20-R-KM-DK-1

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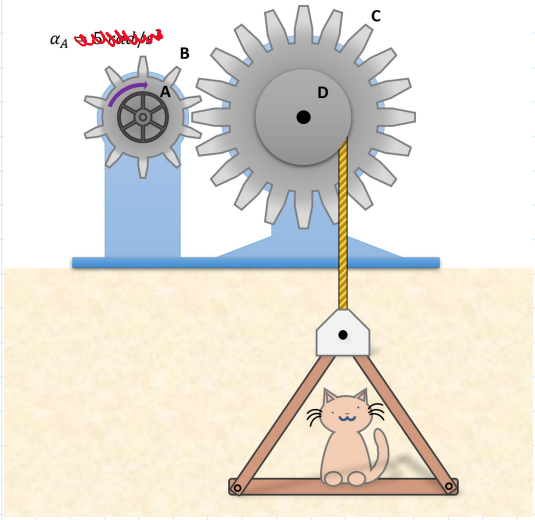
20-R-KM-DK-1 Intermediate Gear System Inspiration: None



A cat has found itself stuck on a platform controlled by a gear system. A bystander attempts to save it by turning handle A at a constant 5 rad/s² in the clockwise direction.
The diameter of handle A and gear B is 0.3 m and 0.6 m respectively, and the two are rigidly attached. Gear C has a radius of 0.8 m while pulley D has a radius of 0.3 m. The cord in which the platform is connected to is wrapped around pulley D which is rigidly attached to gear C. Assume the system starts from rest.

a) Determine the velocity of the cat and the distance it travels in 5 seconds

b) If the cat gets motion sickness and cannot handle an acceleration of 3 m/s² upwards, what is the maximum angular acceleration the bystander can turn the handle at? Are they currently over or under the limit?

$\vec{\alpha}_A = -5\ rad/s^2\ \hat{k}$ $\alpha_A = 5\ rad/s^2$

$d_A = 0.3m$ $d_B = 0.6m$

$r_A = 0.15m$ $r_B = 0.3m$ $r_c = 0.8m$ $r_d = 0.3m$

$a_t = \alpha r$

$\alpha_A = \alpha_B$ $\alpha_c = \alpha_D$

$\alpha_B = 5\ rad/s^2$ $a_1 = \alpha_B r_B = (5\ rad/s^2)(0.3m) = 1.5\ m/s^2$

$a_1 = \alpha_c r_c \rightarrow \alpha_c = \frac{a_1}{r_c} = \frac{(1.5\ m/s^2)}{0.8\ m} = 1.875\ rad/s^2$

$\alpha_D = 1.875\ rad/s^2$ $a_2 = \alpha_D r_D = (1.875\ rad/s^2)(0.3m) = 0.5625\ m/s^2$

$V = V_0 + at$ $d = d_0 + V_0 t + \frac{1}{2} a t^2$

$V = 0\ m/s + (0.5625\ m/s^2)(5s)$
$= 2.8125\ m/s$

$d = 0m + (0\ m/s)(5s) + \frac{1}{2}(0.5625\ m/s^2)(5s)^2$
$= 7.03125\ m$

$V = 2.8125\ m/s$ $d = 7.03125\ m$

$\vec{\alpha}_A = -5\ rad/s^2\ \hat{k}$ $\alpha_A = 5\ rad/s^2$

$d_A = 0.3m$ $d_B = 0.6m$

$r_A = 0.15m$ $r_B = 0.3m$ $r_c = 0.8m$ $r_d = 0.3m$

$a_t = \alpha r$ $\left|\frac{\alpha_B}{\alpha_A}\right| = \frac{r_A}{r_B}$

$\alpha_A = \alpha_B$ $\alpha_c = \alpha_D$ $a_2 = 3\ m/s^2$

$a_2 = \alpha_D r_D$ $\alpha_D = \frac{a_2}{r_D} = \frac{3\ m/s^2}{0.3m} = 10\ rad/s^2$

0.8m

$a_2 = \alpha_D r_D \qquad \alpha_D = \frac{}{r_D} = \frac{}{0.3\,m} = 10\ rad/s^2$

$\alpha_C = 10\ rad/s^2 \qquad \frac{\alpha_B}{\alpha_C} = \frac{r_C}{r_B} \qquad \frac{\alpha_B}{10\ rad/s^2} = \frac{0.8\,m}{0.3\,m}$

$\alpha_B = 10\left(\frac{0.8}{0.3}\right) = 26.\overline{66}\ rad/s^2 \qquad \alpha_A = \alpha_B \qquad \alpha_A = 26.\overline{66}\ rad/s^2$

$\alpha_A = 26.\overline{66}\ rad/s^2$ Under