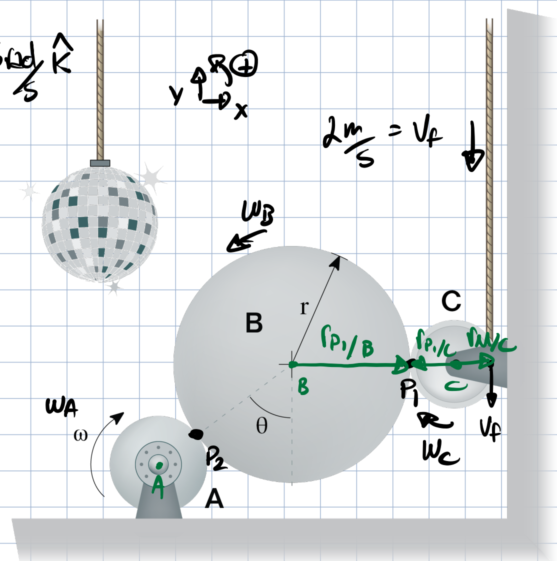
It is time for the annual Groovy Gathering where everyone from your physics classes dance while a giant disco ball spins overhead. As the party ends, the disco ball is raised back through a hole in the ceiling at a speed of 2m/s. The wheel system shown below controls how fast the disco ball is raised. All the wheels are surrounded in a band of rubber so that no slipping occurs between any of them. What is the required angular velocity of wheel A? What are the angular velocities of the other wheels? The wheels have radii $r_A = 0.3\ m$, $r_B = 1.2\ m$, and $r_C = 0.4\ m$.

$$\vec{V}_f = \vec{\omega}_c \times \vec{r}_{M/C} \Rightarrow \vec{\omega}_c = \frac{2\,m/s}{0.4\,m}\,(-\hat{k}) = -5\,rad/s\,\hat{k}$$

$$|\vec{\omega}| = 5\,rad/s$$



$$\vec{V}_{P_1} = \vec{\omega}_c \times \vec{r}_{P_1/C} \ ① \quad \& \quad \vec{V}_{P_1} = \vec{\omega}_B \times \vec{r}_{P_1/B} \ ②$$

$$① \ \vec{v}_{P_1} = \underbrace{-|\vec{\omega}_c|\,\hat{k}}_{\vec{\omega}_c} \times (-0.4\,m\,\hat{i}) = 0.4\,|\vec{\omega}_c|\,\hat{j}$$

$$② \ \vec{v}_{P_1} = \underbrace{(\vec{\omega}_B)}_{|\vec{\omega}_B|\hat{k}} \times (1.2\,m\,\hat{i}) = 1.2\,|\vec{\omega}_B|\,\hat{j}$$

$$0.4\,|\vec{\omega}_c| = 1.2\,|\vec{\omega}_B| \Rightarrow |\vec{\omega}_B| = \frac{0.4\,m}{1.2\,m}(5\,rad/s) = 1.68\,rad/s$$

similarly : $\vec{v}_{P2} = \vec{\omega}_B \times \vec{r}_{P2/B}$ & $\vec{v}_{P2} = \vec{\omega}_A \times \vec{r}_{P2/A}$

$$|\vec{r}_{P2/B}|\,|\vec{\omega}_B| = |\vec{r}_{P2/A}|\,|\vec{\omega}_A|$$

$$\Rightarrow |\vec{\omega}_A| = |\vec{\omega}_B|\left(\frac{|\vec{r}_{P2/B}|}{|\vec{r}_{P2/A}|}\right) = (1.68\,rad/s)\left(\frac{1.2\,m}{0.3\,m}\right) = 6.67\,rad/s$$

$$\boxed{\vec{\omega}_A = -6.67\,rad/s\,\hat{k}}$$