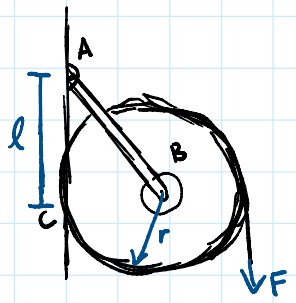
20-R-IM-DK-8

July 7, 2020 9:12 AM

Intermediate Principle of Impulse and Momentum

Inspiration: 19-12 Hibbeler

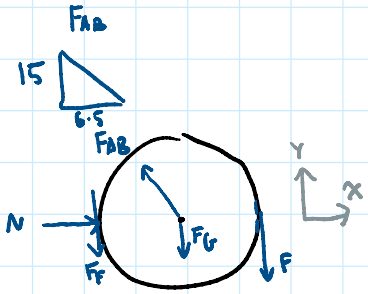
(Similar scenario as 20-R-KIN-DK-23)



You were able to obtain a roll of toilet paper during quarantine and put it to good use. If the roll rests against a wall where its coefficient of friction is ***mu_k = 0.2*** and you apply a vertical force ***F = 10 N*** downwards, determine the magnitude of the angular velocity of the roll after ***t = 5 seconds***. Point B and point C are located a vertical distance ***l = 0.15 m*** under point A. Assume the roll can be treated as a cylinder with a mass of ***m = 0.25 kg***, a width of w = 0. 115 m, and a radius of ***r = 0.065 m***. Neglect the mass of the unraveled toilet paper and make sure to wash your hands after.

For Webwork, decrease F and t variables to lower the magnitude of the final answer

$$I_B = \frac{1}{2}mr^2 = \frac{1}{2}(0.25)(0.065)^2 = \frac{169}{320000}$$



$$x: \quad m v_{Bx_1} + \sum \int_{t_1}^{t_2} F_x \, dt = m v_{Bx_2}$$

$$0 + \int_0^5 N - F_{AB}\frac{6.5}{\sqrt{15^2+6.5^2}} = 0$$

$$5N = 5(0.3976)F_{AB}$$

$$N = 0.3976 F_{AB}$$

$$y: \quad m v_{By_1} + \sum \int_{t_1}^{t_2} F_y \, dt = m v_{By_2}$$

$$0 + \int_0^5 -F_F + F_{AB}\frac{15}{\sqrt{15^2+6.5^2}} - F_G - F \, dt = 0$$

$$-5(0.2N) + 5\left(\frac{15}{\sqrt{15^2+6.5^2}}F_{AB}\right) - 5(0.25)(9.81) - 5(10) = 0$$

$$0.917556 F_{AB} - 0.2N = 12.4525$$

$$0.438036 F_{AB} = 12.4525$$

$$F_{AB} = 14.45915 N$$

$$N = 5.908 N$$

$$M: \quad I_B w_1 + \sum \int_{t_1}^{t_2} M_B \, dt = I_B w_2$$

$$0 + \int_0^5 -Fr + F_F r \, dt = I_B w_2$$

$$-10(0.065)(5) + 0.2(5.908)(0.065)(5) = \frac{169}{320000} w_2$$

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$$-10(0.065)(5) + 0.2(5.908)(0.065)(5) = \frac{1}{320000} w_2$$

$$\vec{w_2} = -5426.707692 \text{ rad/s}$$

$$w_2 = 5426.708 \text{ rad/s}$$