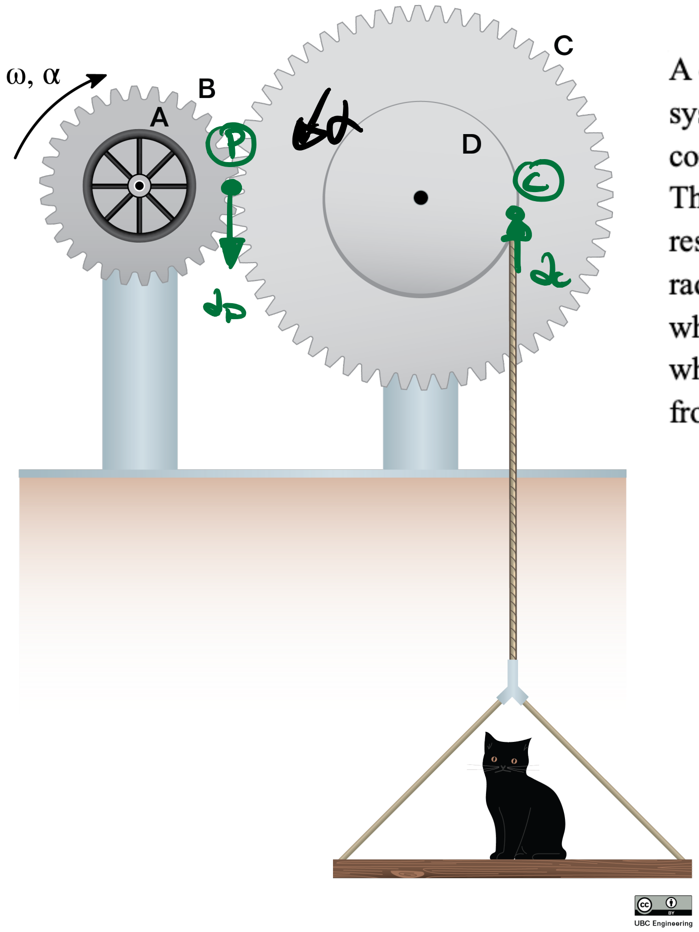
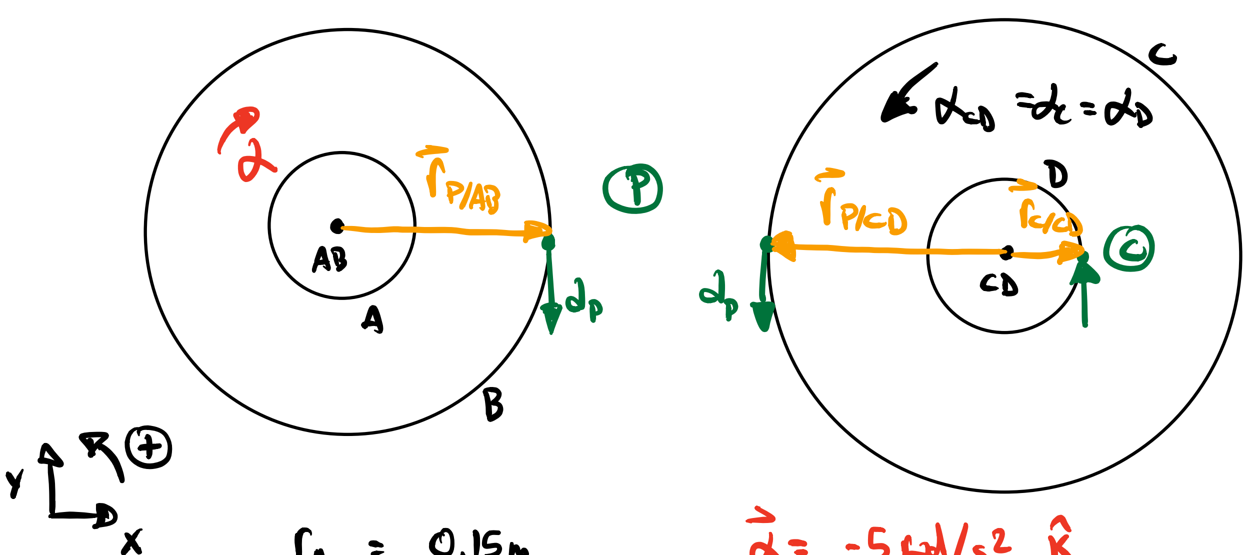


A cat has found itself stuck on a platform controlled by a gear system. A bystander attempts to save it by turning handle A at a constant 5 rad/s² in the clockwise direction.
The diameter of handle A and gear B is 0.3m and 0.6m respectively, and the two are rigidly attached. Gear C has a radius of 0.8m while pulley D has a radius of 0.3m. The cord to 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 3m/s² upwards, what is the maximum angular acceleration the bystander can turn the handle at? Are they currently over or under the limit?

① Diagram



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

$r_A = 0.15 m$

$r_B = 0.3 m$

$r_C = 0.8 m$

$r_D = 0.3 m$

② Assumptions - AB & CD are rigid bodies

↳ $\alpha_A = \alpha_B$

↳ $\alpha_C = \alpha_D$

- Start from rest

↳ α_0 } $V_0 = 0$

③ Solution

a) $\vec{a} = \vec{\alpha} \times \vec{r}$

$\vec{a}_P = \vec{\alpha}_A \times \vec{r}_{P/AB} = -5\hat{k} \times 0.3\hat{i} = -1.5\ m/s^2\ \hat{j}$

$\vec{a}_P = \vec{\alpha}_C \times \vec{r}_{P/CD} = -1.5\ m/s^2\ \hat{j} = \alpha_C\hat{k} \times -0.8\hat{i}$

↳ $\vec{\alpha}_C = 1.875\ rad/s^2\ \hat{k}$

$\vec{a}_C = \vec{\alpha}_D \times \vec{r}_{C/CD} = 1.875\ rad/s^2\ \hat{k} \times 0.3\ m\ \hat{i} = 0.56\ m/s^2\ \hat{j}$

$v = \cancel{v_0}^{0} + at \Rightarrow v(t=5sec) = (0.56\ m/s^2)(5\ sec) = \boxed{2.81\ m/s}$

$d = \cancel{d_0}^{0} + \cancel{v_0 t}^{0} + \frac{1}{2}at^2 \Rightarrow d(t=5sec) = 0.5\,(0.56\ m/s^2)(5s)^2$

$\boxed{d = 7.03\ m}$

b) $\vec{a}_C = 3\ m/s^2\ \hat{j}$

$\vec{a}_C = \vec{\alpha}_D \times \vec{r}_{C/CD} \Rightarrow 3\ m/s^2\ \hat{j} = \vec{\alpha}_D\hat{k} \times 0.3\ m\ \hat{i}$

$\vec{\alpha}_D = 10\ rad/s^2\ \hat{k}$

$\vec{a}_P = \vec{\alpha}_D \times \vec{r}_{P/CD} \Rightarrow \vec{a}_P = 10\hat{k} \times -0.8\hat{i} = -8\hat{j}$

$\vec{a}_P = \vec{\alpha}_A \times \vec{r}_{P/AB} \Rightarrow -8\hat{j} = \alpha_A \hat{k} \times 0.3\hat{i}$

$\hookrightarrow \boxed{\vec{\alpha}_A = -26.6\overline{6} \text{ rad/s}^2 \ \hat{k}}$