Suspensions and polymer solutions

Exercise 2

16 March 2011

1. A molecule having a fixed dipole moment μ is held at temperature T in a uniform electric field $\vec{E}$. Show that, to linear order in E, the induced dipole moment is $\vec{\mu}^{\mathrm{ind}} = \alpha \vec{E}$, with the polarizability $\alpha = \mu^2/(3k_{\mathrm{B}}T)$.

2. A water molecule lies at a height h above the surface of a semi-infinite bulk of water. The van der Waals interaction coefficient for water is $C = 1.4 \times 10^{-58}$ erg cm^6, and water mass density is 1 g/cm^3.

   (a) Derive the expression for the van der Waals attraction energy between the molecule and the bulk as a function of h.

   (b) At what height h will the van der Waals interaction be equal to $k_{\mathrm{B}}T$ at room temperature? (This can be used as an estimate of the width of the liquid/vapor interface.)