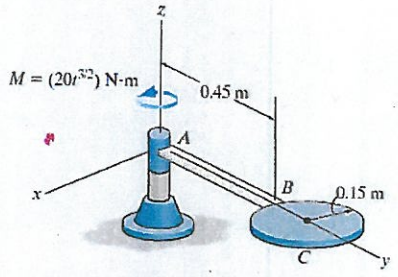
19–15.

The assembly shown consists of a 10-kg rod $AB$ and a 20-kg circular disk $C$. If it is subjected to a torque of $M = (20t^{3/2})\ \mathrm{N \cdot m}$, where $t$ is it in seconds, determine its angular velocity when $t = 3\ \mathrm{s}$. When $t = 0$ the assembly is rotating at $\omega_1 = \{-6\mathbf{k}\}\ \mathrm{rad/s}$.




CLASSIFY MOTION

RAFA

PROPERTIES

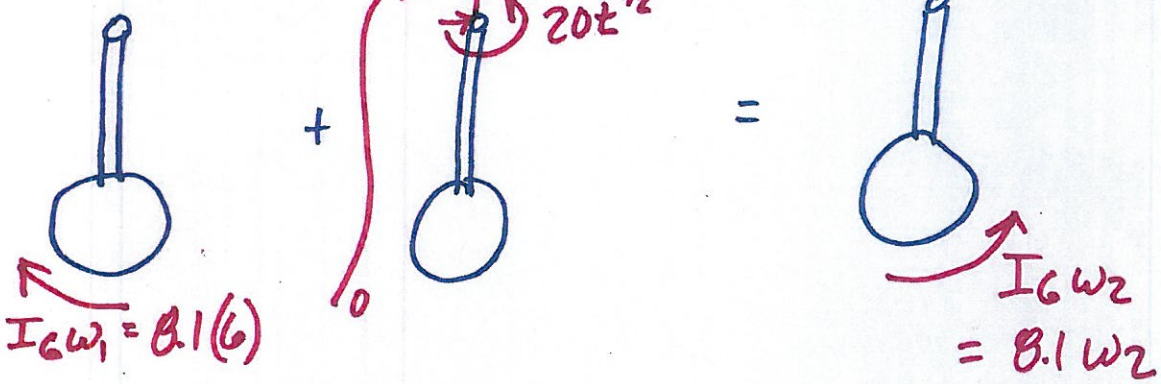
$m_R = 10\ \mathrm{Kg}$

$m_D = 20\ \mathrm{Kg}$

| SHAPE | $I_G$ | $md^2$ | $I_G + md^2$ |
|---|---|---|---|
| | $\frac{1}{3}ml^2$ $\frac{1}{3}(10)(.45)^2 = 0.675$ | — | 0.675 |
| | $\frac{1}{2}mr^2$ $\frac{1}{2}(20)(.15)^2 = 0.225$ | $20(0.6)^2 = 7.2$ | 7.425 |

$I_A = 8.1\ \mathrm{kg \cdot m^2}$

$MOM_1 + IMP_{1-2} = MOM_2$



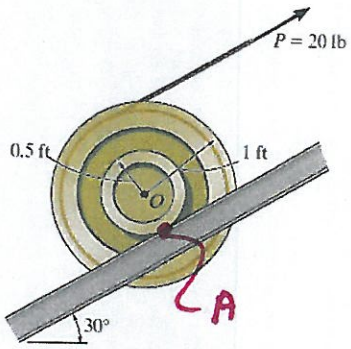

$$+\downarrow \quad 8.1(6) - \int_0^3 20t^{3/2}\,dt = -8.1\omega_2$$

$$48.6 - 124.7 = -8.1\omega_2$$

$$\omega_2 = 9.40\ \mathrm{rad/s}\ \curvearrowright$$

*19–20.

The cable is subjected to a force of $P = 20$ lb, and the spool rolls up the rail without slipping. Determine the angular velocity of the spool in 5 s, starting from rest. The spool has a weight of 100 lb and a radius of gyration about its center of gravity $O$ of $k_O = 0.75$ ft.



