Phys 3010 <u>Assignment 7</u>

10.1 The accelerations we feel at surface of Earth are:

1) Gravitational $g = 980\ cm/sec^2$

2) Due to Earth's rotation on its own axis

$$r\omega^2 = (6.4 \times 10^8\ cm) \times \left[\frac{2\pi\ rad/day}{86{,}400\ sec/day}\right]^2$$

$$= 3.4\ cm/sec^2$$

3) Due to rotation about sun

$$r\omega^2 = (1.5 \times 10^{13}\ cm) \times \left[\frac{2\pi\ rad/yr}{86400 \times 365\ sec/day}\right]^2$$

$$= 0.6\ cm/sec^2$$

Coriolis acceleration is $\vec{a} = -2\vec{\omega} \times \vec{v}$.

Approximating $\vec{v} = (0, 0, \dot{z})$ gives:

$$\vec{a} = -2 \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ -\omega\cos\lambda & 0 & \omega\sin\lambda \\ 0 & 0 & \dot{z} \end{vmatrix}$$

$$= -2(0, \omega\dot{z}\cos\lambda, 0)$$

Hence, the Coriolis force accelerates the particle in the $\hat{y}$ direction.

$$\ddot{y} = -2\omega\dot{z}\cos\lambda$$

$$\dot{y} = -2\omega z\cos\lambda \quad \text{since } \dot{y}(t=0)=0$$

$$= -2\omega\cos\lambda\left(v_0 t - \frac{g}{2}t^2\right) \quad \text{using (2)}$$

$$y(t) = -2\omega\cos\lambda\left(v_0\frac{t^2}{2} - g\frac{t^3}{6}\right)$$

Total deflection of particle is:

$$y\left(\frac{2v_0}{g}\right) = -2\omega\cos\lambda\left(\frac{4v_0^3}{2g^2} - g\frac{8v_0^3}{6g^3}\right)$$

$$= -\frac{4}{3}\omega\cos\lambda\frac{v_0^3}{g^2}$$

Using $v_0 = \sqrt{2gh}$ we get $y = -\frac{4}{3}\omega\cos\lambda\sqrt{\frac{8h^3}{g}}$.

The negative sign means particle is deflected westward.