Physics 410 - 2003

Thermal Physics

Problem Set 8

1. Chapter 5, p. 145, problem 3 (5 pt)

2. Chapter 5, p. 146, problem 6 (5 pt)

3. Chapter 5, p. 147, problem 10 (5 pt)

4. Consider an ideal gas of molecules with an electric dipole moment $\mathbf{p}_0$, which can point in an arbitrary direction. The gas is placed into a uniform electric field $\mathbf{E}$. The gas density is n. Neglect the effect of the electric field of one molecule on another, i.e. neglect the interaction between the molecules. Show that the polarization of the gas (the dipole moment per unit volume) is
$$P = np_0 \left[\coth \frac{p_0 E}{\tau} - \frac{\tau}{p_0 E} \right]$$
(6 pt)

5. For given temperature, pressure of a classical ideal gas is proportional to density, i.e., to the average number of molecules per unit volume n. Show this (5 pt). Use the result to show that, if temperature is constant, in a uniform gravitational field (close to the Earth surface) pressure in a gas depends on height z as $p(z) = p(0) \exp(-mgz/\tau)$, where m is the mass of a molecule (4 pt)

You need to have 25 points

The problems are from Kittel & Kroemer, *Thermal Physics*, 2nd edition, (Freeman, NY 1980).