

Tentamen i rymdfysik, 2003–01–03, kl 0900–1500

Hjälpmedel: Physics Handbook, räknare, engelska lexikon

1. A satellite is after launch orbiting the Earth in a transfer orbit. To reach the planned final orbit, the velocity of the satellite should be increased by $\Delta v = 3000$ m/s. How much fuel must be carried by the satellite in the transfer orbit if its rocket motor can eject gases with a velocity $v_e = 2000$ m/s and the payload is to have a mass $m_p = 500$ kg in the final orbit?
2. In the core of the Sun, nuclear fusion produces a power of about $4 \cdot 10^{26}$ W. Describe how this energy is transported at various distances from the center of the Sun.
3. The geomagnetic field is approximately a dipole with field strength given by

$$B(L, \lambda) = B_0 \frac{(1 + 3 \sin^2 \lambda)^{1/2}}{L^3 \cos^6 \lambda}$$

where λ is the latitude and the distance from the center of earth to a point on the field line is $r(\lambda) = LR_E \cos^2 \lambda$. An electron that passes through the equatorial plane ($\lambda = 0$) at a geocentric distance $r_E = 7 R_E$ is reflected at $r_M = 1.4 R_E$ from the center of Earth. What is the equatorial pitch angle of this electron?

4. Small amounts of ozone are a very important component of the atmosphere. Discuss at what altitudes ozone is found, how it affects the temperature of the atmosphere, how it is formed, how it is removed, how we are affected if the ozone disappears, and other things you know about ozone in the atmosphere.
5. Collisionless plasmas are in the absence of field-aligned electric fields drifting with velocity $\mathbf{U} = \mathbf{E} \times \mathbf{B}/B^2$. Show that the time it takes the plasma to drift across a flux tube is the same all along the flux tube, even if the magnetic field strength varies by orders of magnitude.
6. Assume that the cross-tail potential is 70 kV, the tail diameter is $30 R_E$, and the magnetic fields on either side of the neutral sheet are ± 10 nT.
 - a. Estimate the power dissipated per R_E in this section of the tail. (2 p)
 - b. What is a typical velocity of the plasma inflow from the tail lobes? (0.5 p)
 - c. The magnetic field in the neutral sheet is 2 nT, directed northward. What is a typical sunward flow velocity in the neutral sheet? (0.5 p)