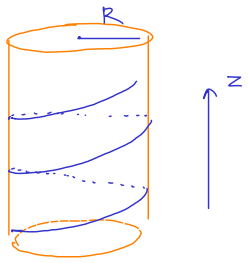
PHY 101 : Quiz 2

1. An insect is spiraling up on a surface of a cylinder (shown below) of radius R with anglular velocity α and upward velocity β along the $z-$ axis, both constants. Find out the relation between the

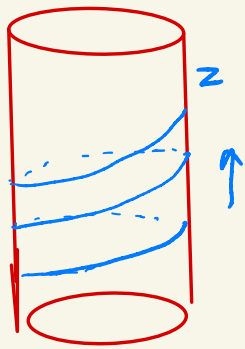


magnitudes of its velocity and acceleration.

2. A particle is moved along the surface of a sphere of radius R first in the $\theta = \pi/2$ plane from $\phi = 0$ to $\phi = \pi/2$ at contstant speed $\mathcal{V}$. Then in the $\phi = \pi/2$ plane it is moved from $\theta = \pi/2$ to $\theta = 0$ at the same constant speed. If a force is causing the particle to move in this trajectory find out the work done by the force aong the whole trajectory asuming Newton's law of motion.

Quiz - 02

1. $\vec{r} = R\hat{\rho} + z(t)\hat{k}$



$\dot{\vec{r}} = R\dot{\hat{\rho}} + \dot{z}\hat{k}$

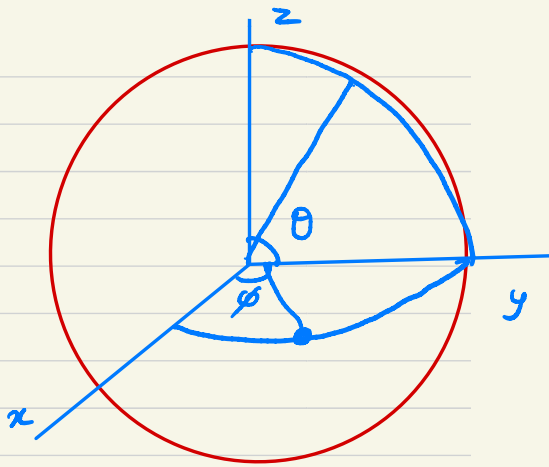
$\dot{\hat{\rho}} = \dot{\theta}\hat{\theta}$

$\dot{\vec{r}} = R\dot{\theta}\hat{\theta} + \dot{z}\hat{k}$; $|\vec{v}| = \sqrt{(R\alpha)^2 + \beta^2}$

$\ddot{\vec{r}} = R\ddot{\theta}\hat{\theta} - R\dot{\theta}^2\hat{\rho} + \ddot{z}\hat{k}$

$\vec{a} = -R\dot{\theta}^2\hat{\rho}$ $\Rightarrow |\vec{a}| = \sqrt{R\dot{\theta}^2}$ $\Rightarrow \dfrac{|\vec{a}|}{|\vec{v}|} = \dfrac{\sqrt{R\alpha^2}}{\sqrt{R^2\alpha^2 + \beta^2}}$

2. For the $\theta = \pi/2$ plane



If $\dot{\phi} = \text{const.} = \alpha$

$m\ddot{\vec{r}} = -mR\dot{\phi}^2\hat{r}$

while, $\dot{\vec{r}} = R\dot{\phi}\hat{\phi}$

$\vec{f} \cdot \dot{\vec{r}} = 0$

Similarly of $\phi = \pi/2$ plane

$m\ddot{\vec{r}} = -mR\dot{\theta}^2\hat{r}$

$\dot{\vec{r}} = R\dot{\theta}\hat{\theta}$ $\Rightarrow$ $\vec{f} \cdot \dot{\vec{r}} = 0$

$$W = \int_{\theta=\pi/2} \vec{f}\cdot d\vec{r} + \int_{\phi=\pi/2} \vec{f}\cdot d\vec{r} = \int_{\theta=\pi/2} \vec{f}\cdot\dot{\vec{r}}\,dt + \int_{\phi=\pi/2} \vec{f}\cdot\dot{\vec{r}}\,dt$$

$$= 0$$