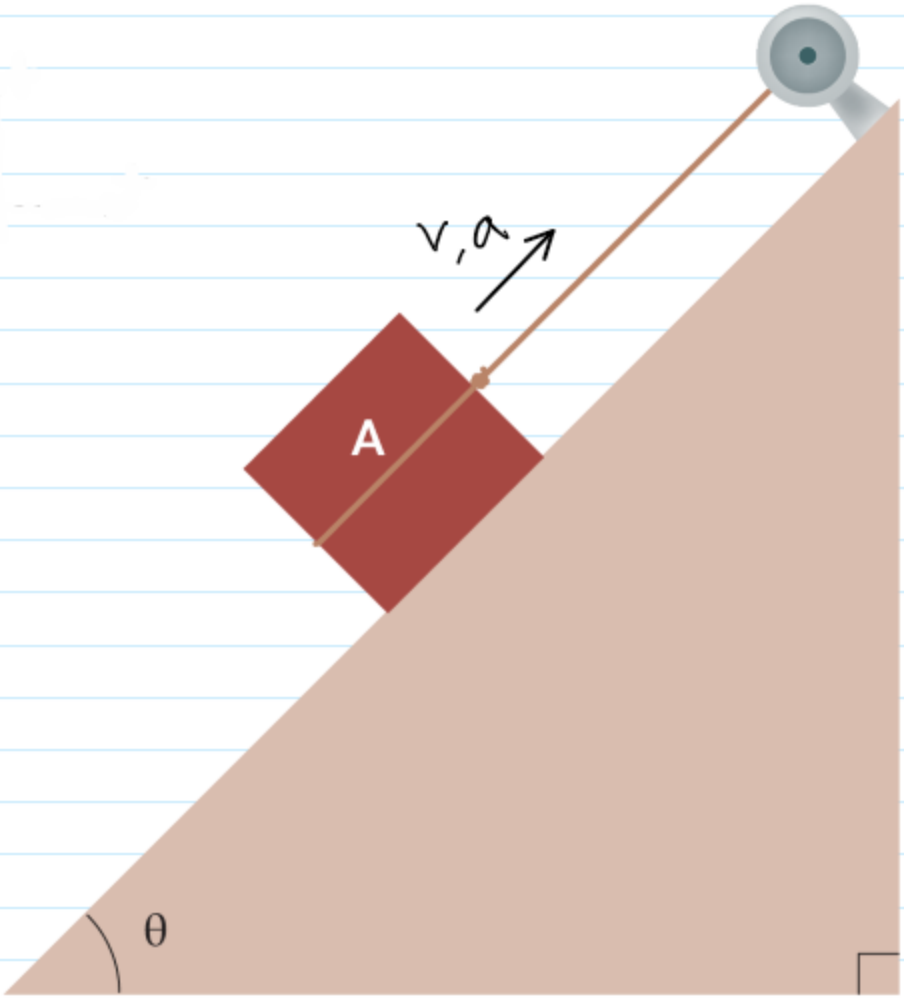
21-P-WE-GD-012



A m Kg red crate is being towed up a θ degree incline, such that it's acceleration a is equal to a m/s^2. The crate has a coefficient of Kinetic friction with the incline of μ_k. At the instant the crate's velocity is v m/s, if the winch's efficiency is ε, how much power is being supplied to the winch?

(Assume $g = 9.81$ m/s^2)

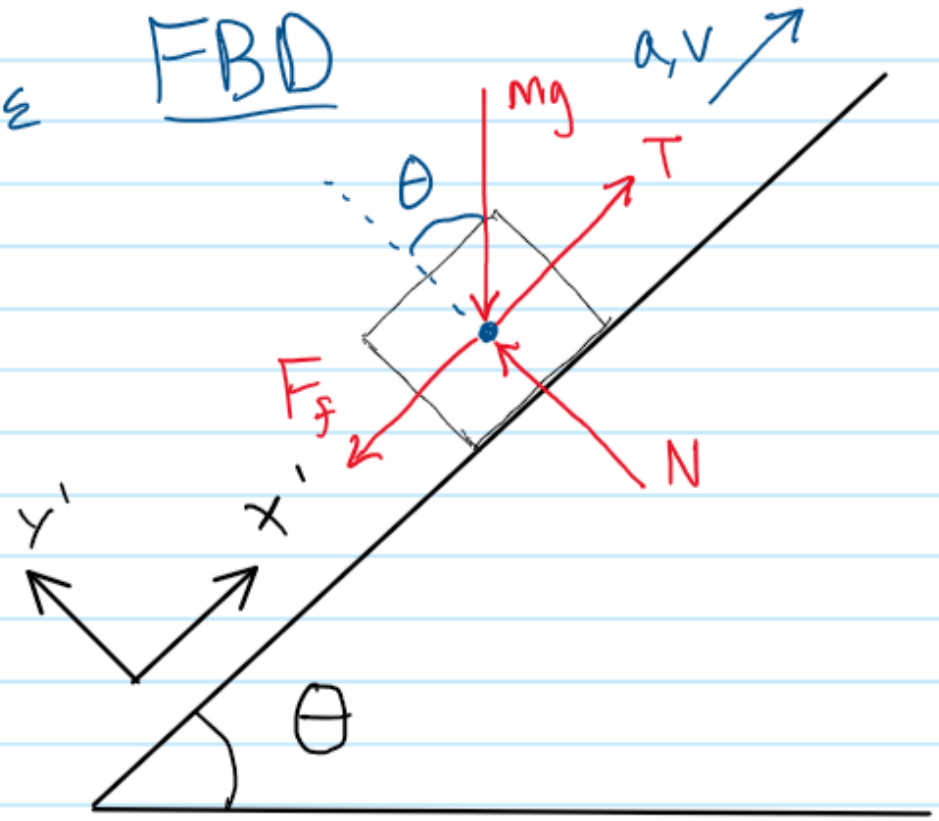
given

$m, g, \theta, a, \mu_k, V, \varepsilon$

find

P_{in}

FBD



Force Equilibrium

$\Sigma F_{x'} = ma = T - F_f - mg\sin\theta$

① $T = ma + F_f + mg\sin\theta$

③ $F_f = \mu_k N$

$\Sigma F_{y'} = 0 = N - mg\cos\theta$

② $N = mg\cos\theta$

[②→③] → ① solve for Tension

$T = ma + \mu_k mg\cos\theta + mg\sin\theta$

Power

$$P_{out} = T \cdot v$$

Efficiency

$$\varepsilon = \frac{P_{out}}{P_{in}} \rightarrow P_{in} = \frac{P_{out}}{\varepsilon}$$

$$P_{in} = \frac{v[ma + \mu_K mg\cos\theta + mg\sin\theta]}{\varepsilon}$$