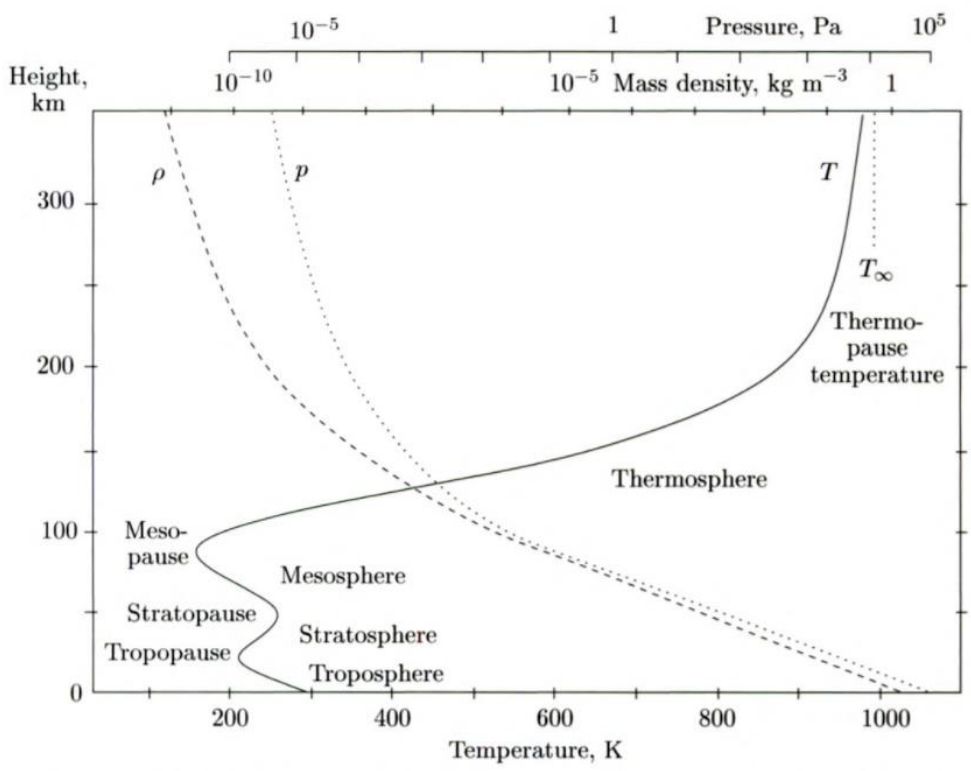
FYS 3610: Week 39 Solutions

Exercise 1 (17 points)

a)



After Prölss, 2004, ISBN 3-540-21426-7

b) See figure above

c)

p = pressure

ρ = mass density

d) $n(z) = n(z_0) \exp\left(-\frac{mg}{k_B T}(z - z_o)\right)$

e) $H \approx 60\ km$

Exercise 2 (12 points)

a) $m\frac{d\vec{v}}{dt} = q\,\vec{E} + q(\vec{v} \times \vec{B})$

$\vec{v}$ = velocity

m = mass

q = elementary charge

$\vec{E}$ = electric field

$\vec{B}$ = magnetic field

b) $m\frac{d\,\vec{v}_{||}}{dt} = q\,\vec{E}_{||}$

$m\frac{d\,\vec{v}_{\perp}}{dt} = q\,\vec{E}_{\perp} + q(\vec{v}_{\perp} \times \vec{B})$

$\vec{v}_{||}\,(t) = \vec{v}_{||}\,(t_0) + \frac{q\,\vec{E}_{||}}{m}(t - t_0)$

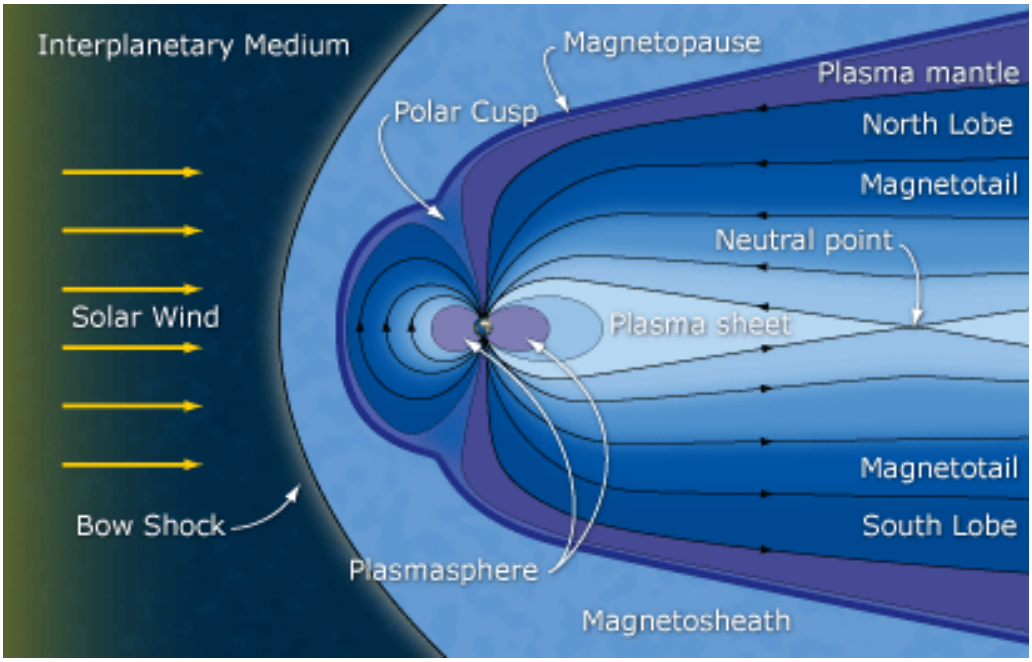
c) $\vec{v}_D^E = \vec{E}_{\perp} \times \vec{B}/B^2$

d) 500 m/s

e) Choose any drift you want. See pages 223, 226, 229, 231 of the book.

Exercise 3 (10 points)

a) See figure:



Credit: ESA (adapted from picture by C. Russel)

b) $\sim 10\ R_E$

c) $L = \frac{r}{R_m} \approx 1.9$

Exercise 4 (8 points) (more difficult)

a) The cross product between the current density and the magnetic field $\vec{j} \times \vec{B}$ and the time derivative $\partial / \partial t$.

b) $\omega(k) = \sqrt{\frac{\gamma p_0}{\rho_0}}\, k$

e)