Problem Set 2

1. What is an eigen function and what are eigen values? Explain with a specific example.

2. In a graph, show the position of a particle (x, y, z) in terms of the spherical co-ordinates (r, Θ, φ). What are the possible values of r, Θ, φ.

3. In quantum mechanics, what is meant by the wavefunction of a particle?

4. At the time that J.J.Thomson conducted his experiments on cathode rays; the nature of the electrons was in doubt. Some considered it to be a form of radiation, like light; others believed it to be particle. Some of the observations made on cathode rays were used to advance one view or the other. Explain how each of the following properties of the cathode rays supports either the wave or the particle model of the electron.

a) They pass through metal foils
b) They travel at speeds slower than that of light
c) If an object is placed in their path, they cast a shadow
d) Their path is deflected when they are passed between electrically charged plates

5. A hydrogen atom in the ground state absorbs a photon whose wavelength is 95.0 nm. The resulting excited atom then emits a photon of 1282 nm. What are the regions of the electromagnetic spectrum for the radiations involved in these transitions? What is the principal quantum number of the final state resulting from the emission from the excited atom.

6. The root mean square speed of an O_2 molecule at 21°C is 479 m/s. Calculate the de Broglie wavelength for an O_2 molecule travelling at this speed. How does this wavelength compare with the approximate length of this molecule, which is about 242 pm. (For this comparison, state the wavelength as a percentage of molecular length)

7. (a) How many values of the quantum number *l* are possible when n = 7? (b) How many values of ml are allowed for an electron in a 6d-subshell? (c) How many values of *m* are allowed for an electron in a 3p-subshell? (d) How many subshells are there in the shell with n = 4?

8. How would you represent the wave function(s) in the $\psi_{n,l,m}$ format for electron in the H-atom that exists in the following orbitals (a) 6p; (b) 3d, Example, $\psi_{n,l,m}$ corresponding to 2p will be $\psi_{2,0,0}$; etc