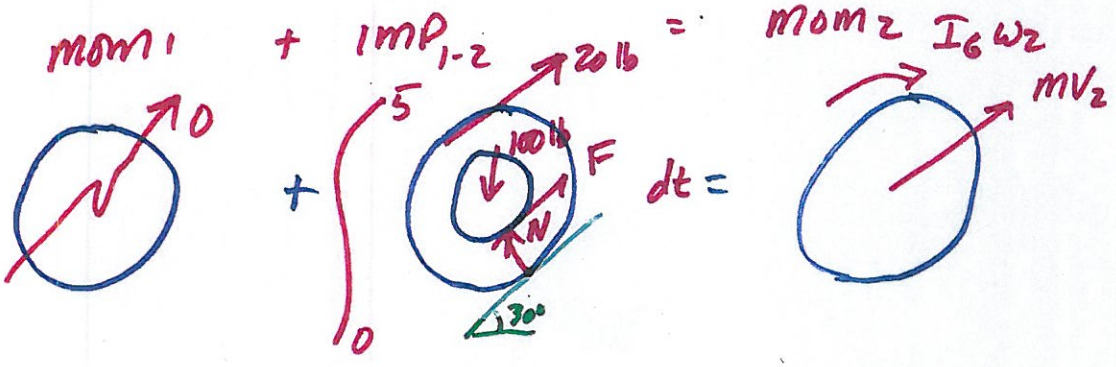

CLASSIFY MOTION

GPM

PROPERTIES

$W = 100$ lb $\quad m = \frac{100}{32.2} = 3.106$ slug $\quad I_G = 3.106(.75)^2 = 1.747$ slug·ft$^2$

mom 1 + $\text{IMP}_{1-2}$ = mom 2




NO SLIP $\therefore$ $v_O = \omega r_{O/A} = \omega(0.5)$

$$\curvearrowright + 0 + \int_0^5 [100\sin 30(0.5) - 20(1.5)]dt = -1.747(\omega) - 3.106(0.5\omega)(0.5)$$

ABOUT A

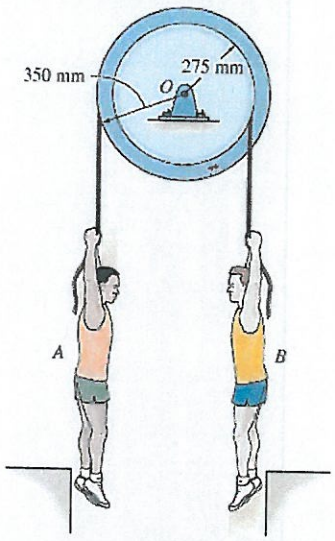
$$100\sin 30(0.5)(5) - 20(1.5)(5) = -1.747\omega - 3.106(.5\omega)(0.5)$$

$$125 - 150 = -2.524\omega$$

$$\omega = 9.91 \text{ rad/s} \curvearrowright$$

**19–25.**

The double pulley consists of two wheels which are attached to one another and turn at the same rate. The pulley has a mass of 30 kg and a radius of gyration $k_O = 250$ mm. If two men $A$ and $B$ grab the suspended ropes and step off the ledges at the same time, determine their speeds in 4 s starting from rest. The men $A$ and $B$ have a mass of 60 kg and 70 kg, respectively. Assume they do not move relative to the rope during the motion. Neglect the mass of the rope.




