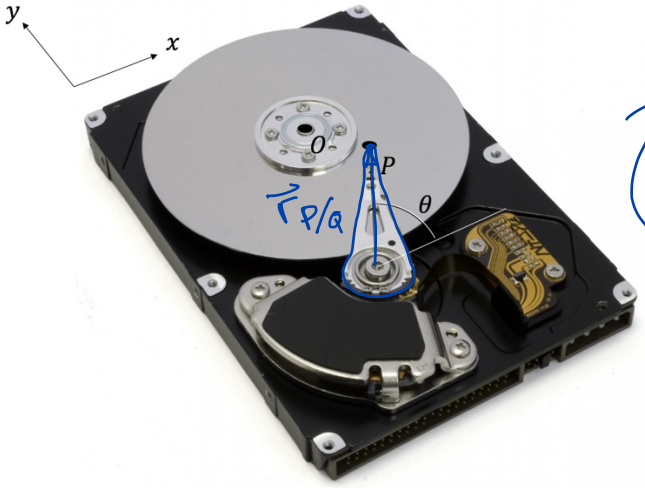
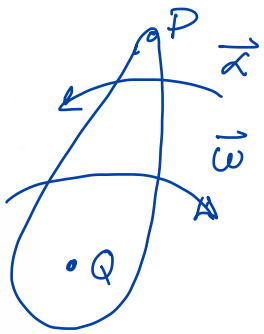
What is the velocity and acceleration of a point, *P*, on the read/write head of a hard drive? The actuator arm that supports the head has an angular velocity of 40 rad/s clockwise, and an angular acceleration of 200 rad/s^2 counter-clockwise. The actuator arm is at 60 degrees above the horizontal at this instant and the distance from *P* to the arm axle is 3.5 cm.





$\vec{\omega} = -40 \text{ rad/s}\,\hat{k}$

$\vec{\alpha} = 200 \text{ rad/s}^2\,\hat{k}$

$\vec{r}_{P/Q} = 0.035\left(\cos 60\,\hat{i} + \sin 60\,\hat{j}\right) \text{m}$

$\vec{v}_P = \vec{\omega} \times \vec{r}_{P/Q} = -40 \text{ rad/s}\,\hat{k} \times 0.035\left(\cos 60\,\hat{i} + \sin 60\,\hat{j}\right) \text{m}$

$= -40(0.035)\cos 60\,\hat{j} + 40(0.035)\sin 60\,\hat{i}$

$\boxed{\vec{v}_P = \left(1.21\,\hat{i} - 0.7\,\hat{j}\right) \text{m/s}}$

$\vec{a}_P = \vec{\alpha} \times \vec{r}_{P/Q} - \omega^2 \vec{r}_{P/Q}$

$= 200 \text{ rad/s}^2\,\hat{k} \times 0.035\left(\cos 60\,\hat{i} + \sin 60\,\hat{j}\right) \text{m}$

$- (-40 \text{ rad/s})^2\, 0.035\left(\cos 60\,\hat{i} + \sin 60\,\hat{j}\right) \text{m}$

$= 200(0.035)\cos 60\,\hat{j} - 200(0.035)\sin 60\,\hat{i}$

$- 1600(0.035)\cos 60\,\hat{i} - 1600(0.035)\sin 60\,\hat{j}$

$= 3.5\,\hat{j} - 6.1\,\hat{i} - 28\,\hat{i} - 48.5\,\hat{j}$

$\boxed{\vec{a}_P = \left(-34.1\,\hat{i} - 45.0\,\hat{j}\right) \text{m/s}^2}$