21-P-WE-AG-033

Port Moody has a very large sulphur processing facility. The sulphur is kept in large containers and transported around the site via long conveyer belts. Today, they are loading a ship, which means that the sulphur needs to be placed on the ship at a constant rate of $R\,\frac{kg}{min}$. It takes T minutes for the sulphur to get from the container to the ship up a θ degree slope. Given that the average power consumed by the electric motor running the conveyer shown below is P watts and that the motor is E% efficient, what is the constant speed at which the conveyer is moving?

ANSWER:

First, we write down the equation for power and rearrange to solve for velocity.

$$Power = P \cdot E = F \cdot v \rightarrow F = \frac{P \cdot E}{v}$$

Next, we apply Newton's Second Law of Motion

$$\sum F_x = ma_x = 0 = F - R\,\frac{kg}{min} \cdot \frac{min}{60\ s} \cdot 9.81\,\frac{m}{s^2} \cdot T \cdot \sin(\theta)$$

$$\frac{P \cdot E}{v} = R\,\frac{kg}{min} \cdot \frac{min}{60\ s} \cdot 9.81\,\frac{m}{s^2} \cdot T \cdot \sin(\theta)$$

$$v = \frac{P \cdot E}{R\,\frac{kg}{min} \cdot 9.81\,\frac{m}{s^2} \cdot T\ \text{min} \cdot \sin(\theta)}$$