Registration no: | | | | | | | | | | |

Total Number of Pages: 02 **M.Sc.I**

FPYC504

5th Semester Regular / Back Examination 2017-18

Atomic and Molecular Physics

BRANCH(S): M.Sc.I(AP)

Time: 3 Hours

Max marks: 70

Q.CODE: B635

Answer Question No.1 which is compulsory and any five from the rest.

The figures in the right hand margin indicate marks.

Q1 **Answer the following Questions :** **(2 x 10)**

a) Write Bohr's atomic model.

b) Show Zeeman pattern of a line due to $^2P_{3/2} \rightarrow {}^2S_{1/2}$

c) Write the significance of the magnetic quantum number m_l.

d) Calculate the allowed angles between the angular momentum vector $\vec{L}$ of an electron in the state ℓ=2 and its Z-component. Show these graphically.

e) Calculate Lande's g factor and total magnetic moment for $^2D_{\frac{5}{2}}$ state.

f) A spectral line of wave length 4500Å when produced in a magnetic field of 10 Tesla is observed to be a normal Zeeman triplet. Calculate the wavelength separation between components of this triplet.

g) Show that the number of terms for pd configuration is the same for LS and JJ coupling.

h) The X-ray emission spectrum of a substance gives the following values of K_α and L_α lines. K_α line=0.2Å; L_α line=1.6Å. using the data find the wavelength of K_β line.

i) Why are the anti-stokes lines fainter than stokes lines.

j) Calculate the rotational energy corresponding to J=1 for hydrogen molecule, given that inter-molecular distance R=0.074nm and mass of H-atom 1.674×10^{-27} kg, h= 6.63×10^{-34}JS

Q2 Discuss relativistic Sommerfeld theory of hydrogen atomic spectrum. How does it explain fine structure of H_α line **(10)**

Q3 What is normal Zeeman effect? On the basis of quantum theory, explain the effect of magnetic field on energy levels of an atom. Hence explain the splitting of spectral lines in normal Zeeman effect and show that a spectral line splits into 3 spectral lines **(10)**

Q4 What do you mean by spin-orbit interaction? Calculate the change in total energy of the atom due to spin-orbit coupling. How the fine structure of hydrogen spectra explained on the basis of spin-orbit interaction **(1+5+4)**

Q5 **a)** How is the production of continuous and characteristic X-ray spectra accounted for. **(5)**

b) State and explain Pauli's exclusion principle as applied to electrons in atoms. On the basis of this principle explain the configuration of electrons in atoms. **(5)**

Q6 **a)** Describe and explain LS coupling. Under what conditions does it hold ? When LS coupling breaks down? **(7)**

b) The quantum numbers of 2 electrons in a 2 valance electron atom are **(3)**

$n_1=6$, $l_1=3$, $s_1=1/2$

$n_2=5$, $l_2=1$, $s_2=1/2$

i) Assuming L-S coupling find the possible values of L and J.

ii) Assuming J-J coupling find the possible values of J.

Q7 **a)** Obtain an expression for rotational energy levels of a diatomic molecules and the frequency of rotational spectra. **(6)**

b) Show that in rotational spectra the energy levels are not equally spaced whereas the frequencies are equally spaced. **(2)**

c) The J=0 to J=1 absorption line in carbon monoxide (CO) occurs at a frequency 1.153×10^{11}Hz. Calculate the moment of inertia. **(2)**

Q8 **a)** What is Raman effect? How is Raman effect explained on the basis of quantum theory? **(1+6)**

b) Give the experimental set up to study Raman effect with the help of net diagram. **(3)**