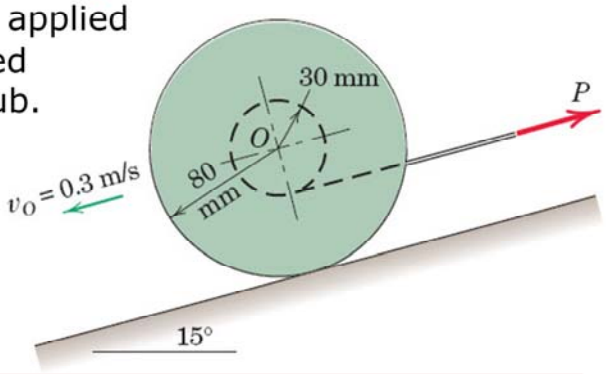
Impulse-Momentum for Rigid Bodies: Exercise 1

The **2-kg** wheel, with **radius of gyration** about ***O*** of **60 mm**, rolls without slipping down the incline with a **velocity v_O = 0.3 m/s** when a **force *P* = 10 N** is applied to the cord wrapped around its inner hub.

Determine the **velocity *v*** of the **center *O*** when ***P*** has been applied for **5 s**.

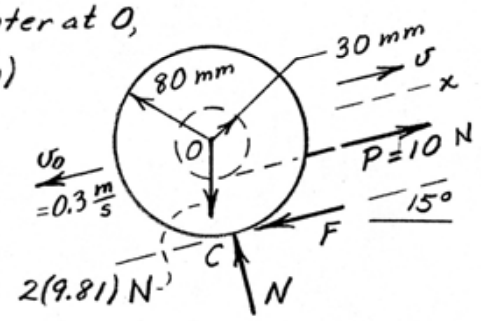


6/182 For no slipping & mass center at O,

$\Sigma M_C = I_C \alpha$ so $\int \Sigma M_C \, dt = \Delta H_C = \Delta(I_C \omega)$

$I_C = m(k_O^2 + r^2) = 2(0.060^2 + 0.080^2)$

$= 0.02 \text{ kg}\cdot\text{m}^2$



$\circlearrowleft + \int_0^5 (10[0.080 - 0.030] - 2(9.81)(0.080)\sin 15°)\, dt$

$= 0.02\left(\frac{v}{0.080} - \left[\frac{-0.3}{0.080}\right]\right)$

$0.469 = 0.25(v + 0.3)$, $\quad \underline{v = 1.575 \text{ m/s}}$ up the incline

Alternative sol. if preferred:

$\circlearrowleft + \int \Sigma M_G \, dt = \Delta H_G : \int_0^5 (F \times 0.080 - 10 \times 0.030) dt = 2 \times 0.060^2 \left(\frac{v}{0.080} - \left[\frac{-0.3}{0.080}\right]\right)$

$0.080F(5) - 0.3(5) = 0.09(v + 0.3)$ (1)

$\int \Sigma F_x \, dt = \Delta G_x : \int_0^5 (10 - F - 2(9.81)\sin 15°)\, dt = 2(v - [-0.3])$

$50 - 25.4 - 5F = 2v + 0.6$ (2)

Solve & get $\underline{v = 1.575 \text{ m/s}}$ ($F = 4.17$ N,

$N = 2(9.81)\cos 15° = 18.95$ N

$(\mu_s)_{min} = 4.17/18.95 = 0.220$)