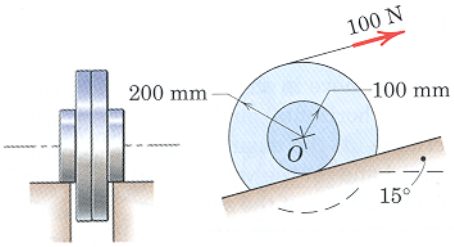
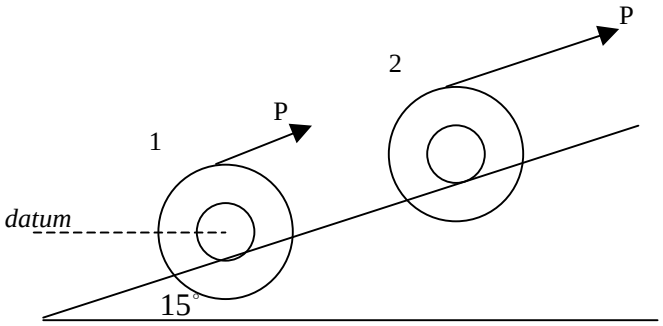
Example Problem - Le 15

Ex. The wheel rolls up the incline on its hubs without slipping and is pulled by the 100-N force applied to the cord wrapped around its outer rim. If the wheel start from rest, compute its angular velocity after its center has moved a distance of 3-m up the incline. The wheel has a mass of 40-kg with a center of mass at O and has a centroidal radius of gyration of 150-mm. (*taken from Engineering Mechanics, 4th Edition by Meriam & Kraige*)





unk	eqs
ω_2	1
E_{K2}	2
E_{G2}	3
E_{K1}	4
E_{G1}	5
W	6
$v_{G,2}$	7
I_G	8
s	9
z	10
$r_{G/IC}$	11

Known:

$$m = 40\ kg \qquad P = 100\ N \qquad k_G = 0.15\ m$$

Kinetics:

COE(FT)

$$\Delta E_{sys} = W$$
$$(E_{K2} + E_{G2}) - (E_{K1} + E_{G1}) = W \quad (1)$$

$$E_{K1} = 0 \quad (2) \qquad E_{K2} = \frac{1}{2} m v_{G,2}^2 + \frac{1}{2} I_G w_2^2 \quad (4)$$
$$E_{G1} = 0 \quad (3) \qquad E_{G2} = mgz \quad (5)$$
$$W = Ps \neq P(3m) \quad (6)$$

Kinematics:

$$v_{G,2} = w_2 r_{G/IC} \quad (7)$$
$$r_{G/IC} = 0.1\ m \quad (8)$$
$$s = 9\ m \quad (9)$$

Other:

$$I_G = mk_G^2 = 0.9\ kg\,m^2 \quad (10)$$
$$z = 3\sin(15^\circ)\ m \quad (11)$$

Solving:

$$\boxed{w_2 = 30.3\ rad/s}$$