1-18

$$\vec{r}(t) = \hat{i}\, b \sin\omega t + \hat{j}\, b\cos\omega t + \hat{k}\, c t^2$$

We need to calculate the acceleration vector:

$$\vec{V}(t) = \frac{d\vec{r}(t)}{dt} = \hat{i}\, b\omega \cos\omega t - \hat{j}\, b\omega \sin\omega t + \hat{k}\, 2ct$$

$$\vec{a}(t) = \frac{d\vec{V}(t)}{dt}$$

$$= -\hat{i}\, b\omega^2 \sin\omega t - \hat{j}\, b\omega^2 \cos\omega t + \hat{k}\, 2c$$

The magnitude of acceleration is

$$|\vec{a}(t)| = \sqrt{a_x^2 + a_y^2 + a_z^2}$$

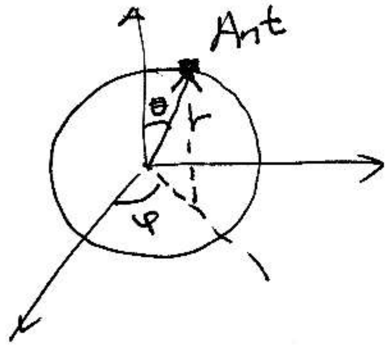
$$= \sqrt{(-b\omega^2 \sin\omega t)^2 + (-b\omega^2\cos\omega t)^2 + (2c)^2}$$

$$= \sqrt{b^2\omega^4 (\underbrace{\sin^2\omega t + \cos^2\omega t}_{1}) + 4c^2}$$

$$\boxed{|\vec{a}| = \sqrt{b^2\omega^4 + 4c^2}} \longleftarrow \text{Constant (i.e. no time dependency)}$$

1.22

The spherical Coordinates are : (r, θ, φ)



In this Case :

$r = b$, $\theta = \frac{\pi}{2}\left(1 + \frac{1}{4}\cos 4wt\right)$

$\phi = wt$

We need "Speed" in ~~the~~ spherical Coordinates :

$$\vec{V} = \hat{e}_r \dot{r} + \hat{e}_\theta r\dot{\theta} + \hat{e}_\varphi r\dot{\phi}\sin\theta$$

$\dot{r} = 0$ $\qquad \dot{\theta} = w\frac{\pi}{2}\left(-\sin 4wt\right)$ $\qquad \dot{\phi} = w$

Thus :

$$\vec{V} = \hat{e}_\theta bw\frac{\pi}{2}\left(-\sin 4wt\right) + \hat{e}_\varphi bw \underbrace{\sin\left(\frac{\pi}{2} + \frac{\pi}{8}\cos 4wt\right)}$$

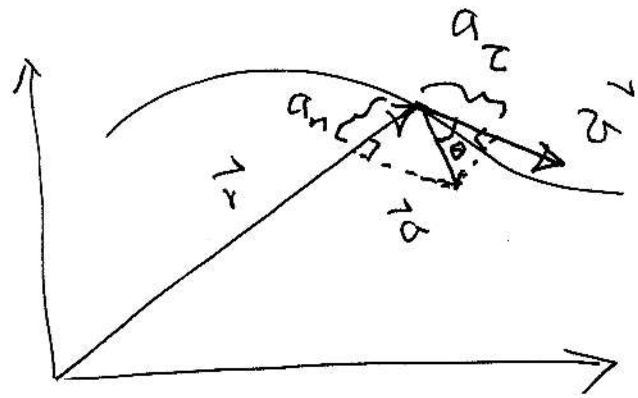
$$= + \cos\left(\frac{\pi}{8}\cos 4wt\right)$$

$$\boxed{\vec{V} = -\hat{e}_\theta bw\frac{\pi}{2}\sin 4wt + \hat{e}_\varphi bw\cos\left(\pi/8\cos 4wt\right)}$$

$$|\vec{V}| = V = bw\sqrt{\frac{\pi^2}{4}\sin^2 4wt + \cos^2\left(\pi/8\cos 4wt\right)}$$

Path = Sinusoidal oscillations about the equator.

1-25



from the figure:

$$a_\tau = a\cos\theta$$

but using: $\vec{v}\cdot\vec{a} = va\cos\theta$

$$\cos\theta = \frac{\vec{v}\cdot\vec{a}}{va}$$

Thus:

$$a_\tau = \cancel{a}\,\frac{\vec{v}\cdot\vec{a}}{v\cancel{a}} = \frac{\vec{v}\cdot\vec{a}}{v}$$

$$a^2 = a_n^2 + a_\tau^2 \rightarrow a_n = \sqrt{a^2 - a_\tau^2}$$

$$a_n = \sqrt{a^2 - \left(\frac{\vec{v}\cdot\vec{a}}{v}\right)^2}$$