

1 | 1)

$$\vec{L} = \vec{p} \times m\vec{v}$$

Rotational velocity is measured in radians/second, so $\vec{v} = R\pi\vec{\omega}$.

$$\vec{L} = \vec{R} \times mR\pi\vec{\omega}$$

The vector is pointing into the page.
$$|\vec{L}| = mR\pi|\vec{R}||\vec{\omega}|$$

$$= mR^2\pi\omega$$

We know that $\sin \theta$ is 1 because the vectors are perpendicular.

2 | 2)

The angular momentum changes because although the momentum of the object does not change, its position changes.

3 | 3)

$$\begin{aligned}\vec{L} &= \vec{p}\vec{v} \\ \frac{d\vec{L}}{dt} &= \frac{d\vec{p}}{dt} \times m\vec{v} + \frac{dm\vec{v}}{dt} \times \vec{p} \\ &= \vec{v} \times m\vec{v} + m\vec{a} \times \vec{p} = 0 + \vec{p} \times m\vec{a} \\ &= \vec{p} \times \vec{F} \\ &= \vec{\tau}\end{aligned}$$