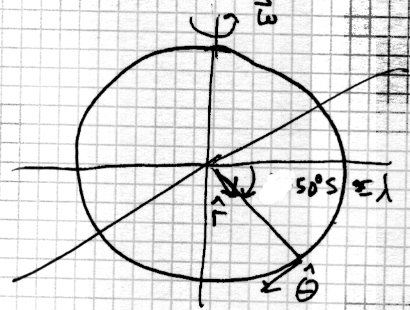
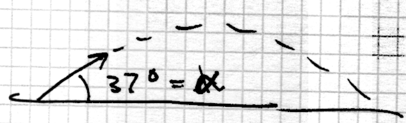


- The coriolis force on the shell is:

$$F_c = -2\, \vec{\omega} \times \vec{v}_r\, m \qquad \text{[eq. 10.34]}$$

- Neglecting the coriolis force, the velocity of the shell would be:

$$\vec{v} = v_r \hat{r} + v_\theta \hat{\theta}$$



- v_θ is the horizontal component of v, i.e. along earth surface: $v_\theta = v_0 \cos\alpha$

$$v_r = v_0 \sin\alpha - gt$$

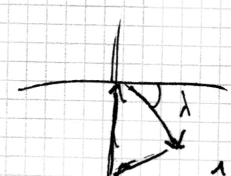
Time to peak: $0 = v_0 \sin\alpha - g t_p$

$$t_p = \frac{v_0 \sin\alpha}{g}$$

Total time aloft $= 2t_p = \dfrac{2 v_0 \sin\alpha}{g}$

so: $\vec{v} = (v_0 \sin\alpha - gt)\,\hat{r} + v_0 \cos\alpha\, \hat{\theta}$

- Coriolis force: $-2m\omega\, \hat{z} \times \left[(v_0 \sin\alpha - gt)\,\hat{r} + v_0 \cos\alpha\, \hat{\theta} \right]$



$\hat{z} = -\hat{r}\sin\lambda - \hat{\theta}\cos\lambda$

$$\hat{z} \times \hat{r} = -(\hat{r}\sin\lambda + \hat{\theta}\cos\lambda) \times \hat{r} = (-\hat{\theta} \times \hat{r})\cos\lambda = \hat{r} \times \hat{\theta} \cos\lambda = \hat{\phi}\cos\lambda$$

$$\hat{z} \times \hat{\theta} = -\hat{r} \times \hat{\theta} \sin\lambda = -\hat{\phi}\sin\lambda$$

$$F_{cor} = -2m\omega \left[(v_0 \sin\alpha - gt)\cos\lambda - v_0 \cos\alpha \sin\lambda \right]$$

- Velocity in the $\hat{\phi}$ direction is

$$v_\phi = -2\omega \left[v_0 (\sin\alpha\cos\lambda - \cos\alpha\sin\lambda)\, t - \frac{gt^2}{2}\cos\lambda \right]$$

$$= -2\omega \left[v_0 \sin(\alpha - \lambda)\, t - \frac{g\cos\lambda}{2} t^2 \right]$$

Displacement in ϕ-direction

$$d = \int_0^{2t_p} v_\phi \, dt$$

$$= \int_0^{2t_p} -2\omega \left[v_0 \sin(\alpha-\lambda)\, t - \frac{g\cos\lambda}{2} t^2 \right] dt$$

$$= -2\omega \left[v_0 \sin(\alpha-\lambda) \frac{t^2}{2} - \frac{g\cos\lambda\, t^3}{6} \right] \Big|_0^{2t_p}$$

$$= -2\omega \left[v_0 \sin(\alpha-\lambda)\, 2t_p^2 - \frac{4}{3} g\cos\lambda\, t_p^3 \right]$$

$$= -4\omega t_p^2 \left[v_0 \sin(\alpha-\lambda) - \frac{2}{3} g \cos\lambda\, t_p \right]$$

(TM 10-18) ②

$$d = -4\omega \left[\frac{v_0 \sin\alpha}{g}\right]^2 \left[v_0 \sin(\alpha - \lambda) - \frac{2}{3} g \cos\lambda \left(\frac{v_0 \sin\alpha}{g}\right)\right]$$

$$= -4\omega \frac{v_0^3 \sin^2\alpha}{g^2} \left[\sin(\alpha-\lambda) - \frac{2}{3} \cos\lambda \sin\alpha \right]$$

$$= 4\omega \frac{v_0^3 \sin^2\alpha}{g^2} \left[\sin(\lambda-\alpha) + \frac{2}{3} \cos\lambda \sin\alpha \right]$$

$= 270$ m, in the $\hat{\phi}$ direction (i.e. to the east, which would be to the left of the ship)