Phys102 Assignment Cover Sheet

First Name:_____ Last Name:_____ Mark: _____

Student ID:_____ Date: _____ Section: _____

Phys102 Written Assignment #5

Due Wed/Thur Oct 27/28, by the end of your tutorial.

Textbook (Giancoli, SFU edition), page728, question #31.

31. Suppose the Earth's magnetic field at the equator has magnitude 0.50×10^{-4} T and a northerly direction at all points. Estimate the speed a singly ionized uranium ion $(m = 238\text{ u}, q = e)$ would need to circle the Earth 5.0 km above the equator. Can you ignore gravity? [Ignore relativity.] $1\text{ u} = 1.66\times10^{-27}$ kg.

[Solution]

The magnetic force will produce centripetal acceleration.
The radius of the Earth is $6.38\times10^{6}\text{ km}$, and the altitude is added to that.

$$F_B = qvB = m\frac{v^2}{r} \quad\rightarrow\quad v = \frac{qrB}{m} = \frac{(1.60\times10^{-19}\text{C})(6.385\times10^{6}\text{m})(0.50\times10^{-4}\text{T})}{238(1.66\times10^{-27}\text{kg})} = \boxed{1.3\times10^{8}\text{ m/s}}$$

Compare the size of the magnetic force to the force of gravity on the ion.

$$\frac{F_B}{F_g} = \frac{qvB}{mg} = \frac{(1.60\times10^{-19}\text{C})(1.3\times10^{8}\text{ m/s})(0.50\times10^{-4}\text{T})}{238(1.66\times10^{-27}\text{kg})(9.80\text{m/s}^2)} = 2.3\times10^{8}$$

Yes, we may ignore gravity. The magnetic force is more than 200 million times larger than gravity.