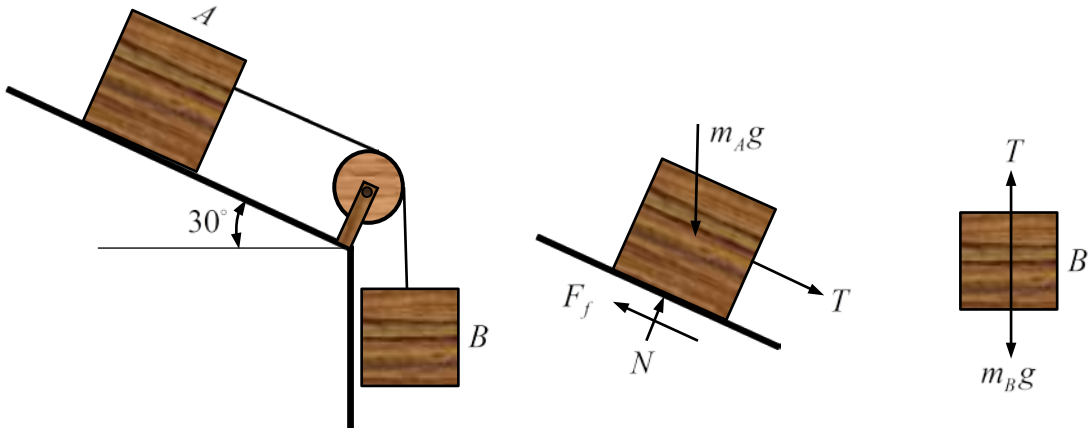
2-18. A pulley system with two crates are released from rest. Crate *A* has a mass $m_A = 50$ kg and crate *B* has a mass $m_B = 30$ kg. The coefficient of kinetic friction between crate *A* and the inclined surface follows a normal distribution $\mu_k \sim N(0.4, 0.05^2)$. When $\theta = 30°$, find the distribution of velocity at $t = 2$ s.



Solution:

Crate *A*

$$F_A = T + m_A g \sin\theta - F_f$$

where

$$F_f = \mu_k N = \mu_k m_A g \cos\theta$$

Impulse

$$F_A t = m_A v$$

$$\left[T + m_A g\left(\sin\theta - \mu_k \cos\theta\right)\right] t = m_A v$$

Crate *B*

$$\left(m_B g - T\right) t = m_B v$$

Combining the two equations above, we have

$$\left[m_A\left(\sin\theta - \mu_k \cos\theta\right) + m_B\right] g t = \left(m_A + m_B\right) v$$

$$v = \frac{\left[m_A\left(\sin\theta - \mu_k \cos\theta\right) + m_B\right] g t}{m_A + m_B}$$

Solving for the final velocity mean

$$\mu_v = \frac{\left[m_A \left(\sin\theta - \mu_{\mu_k} \cos\theta \right) + m_B \right] gt}{m_A + m_B}$$

$$= 9.24 \text{ m/s}$$

$$\sigma_v = \frac{m_A \cos\theta g t \sigma_{\mu_k}}{m_A + m_B} = 0.53 \text{ m/s}$$

Therefore, $v \sim N(9.24, 0.53)$ m/s . **Ans.**