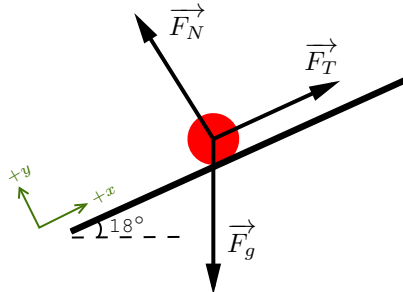
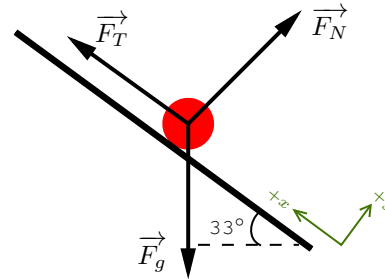


## SPH4U: Dynamics Assignment

Q01.

(a) Draw FBD(s).

 $m_1$  FBD: $m_2$  FBD:

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

 $m_1$ :

$$\begin{aligned}
 F_{net1x} &= 0 \\
 0 &= |\vec{F}_T| - F_{gx} \\
 0 &= |\vec{F}_T| - 380(9.81) \sin 18^\circ \\
 |\vec{F}_T| &= 380(9.81) \sin 18^\circ \\
 |\vec{F}_T| &= 1151.95 \text{ N} \\
 |\vec{F}_T| &= 1200 \text{ N}
 \end{aligned}$$

$\therefore$  The magnitude of tension in the cable is **1200 N**.

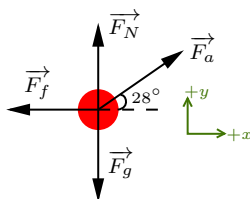
(c) Calculate the mass of  $m_2$  needed to keep the system in equilibrium.

$$\begin{aligned}
 F_{net2x} &= 0 \\
 0 &= \vec{F}_T - F_{gx} \\
 0 &= 1151.95 - m_2(9.81) \sin 33^\circ \\
 m_2 &= \frac{1151.95}{9.81 \sin 33^\circ} \\
 m_2 &= 215.6 \text{ kg} \\
 m_2 &= 220 \text{ kg}
 \end{aligned}$$

$\therefore$  The mass of the second box ( $m_2$ ) is **220 kg**.

Q02.

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



$$\begin{aligned}
 F_{netx} &= F_{ax} - F_f \\
 &= 140 \cos 28^\circ - 55 \\
 &= 68.81 \text{ N [forward]}
 \end{aligned}$$

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

$\therefore$  The horizontal acceleration of the bale will be **2.0 m/s<sup>2</sup> [forward]**.

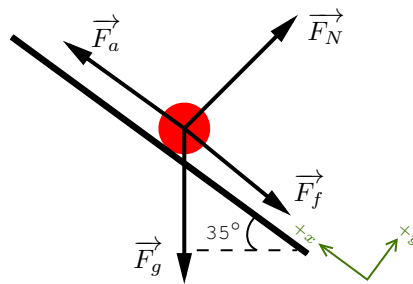
(b) What is the coefficient of friction between the bale and the ground?

$$\begin{aligned}\vec{F}_f &= \mu_f \vec{F}_N \\ 55 &= \mu_f (\vec{F}_g - \vec{F}_{a_y}) \\ \mu_f &= \frac{55}{\vec{F}_g - \vec{F}_{a_y}} \\ \mu_f &= \frac{55}{35(9.81) - 140 \sin 28^\circ} \\ \mu_f &= 0.198 \\ \mu_f &= 0.20\end{aligned}$$

$\therefore$  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)

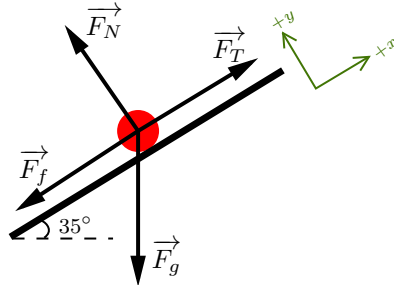
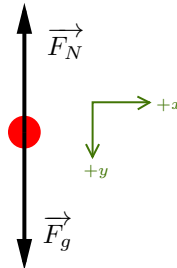


(b) What minimum force,  $F$ , would be necessary to move the box up the ramp at a constant speed?

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

$\therefore$  Since constant speed implies no acceleration in this scenario ( $F_{net}^\rightarrow = 0$ ), 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,  $F_{net_x} = 0$

 $m_1$ :

$$F_{net_x} = \vec{F}_T - \vec{F}_f - \vec{F}_{gx}$$

$$0 = \vec{F}_T - \vec{F}_f - 0.45(9.81) \sin 35^\circ$$

$$\vec{F}_T = \vec{F}_f + 0.45(9.81) \sin 35^\circ$$

$$\vec{F}_T = \vec{F}_f + 2.53 \text{ N[uphill]}$$

 $m_2$ :

$$F_{net_y} = \vec{F}_g - \vec{F}_T$$

$$0 = 0.35 \times 9.81 - \vec{F}_T$$

$$\vec{F}_T = 3.43 \text{ N[up]}$$

Set Equations for  $F_T$  Equal:

$$3.43 = \vec{F}_f + 2.53$$

$$\vec{F}_f = 0.9 \text{ N[downhill]}$$

Solve for Friction Coefficient:

$$\vec{F}_f = \mu_f \vec{F}_N$$

$$0.9 = \mu_f \times 0.45(9.81) \cos 35^\circ$$

$$\mu_f = \frac{0.9}{0.45(9.81) \cos 35^\circ}$$

$$\mu_f = 0.249$$

$$\mu_f = 0.25$$

$\therefore$  The coefficient of friction between the box and incline is **0.25**.