1. In the mid-latitude, the $\vec{B}_0$ points to the north with a dip angle I (see the figure below). Assuming a neutral wind $\vec{U}$ which is eastward and the equation of ion motion can be expressed as :

$$e\vec{V}_i \times \vec{B}_0 = m_i \nu_{ic}(\vec{V}_i - \vec{U})$$
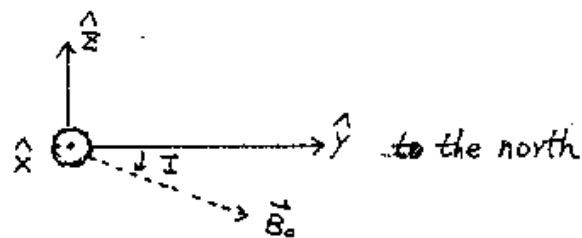
Defining $\kappa_i = e|\vec{B}_0|/m_i\nu_{ic}$

Discuss the ion motion at $\kappa_i \gg 1$ and $\kappa_i \ll 1$　　　(20%)

2. what's the echo mechanism of "Ionosonde" ? Are there other instruments that can investigate the ionosphere ? How to obtain the electron density by using the Ionosonde ?　(20%)

3. State the phenomena listed below. How do they affect the communication ?
   ① Sporadic E　　② Spread F　　③ Ionospheric storm　　　(20%)

4. What are the feature and application by using the UHF, VHF, HF, VLF and ULF bands to probe the ionosphere ?
   What's the "Faraday rotation" ?　　　　(20%)

5. Given the Appleton-Hartree formula

$$N^2 = 1 - \frac{2X(1-X)}{2(1-X)-Y_T^2 \pm \sqrt{Y_T^4 + 4Y_L^2(1-X)^2}} \quad \text{and} \quad \tan^2\theta = -\frac{\kappa_{//}(N^2-\kappa_R)(N^2-\kappa_L)}{(N^2-\kappa_{//})(\kappa_T N^2 - \kappa_R\kappa_L)}$$

Discuss the polarization and dispersion relation of the ordinary and exordinary waves at $\theta = 90°$ and $\theta = 0°$ when the vertical reflection takes place, respectively.　　(20%)