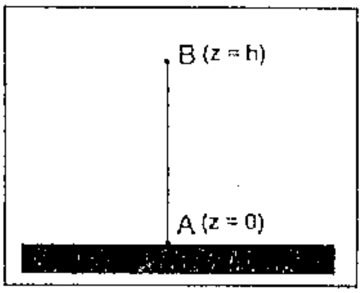
國立中央大學八十七學年度碩士班研究生入學試題卷

所別：太空科學研究所　不分組　科目：　太空物理及電離層物理　

1. Assume that, in the ionosphere, the refractive index (μ) as a function of the height (z) and the radio frequency (f) is given by

$$\mu = 1 - \frac{1}{2}\left(\frac{z \cdot f_{NB}}{h \cdot f}\right)^2 ,$$

where h is the height at the point B, and f_{NB} is the plasma frequency at B. Find (1) the phase path (P), (2) the real path, and (3) the group path (P') between A and B as shown as the following figure, when $f = 2\,f_{NB}$. (20%)



2. Assume that, in the ionosphere, the electron density N_e is a function of the height z and given by

$$N_e = N_0 e^{\frac{1}{2}\left(1 - \frac{z - z_0}{H} - \sec\chi \cdot e^{-\frac{z - z_0}{H}}\right)} \quad \text{-- the Chapman law}$$

where N_0 is a reference electron density, H is the scale height of the Chapman layer, z_0 is a reference height, and χ is the angle between the sun's radiation and the zenith of the Earth. Show (1) the maximum value of N_e and (2) its corresponding height z_m. (15%)

3. The refractive index μ is given by $\mu^2 = 1 - X/(1-Y)$, where $X = (f_N^2)/(f^2)$, $Y = f_B/f$, f is the radio frequency, f_N is the plasma frequency, and f_B is the gyrofrequency. Show that the group refractive index μ' is given by $\mu\mu' = 1 + 0.5\, XY/(1-Y)^2$. (15%)

注意：背面有試題

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4. Earth magnetosphere is shaped by electric currents flowing in the magnetosphere.

[6%] (a) Describe the direction of electric currents at (1) dayside magnetopause, (2) nightside magnetopause, (3) plasmasheet boundary layer, and (4) plasmapause. Explain the physical mechanism of the formation of these electric currents.

[2%] (b) What kinds of variations (in both location and strength) of which current are responsible for the observed magnetic field changes at Earth's surface during sudden commencement of a magnetic storm?

[2%] (c) What kinds of variations (in both location and strength) of which current are responsible for the observed magnetic field changes at Earth's surface during main phase of a magnetic storm?

[5%] (d) Describe and sketch the Region I field-aligned current system and Region II field-aligned current system, including their distribution at ionosphere, and their connection to the current system in the magnetosphere.

5. Charge particle motion:

[10%] (a) Explain physical conditions and physical processes that lead to $\mathbf{E} \times \mathbf{B}$ drift, ∇B drift, curvature **B** drift, and gravitational drift of a single charged particle. Sketch particle trajectory if it can help you to write your explanation.

[5%] (b) Describe particle drift directions of the following four group of particles in plasmasphere (inner magnetosphere) (1) low energy ions, (2) low energy electrons, (3) energetic ions, and (4) energetic electrons. Explain how you obtain these results.

6. Diffuse aurora is formed when wave-particle interaction occurred in the ring current region, in which some of the energetic particles are scattered by the waves to fall into *loss cone* and then loss at ionosphere.

[5%] (a) What is *loss cone*? If you sketch a loss cone, you have to indicate the name of each axis in your plot.

[5%] (b) What kind of magnetic field configuration can lead to the formation of a loss cone distribution in plasma? Why?

7. An MHD (magnetohydrodynamic) plasma model is used to describe physical phenomena in a magnetized plasma with at very long wavelength and very low frequency (that is, when wavelength is much greater than ion gyroradius and frequency is much less than ion gyrofrequency). Please answer the following questions for a nonrelativistic MHD plasma. (i.e., $v^2/c^2 << 1$).

[2%] (a) What is the Ohm's law of an MHD plasma?

[8%] (b) Show that magnetic field flux is frozen-in the flow of an MHD plasma.