November 26, 2007

PHY 711 – Problem Set # 23

Continue reading Chapter 12 in **Fetter and Walecka**.

For the purpose of this problem, define the Reynold's number for the motion of a spherical object of radius a in a fluid of density n_f at velocity u and viscosity η as

$$\mathcal{R} = \frac{2n_f a u}{\eta}.$$

1. Show that from Stoke's relation, the terminal velocity of the sphere (having density n_o) falling under uniform gravitational acceleration g within a large container of the fluid of density n_f and viscosity η as is given by

$$u = \frac{2a^2(n_o - n_f)g}{9\eta}.$$

2. Find an expression for the Reynold's number for this situation.

3. Suppose $n_o = 7900$ kg/m^3 (steel), $n_f = 1000$ kg/m^3 (water) and $\eta = 0.001$ Pa·s. Find the radius a at which $\mathcal{R} = 0.5$.

4. Repeat the calculation for the fluid of castor oil $n_f = 960$ kg/m^3 and $\eta = 1$ Pa·s.