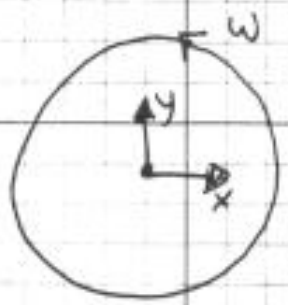
(4)



z-axis up $\quad \vec{\omega} = \omega \hat{z}$

(x y z) axes are rotating

Take boy as going in x-direction.

$x(t) = v_0 t \qquad y(t) = 0 \qquad z(t) = 0 \qquad \vec{r} = (v_0 t \;\; 0 \;\; 0)$

Centrifugal force $\quad \vec{F}_{cent} = -m\vec{\omega} \times (\vec{\omega} \times \vec{r})$

$$\vec{\omega} \times \vec{r} = \begin{vmatrix} \hat{x} & \hat{y} & \hat{z} \\ 0 & 0 & \omega \\ v_0 t & 0 & 0 \end{vmatrix} = \omega v_0 t \, \hat{y}$$

$$\vec{\omega} \times (\vec{\omega} \times \vec{r}) = \begin{vmatrix} \hat{x} & \hat{y} & \hat{z} \\ 0 & 0 & \omega \\ 0 & \omega v_0 t & 0 \end{vmatrix} = -\omega^2 v_0 t \, \hat{x} \qquad \boxed{\vec{F}_{cent} = m\omega^2 v_0 t}$$

Coriolis force $\quad \vec{F}_{Coriolis} = -2m\vec{\omega} \times \vec{v}_r \qquad \vec{v} = (v_0 \;\; 0 \;\; 0)$

$$\vec{F}_{Coriolis} = -2m \begin{vmatrix} \hat{x} & \hat{y} & \hat{z} \\ 0 & 0 & \omega \\ v_0 & 0 & 0 \end{vmatrix} = -2m \left[\omega v_0 \hat{y} \right]$$

$$\boxed{\vec{F}_{coriolis} = -2m\omega v_0 \hat{y}}$$