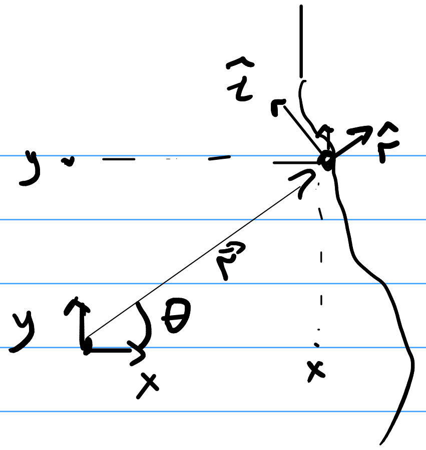
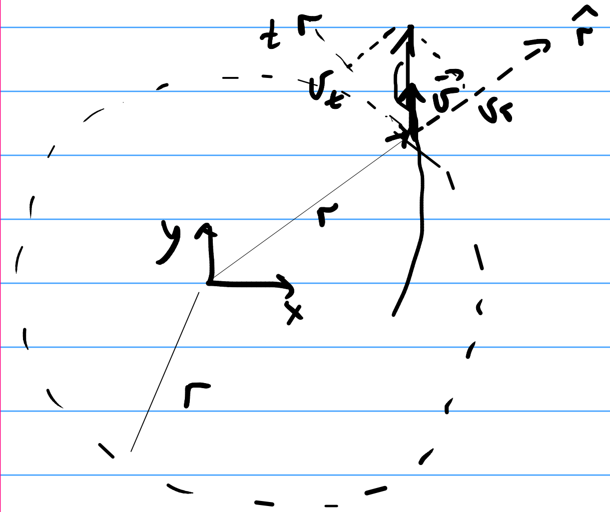


cartesian $\vec r = \{x, y\}$

polar $\vec r = \{\vec r, \vec \theta\}$

$x = r \cdot \cos\theta, \quad y = r \cdot \sin\theta$



$\vec v = \{v_r, v_t\}$

$v_t = \omega \cdot r$

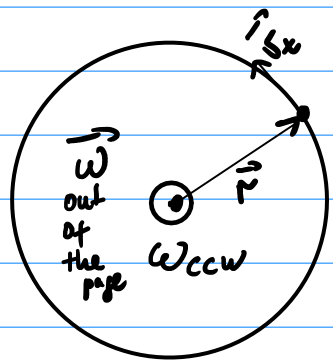
$$\vec a = \frac{d\vec v}{dt} = \left\{\frac{d(v_r)}{dt}, \frac{d(\omega\cdot r)}{dt}\right\}$$

$$= \left\{a_r, \underbrace{\left(\frac{d\omega}{dt}\right)}_{\alpha}\cdot r\right\} =$$

$$= \{\underbrace{a_r}_{(-\hat r)\frac{v^2}{r} = \vec a_c}, \alpha \cdot r\}$$

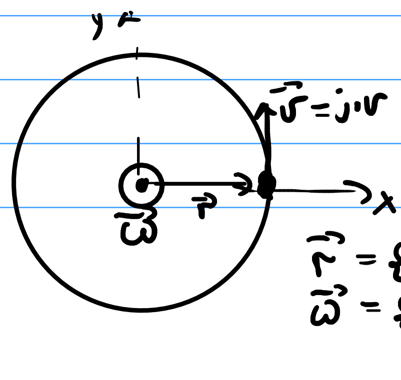
$$\vec v_t = v_t \cdot \hat t = \vec\omega \times \vec r$$

↑vector product



$$\vec\omega \times \vec r = \begin{vmatrix} \hat i & \hat j & \hat k \\ \omega_x & \omega_y & \omega_z \\ r_x & r_y & r_z \end{vmatrix} =$$

$$= \hat i(\omega_y r_z - \omega_z r_y) +$$
$$+ \hat j(\omega_z r_x - \omega_x r_z) +$$
$$+ \hat k(\omega_x r_y - \omega_y r_x)$$



$\vec r = \{r, 0, 0\}$
$\vec\omega = \{0, 0, \omega\}$

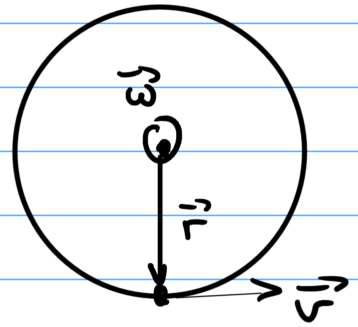
$$\vec\omega \times \vec r = \hat i \cdot 0 + \hat j(\omega\cdot r - 0) + \hat k(0) = \hat j \omega r$$

$\vec{\omega} = \{0, 0, \omega\}$

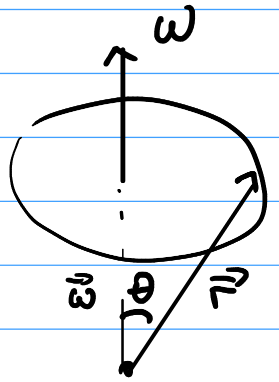
$\vec{r} = \{0, -r, 0\}$

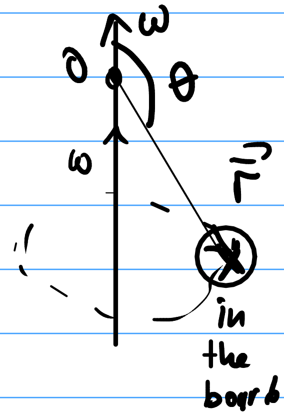
$\vec{\omega} \times \vec{r} =$

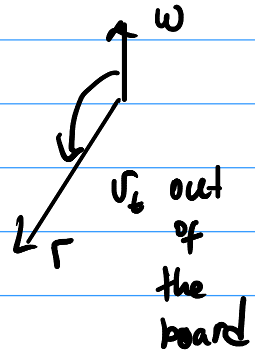
$= \hat{i}\,\omega r + \hat{j}0 + \hat{k}0$

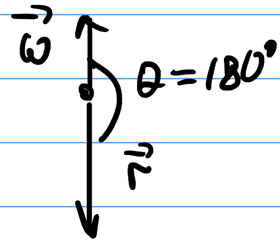


$$\left(\vec{\omega} \times \vec{r}\right)_t = \omega \cdot r \cdot \sin\theta$$







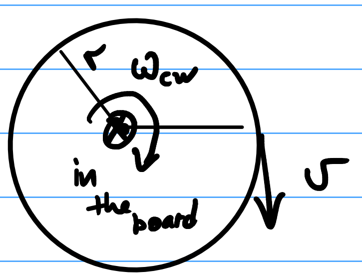


<u>example</u>

$v_0 = 100\ m/s$

$r = 0.1\ m$

$\Delta t = 20s$ to $v_f = 0$



$\omega_f = \omega_i + \alpha t$

$\omega_0 = \frac{v_0}{r}$

$-\omega^2 r$ — centripetal

$\vec{a} - ?$

$\vec{a} = \{a_r, a_t\}$

$$\frac{d\vec{\omega}}{dt} = \vec{\alpha} = \frac{\Delta\vec{\omega}}{\Delta t} = \frac{(\omega_f - \omega_i)}{\Delta t} = -\frac{v_0}{r\Delta t}\,(\hat{\omega})$$ out of the board