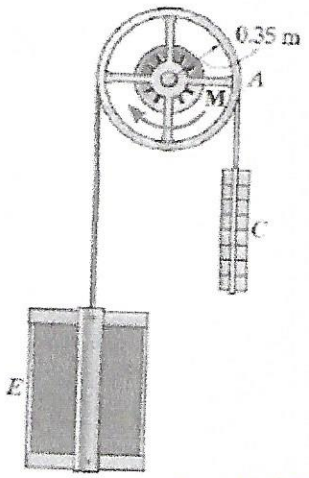
Work Energy III - Problem 1

The elevator car E has a mass of 1.80 Mg and the counterweight C has a mass of 2.30 Mg. If a motor turns the driving pulley A with a torque of $M = 100$ N·m, determine the speed of the elevator when it has ascended 12 m starting from rest. Pulley A has a mass of 150 kg and a radius of gyration of k = 0.2 m about its center. Neglect the mass of the cable and assume the cable does not slip on the pulley.



MOTION

C+E TRANS, A RAFA

PROPERTIES

$m_E = 1.8\,Mg \quad W_E = 1.8Mg \times 9.81 = 17.65\,kN$

$m_C = 2.3\,Mg \quad W_C = 2.3Mg \times 9.81 = 22.56\,kN$

$m_A = 150\,kg \quad I_{GA} = mk^2 = 150(0.2)^2 = 6\,kg\cdot m^2$

$s = \theta r$

$12m = \theta(.35m)$

$\theta = 12/.35$

$V = \omega r$

$\omega = V/r = V/.35$

WORK

WEIGHTS C+E, MOMENT

WEIGHT E: $U_E = -12(17.65) = -21.19\times10^4\ N\cdot m$

WEIGHT C: $U_C = 12(22.56) = 27.1\times10^4\ N\cdot m$

MOMENT: $U_M = 100\ N\cdot m\,(12/.35) = 3.43\times10^3\ N\cdot m$

$\Sigma U_{1-2} = 62{,}288\ N\cdot m$

ENERGY

$T_1 = 0$ @ REST $\quad T_2 = \frac{1}{2}m_C V_2^2 + \frac{1}{2}m_E V_2^2 + \frac{1}{2}I_{GA}\omega_2^2$

$T_2 = \frac{1}{2}(2.3\times10^3)V_2^2 + \frac{1}{2}(1.8\times10^3)V_2^2 + \frac{1}{2}(6)\left(\frac{V}{.35}\right)^2$

$T_2 = (900 + 1150 + 24.5)V_2^2$

W-E

$T_1 + U_{1-2} = T_2$

$62{,}288 = 2075\,V_2^2$

$V_2 = V_E = 5.48\ m/s\ \uparrow$