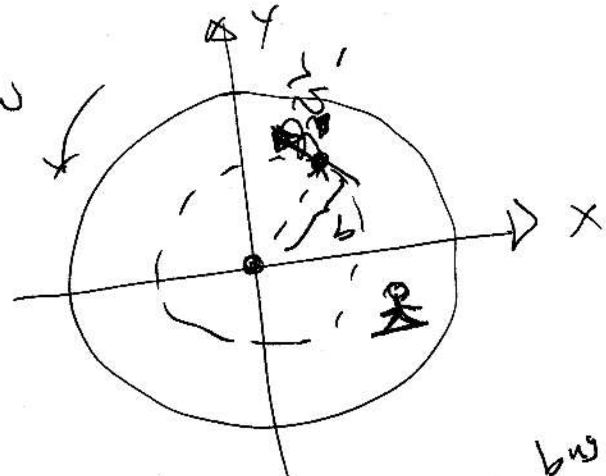
5.8

$\vec{\omega} = \omega \hat{k}$

m = mass

μ = Coefficient of frict



Two forces acting on the bug:

1) Centrifugal: $\vec{f}_{centri} = \overbrace{\frac{mv'^2}{b}\hat{e}_{r'}}^{\text{due to the bug rotat}} + \overbrace{b\omega^2 \hat{e}_{r'}}^{\text{due to the turntable}}$

2) Coriolis: $\vec{f}_{coriolis} = 2m\omega v' \hat{e}_{r'}$

$$F'_{net} = \frac{\cancel{m}v'^2}{b} + 2\cancel{m}\omega v' - \mu \cancel{m} g + b\omega^2 = 0$$

$$v'^2 + 2b\omega v' - b\mu g + b^2\omega^2 = 0$$

$$v' = -b\omega \pm \sqrt{b^2\omega^2 + b\mu g - b^2\omega^2} \rightarrow \boxed{v' = -b\omega + \sqrt{b\mu g}}$$

5.$0

From Example 5.3.3 in the text:

$$x'(t) = Ae^{wt} + Be^{-wt}$$

a)

$$\Rightarrow \quad \dot{x}'(t) = wAe^{wt} - wBe^{-wt}$$

At $t=0$ $\quad x'(0) = l/2 \Rightarrow l/2 = A+B$

$t=0$ $\quad \dot{x}'(0) = 0 \Rightarrow 0 = w(A-B)$

$\Rightarrow$ Solving for A and B $\Rightarrow$ $\boxed{A = B = l/4}$

b) Thus: $x'(t) = l/4\left(e^{wt} + e^{-wt}\right) = \frac{l}{2}\cosh wt$

when the bead reaches the end, $x' = l$, thus

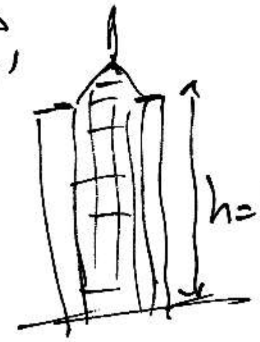
$$l = \frac{l}{2}\cosh wt \Rightarrow t = \frac{1}{w}\cosh^{-1} 2 = \frac{1.317}{w}$$

c) $\dot{x}'(t) = wl/2 \sinh wt \Big|_{t=\frac{1.317}{w}} \Rightarrow$

$$\dot{x}'(t = 1.317/w) = \cdots = 0.866wl$$

5-13

$$\vec{F}' = \cancel{m}\ddot{\vec{r}}' = \cancel{m}\vec{g} - 2\cancel{m}\vec{\omega}\times\vec{v}'$$



$$\vec{v}' : \begin{cases} \dot{x}_0' = 0 & x_0' = 0 \\ \dot{y}_0' = 0 & y_0' = 0 \\ \dot{z}_0' = 0 & z_0' = h = 1250\ \text{ft} \end{cases}$$

Substituting initial values:

$$\begin{cases} x'(t) = \tfrac{1}{3}\omega g t^3 \cos\lambda \\ y'(t) = 0 \\ z'(t) = -\tfrac{1}{2} g t^2 + z_0' \end{cases}$$

when it hits the ground, $z'(t) \to 0$

$$\Rightarrow \frac{1}{2} g t^2 = z_0' \to t = \sqrt{\frac{2(1250\,\text{ft})}{32\,\text{ft}/\text{s}^2}}$$

$$\boxed{t = 8.84\ \text{s}}$$

$$x'(t) = \frac{1}{3}\left(7.27\times10^{-5}\ \text{rad}/\text{s}\right)\left(\overset{32\,\text{ft}/\text{s}^2}{\cancel{9.8}}\right)(8.84)^3 \cos 41^\circ$$

$$\boxed{x'(t) = 0.404\ \text{ft}}$$