Answer to Electromagnetism Example Question 7

a) The number of carbon atoms per m^3 is

$$N = \frac{3500}{12} \times 6 \times 10^{26} = 1.75 \times 10^{29} \text{ m}^3$$

b) As $P_o = Np$ where p is the dipole moment of individual atoms then

$$p = \frac{1.5 \times 10^{-7}}{1.75 \times 10^{29}} = 8.57 \times 10^{-37} \text{ Cm}$$

c) Carbon has a nucleus with charge +6e and surrounding electron charge –6e. An estimate for the separation of the +/- charge centres is obtained from

$$p = sq \quad \text{i.e. } 8.57 \times 10^{-37} = s.(6 \times 1.6 \times 10^{-19})$$

Thus $s = 8.92 \times 10^{-19}$ m, that is about 10^{-18} m, a very small displacement!

d) We have that $J_b = \frac{\partial P}{\partial t} = \omega P_o \cos(\omega t)$ in this case.

The amplitude of the resultant polarisation current density oscillation is then just given by

$$\omega P_o = 2\pi \times 10^{12} \times 1.5 \times 10^{-7} = 9.42 \times 10^{5} \text{ Am}^{-2} .$$