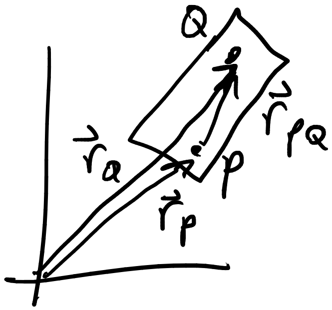
Rigid Body Acceleration and Velocity

rotating vector $\dot{\vec{r}} = \vec{\omega} \times \vec{r}$ (pure rotation).



$$\boxed{\vec{r}_Q = \vec{r}_P + \vec{r}_{PQ}}$$

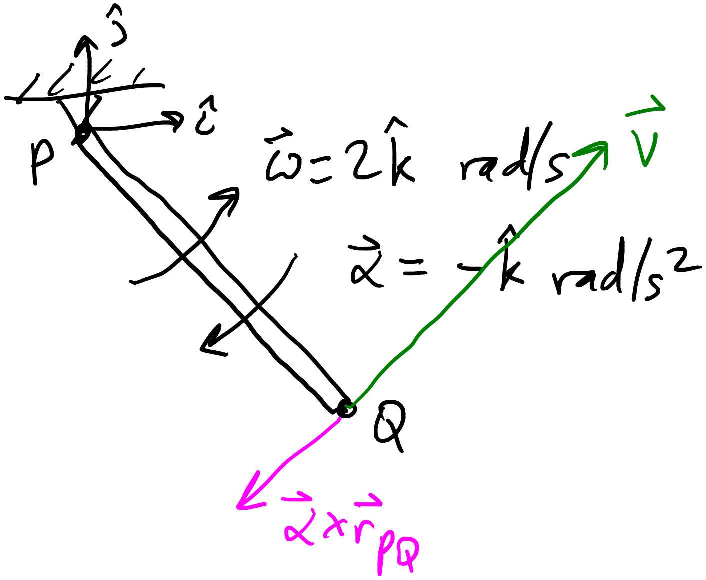
$$\boxed{\vec{v}_Q = \vec{v}_P + \vec{\omega} \times \vec{r}_{PQ}}$$

$$\vec{a}_Q = \vec{a}_P + \dot{\vec{\omega}} \times \vec{r}_{PQ} + \vec{\omega} \times \dot{\vec{r}}_{PQ}$$

$$\boxed{\vec{a}_Q = \vec{a}_P + \vec{\alpha} \times \vec{r}_{PQ} + \vec{\omega} \times (\vec{\omega} \times \vec{r}_{PQ})}$$

$$\cancel{(\omega \times \vec{r}_{PQ}) \times \vec{\omega}}$$

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



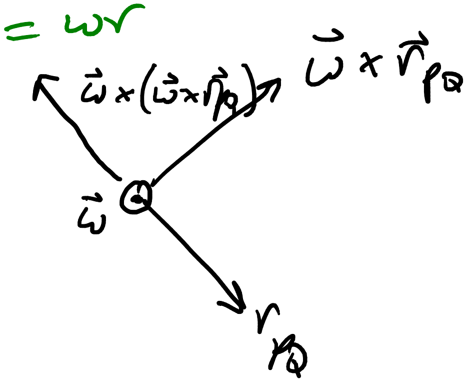
$$\vec{r}_{PQ} = 3\hat{\imath} - 4\hat{\jmath}$$

$$\vec{v}_Q = \cancel{\vec{v}_P}^{\,0} + \vec{\omega} \times \vec{r}_{PQ}$$

$$= 0 + 2\hat{k} \times (3\hat{\imath} - 4\hat{\jmath})$$

$$= 8\hat{\imath} + 6\hat{\jmath} \quad m/s$$

$v = \omega r$



$$\vec{a}_Q = \cancel{\vec{a}_P}^{\,0} + \vec{\alpha} \times \vec{r}_{PQ} + \vec{\omega} \times (\vec{\omega} \times \vec{r}_{PQ})$$

$$= -\hat{k} \times (3\hat{\imath} - 4\hat{\jmath}) + 2\hat{k} \times (8\hat{\imath} + 6\hat{\jmath})$$

$$= \underbrace{-4\hat{\imath} - 3\hat{\jmath}}_{\alpha \times r} \underbrace{- 12\hat{\imath} + 16\hat{\jmath}}_{\omega^2 r}$$

change in speed

centripetal
change in dir of $\vec{v}$

$$\vec{a}_Q = \ddot{s}\,\hat{e}_t + \frac{\dot{s}^2}{s}\,\hat{e}_n$$

correspondance due to simple circular motion.