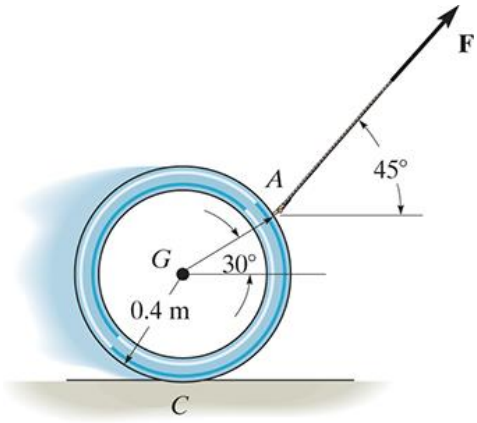
Quiz 12: Chapter 17

Due: Friday 08 Mar 2024

Examine the solved problem below. There are four errors. Your task is to locate and identify any mistakes, then correct them and calculate the proper result. If the same error occurs more than once, only count it as a single error, even if you have to correct it in more than one instance.

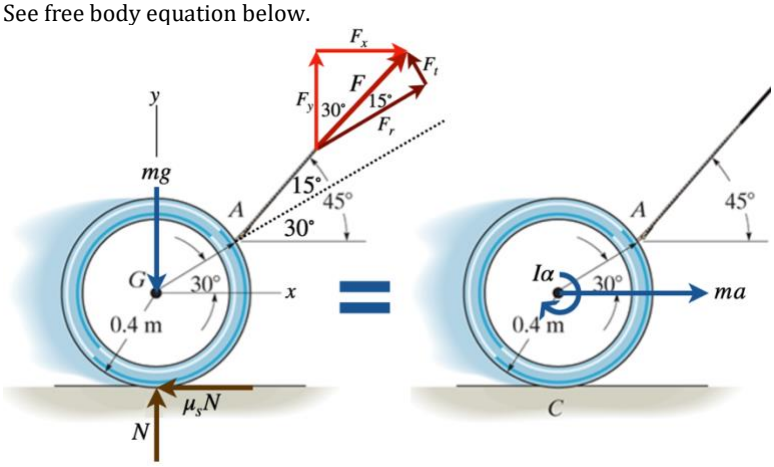
Each correctly identified error is worth 4 points, and the re-calculated results are worth 4 points as well. You must save your work in pdf format and submit via the Quiz 14 Assignment in the Chapter 17 in the Quizzes folder of the Online Classroom in Blackboard. Please do not use any other file format than pdf.

The coefficient of static friction at point C is $\mu_s = 0.3$. Determine the largest force F that can be applied to the ring (mass $m = 10\text{kg}$) without causing it to slip. Also solve for the linear acceleration of the ring a, and its angular acceleration α.



A) Construct the free body diagram for the ring:

See free body equation below.



B) Write the Newton #2 equations of motion for the system:

$$\sum F_x = F_x - \mu_s N = ma$$
$$\sum F_y = F_y + N - mg = 0$$
$$\sum M_G = F_t r - (\mu_s N) r = I_G \alpha$$

$$\sum F_x = F\cos 30° - \mu_s N = m(\alpha r)$$
$$\sum F_y = F\sin 30° + N - mg = 0$$
$$\sum M_G = (F\sin 15°) r - (\mu_s N) r = \left(\tfrac{1}{2} m r^2\right) \alpha$$

C) Solve the system for F, N, and α:

$$F\cos 30° - \mu_s N = m(\alpha r)$$
$$F\sin 30° + N - mg = 0$$
$$(F\sin 15°) r - (\mu_s N) r = \left(\tfrac{1}{2} m r^2\right) \alpha$$

Using Wolfram α:

$$F = -148.5\text{N}$$
$$N = 172.2\text{N}$$

$$0.866F - 0.3N = (10\text{kg})(0.4\text{m})\alpha = 4\alpha$$
$$0.5F + N = (10\text{kg})\left(9.8\tfrac{\text{m}}{\text{s}^2}\right) = 98$$
$$0.259F - 0.3N = 0.5(10\text{kg})(0.4\text{m})\alpha = 2\alpha$$

$$\alpha = -45.1\tfrac{\text{rad}}{\text{s}}$$
$$a = \alpha r = \left(-45.1\tfrac{\text{rad}}{\text{s}}\right)(0.4\text{m}) = -18.03\tfrac{\text{m}}{\text{s}^2}$$