CLASSIFY MOTION

PULLEY - RAFA

PEOPLE - TRANS

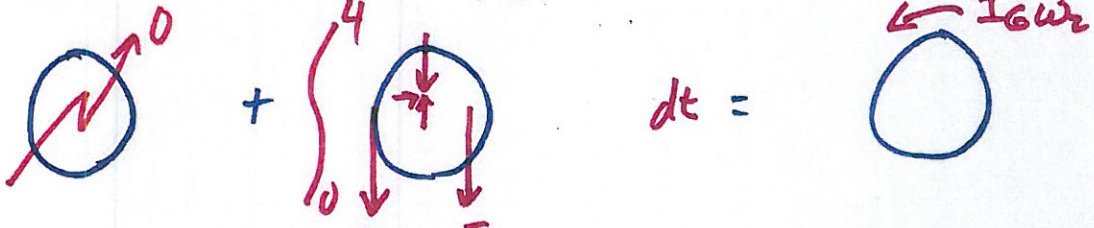
PROPERTIES

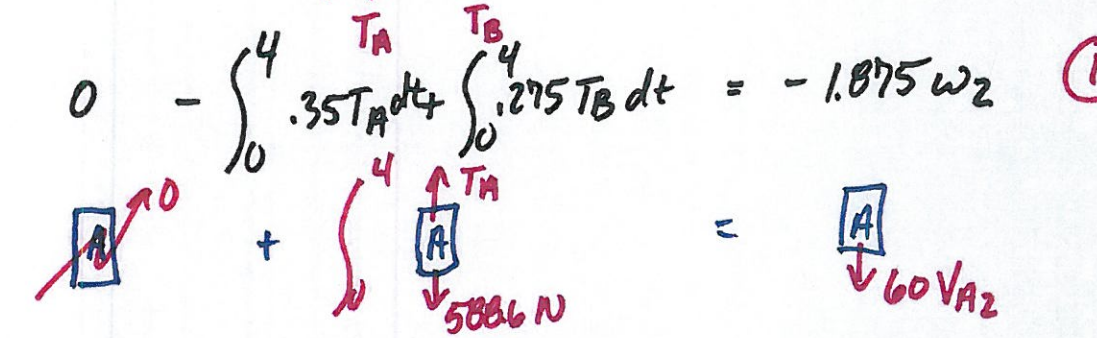
$m_{ASS\,P} = 30\,kg$ $\quad I_G = 30(.250)^2 = 1.875\ kg\cdot m^2$

$m_{ASS\,m_A} = 60\,kg$ $\quad W_A = 60 \times 9.81 = 588.6\ N$

$m_{ASS\,m_B} = 70\,kg$ $\quad W_B = 70 \times 9.81 = 686.7\ N$

$MOM_1 + IMP_{1-2} = MOM_2$



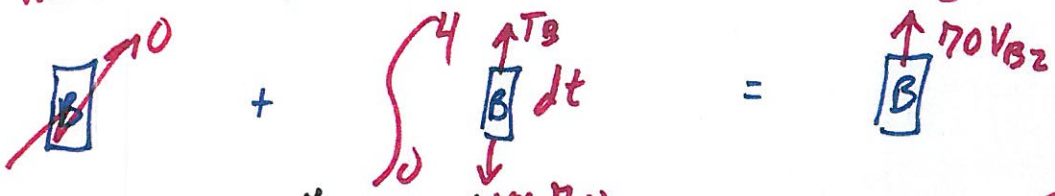




$$+\circlearrowright \quad 0 - \int_0^4 .35T_A\,dt + \int_0^4 .275T_B\,dt = -1.875\omega_2 \qquad (1)$$




$$+\uparrow \quad 0 + \int_0^4 T_A\,dt - \int_0^4 588.6\,dt = -60v_{A2} \qquad (2)$$

Mom 1 + Imp 1-2 = Mom 2




$$\uparrow 0 + \int_0^4 T_B\,dt - \int_0^4 686.7\,dt = 70\,V_{B2} \quad (3)$$

KINEMATICS - RAFA

$$V_{A_2} = \omega_2 r_A = 0.35\omega_2$$
$$V_{B_2} = \omega_2 r_B = 0.275\omega_2$$

EQNS 1, 2 + 3

$$-0.35\int T_A dt + 0.275\int T_B dt + 1.875\omega_2 = 0$$

$$\int T_A dt + 21\omega_2 = 2354$$

$$\int T_B dt - 19.25\omega_2 = 2747$$

SOLVE

$$\begin{bmatrix} -0.35 & 0.275 & 1.875 \\ 1 & 0 & 21 \\ 0 & 1 & -19.25 \end{bmatrix} \begin{Bmatrix} \int T_A dt \\ \int T_B dt \\ \omega_2 \end{Bmatrix} = \begin{Bmatrix} 0 \\ 2354 \\ 2747 \end{Bmatrix}$$

$$\omega_2 = 4.72 \text{ rad/s} \circlearrowleft$$

$$V_{A2} = \omega_2 r_A = 4.72(.35) = 1.65 \text{ m/s} \downarrow$$

$$V_{B2} = \omega_2 r_B = 4.72(.275) = 1.30 \text{ m/s} \uparrow$$