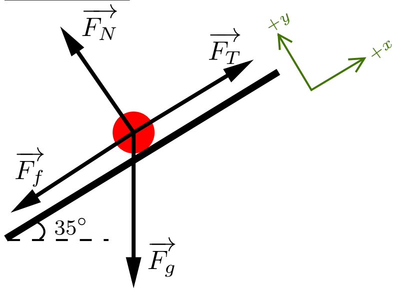
(b) **What minimum force, *F*, would be necessary to move the box up the ramp at a constant speed?**

$$\begin{aligned}
\vec{F_{net_x}} &= \vec{F_a} - \vec{F_{g_x}} - \vec{F_f} \\
0 &= \vec{F_a} - 15(9.81)\sin 35^\circ - 110 \\
\vec{F_a} &= 15(9.81)\sin 35^\circ + 110 \\
\vec{F_a} &= 194.4\ \text{N[uphill]} \\
&\boxed{\vec{F_a} = 190\ \text{N[uphill]}}
\end{aligned}$$

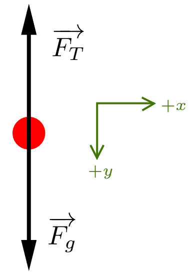
$\therefore$ Since constant speed implies no acceleration in this scenario ($\vec{F_{net}} = 0$), the force needed to move the box at constant speed must also result in 0 net force, meaning the minimum force required is **190 N[uphill]**.

Q04.

m_1 FBD:



m_2 FBD:



Since there is constant speed, $\vec{F_{net_x}} = 0$

m_1:

$$\begin{aligned}\vec{F_{net_x}} &= \vec{F_T} - \vec{F_f} - \vec{F_{g_x}}\\ 0 &= \vec{F_T} - \vec{F_f} - 0.45(9.81)\sin 35^\circ\\ \vec{F_T} &= \vec{F_f} + 0.45(9.81)\sin 35^\circ\\ \vec{F_T} &= \vec{F_f} + 2.53 \text{ N[uphill]}\end{aligned}$$

m_2:

$$\begin{aligned}\vec{F_{net_y}} &= \vec{F_g} - \vec{F_T}\\ 0 &= 0.35 \times 9.81 - \vec{F_T}\\ \vec{F_T} &= 3.43 \text{ N[up]}\end{aligned}$$

Set Equations for F_T Equal:

$$\begin{aligned}3.43 &= \vec{F_f} + 2.53\\ \vec{F_f} &= 0.9 \text{ N[downhill]}\end{aligned}$$

Solve for Friction Coefficient:

$$\begin{aligned}\vec{F_f} &= \mu_f \vec{F_N}\\ 0.9 &= \mu_f \times 0.45(9.81)\cos 35^\circ\\ \mu_f &= \frac{0.9}{0.45(9.81)\cos 35^\circ}\\ \mu_f &= 0.249\\ \mu_f &= 0.25\end{aligned}$$

$\boxed{\therefore \text{ The coefficient of friction between the box and incline is } \mathbf{0.25}.}$