SPH4U: Dynamics Assignment

Q01. Two heavy boxes, m_1 and m_2, lie stationary on different inclines, as shown. A rope runs over a pulley and connects the boxes. Mass 1, m_1 is 380kg. Assuming that each incline is frictionless and the system is in equilibrium, answer the following:

(a) **Draw FBD(s).**
Insert Free Body Diagram Here

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

$$\begin{aligned} \vec{F_{net_{1x}}} &= 0 \\ 0 &= \vec{F_{g_1}} \sin 18^\circ + |F_T| \\ 0 &= m_1 g \sin 18^\circ + |F_T| \\ 0 &= 380(-9.8) \sin 18^\circ + |F_T| \\ |F_T| &= 1150.78\text{N} \\ |F_T| &= 1200\text{N} \end{aligned}$$

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

(c) **Calculate the mass of m2 needed to keep the system in equilibrium.**

$$\begin{aligned} F_{net_{2x}} &= 0 \\ 0 &= \vec{F_{g_2}} \sin 33^\circ + 1150.78 \\ m_2 &= \frac{-1150.78}{-9.8 \sin 33^\circ} \\ m_2 &= 215.6\text{kg} \\ m_2 &= 220\text{kg} \end{aligned}$$

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

Q02. A girl applies a 140N force to a 35.0kg bale of hay at an angle of 28°above the horizontal. The force of friction acting on the bale is 55N.

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

$$\begin{aligned} \vec{F_{net_x}} &= \vec{F_{a_x}} - \vec{F_f} \\ &= 140 \cos 28^\circ - 55 \\ &= 66.81\text{N[right]} \end{aligned} \qquad \begin{aligned} \vec{F_{net_x}} &= m\vec{a} \\ 66.81 &= 35\vec{a} \\ \vec{a} &= 1.96\text{m/s}^2\text{[right]} \\ \vec{a} &= 2.0\text{m/s}^2\text{[right]} \end{aligned}$$

$\therefore$ The horizontal acceleration is 2.0m/s^2[right]

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

$$\begin{aligned}\vec{F_f} &= \mu_f \vec{F_N} \\ 55 &= \mu_f(35 \times 9.8) \\ \mu_f &= \frac{55}{35 \times 9.8} \\ \mu_f &= 0.16\end{aligned}$$

$\therefore$ The coefficient of friction between the bale and ground is 0.16.

Q03. A 15kg box is pushed upa 35°ramp. A force of 110N exists between the box adn the ramp.

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

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

$$\begin{aligned}\vec{F_{net_x}} &= \vec{F_a} + \vec{F_{g_x}} + \vec{F_f} \\ 0 &= \vec{F_a} + 15(-9.8)\sin 35^\circ - 110 \\ 0 &= \vec{F_a} - 194.31 \\ \vec{F_a} &= 194.31\text{N}\end{aligned}$$

$\therefore$ Since 194.31N is the force required to keep the object at rest, the minimum force for constant speed must be great than 194.31N.