Phys 410/F16

Soln PS 11

9.26 From Sec 9.8,

$$\ddot{x}' = 2\Omega \dot{y}' \cos\theta - 2\Omega \dot{z}' \sin\theta$$

$$\ddot{y}' = -2\Omega \dot{x}' \cos\theta$$

$$\ddot{z}' = -g + 2\Omega \dot{x}' \sin\theta$$

- we expect that Ω effects are "small."
- Solve by iteration, ie, neglect all Ω's @ lowest order, then re-introduce as successive refinement.
- Lowest order $\ddot{z}' = -g$, $\ddot{y}' = 0$, $\ddot{x}' = 0$

(No Ω's). But allow $\vec{v}_0$ and g.

$\Rightarrow$ use $\vec{r}(0) = 0$, $\dot{\vec{r}}(0) = \vec{v}_0$

$\Rightarrow$ $z = v_{z0} t - \frac{1}{2} g t^2$

$$x = v_{x0} t$$

$$y = v_{y0} t$$

1st order Retain the 1st Ω terms

but neglect Ω^2 terms. For Ω terms,

use the lowest order form above

$$\Rightarrow \quad \ddot{z} \simeq -g + 2\Omega V_{x0} \sin\theta$$

$$\ddot{x} \simeq 2\Omega V_{y0} \cos\theta - 2\Omega \sin\theta (V_{z0} - gt)$$

$$\ddot{y} \simeq -2\Omega V_{x0} \cos\theta$$

Now integrate again (iteration)

Note only 1st order Ω's

$$\Rightarrow z = V_{z0} t - \frac{1}{2} g t^2 + \Omega V_{x0} \sin\theta \, t^2$$

$$x = V_{x0} t + 2\Omega V_{y0} \cos\theta \frac{t^2}{2}$$

$$- 2\Omega \sin\theta V_{z0} \frac{t^2}{2} + \Omega \sin\theta g \frac{t^3}{3}$$

$$y = \overset{V_{y0} t}{\wedge} - 2\Omega V_{x0} \cos\theta \frac{t^2}{2}$$

$$z = v_{z0}t - \frac{1}{2}gt^2 + \Omega v_{x0}\sin\theta\, t^2$$

$$x = v_{x0}t + \Omega t^2(v_{y0}\cos\theta - v_{z0}\sin\theta) + g\Omega\sin\theta\, t^3/3$$

$$y = v_{y0}t - \Omega v_{x0}\cos\theta\, t^2$$

Correct to 1st order in Ω

Suppose $\vec{v}(0) = 0$ (ie free fall)

$\Rightarrow y = 0$, $x = g\Omega\sin\theta\, t^3/3$

$z = -\frac{1}{2}gt^2$.

agrees with text.