(b) Find most populated rotational level for the molecule HCl at temperature of 600 K. Moment of inertia of molecule is 2.71×10^{-47} kg-m^2, $h = 6.63 \times 10^{-34}$ Js and K = 1.38×10^{-23} Jk^{-1}. 5

8. Discuss the salient features of electronic vibrational transitions. At room temperature and moderate path length, the absorption spectrum of I_2 molecule shows progressions with $v'' = 0$, 1 and even higher; but under similar circumstances the absorption spectrum of CO generally shows only the $v'' = 0$ progression. Explain this. 15

9. (a) Explain the resolution of eigen function and total energy based on Born-Oppenheimer approximation. 8

(b) How isotopic effect influence the electronic spectra of diatomic molecules ? 7

Roll No. .....

(07/21-II)

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M.Sc. EXAMINATION

(For Batch 2017 & Onwards)

(Fourth Semester)

PHYSICS

Phy-402

Atomic and Molecular Physics

Time : Three Hours *Maximum Marks : 70*

Note : There are nine questions in all. Q. No. **1** is compulsory consisting of five short questions of 2 marks each. Attempt *Five* questions in all, selecting *one* question from each Unit.

1. (a) What is physical significance of Pauli's exclusion principle ?

(b) Find magnitude of spin magnetic dipole moment of an electron in terms of Bohr magneton.

(c) Calculate Zeeman pattern for $^2D_{3/2}$-$^2P_{3/2}$ transition in one-electron atom.

(d) The $J = 0 \rightarrow J = 1$ absorption line in CO occurs at a frequency of 1.153×10^{-11} c/s. Calculate the moment of inertia and the inter nuclear separation of CO molecule.

(e) Give the exact designation for $^3\Pi$ substate. Do such substates exist for $^3\Sigma$ states ? 2×5=10

2. What is quantum mechanical relativity correction ? Show that transition from state $n = 3$ to $n = 2$ in case of hydrogen following Bohr-Summerfield and Dirac theories for fine structure splitting. 15

3. (a) Describe Stem-Gerlach experiment. Discuss how it explains space quantization and electron spin. 10

(b) How vector atom model of atom has led to the assignment of quantum number 1/2 to the spin of electron. 5

4. Explain He atom spectrum quantum mechanically with all its important salient features. Why does the ground Heliun level lie much deeper than that of H ground level, but the excited He level agree closely with the corresponding H levels ? 15

5. What is Stark Effect ? Discuss the weak and strong field Stark Effect in hydrogen. 15

6. Discuss origin of fine structure of infrared bands of diatomic molecule. How are different branches formed in vibrational-rotational spectra ? Why are they all degraded towards red ? 15

7. (a) Write down the expression of energy for anharmonic oscillator model of a diatomic molecule. Show how from the infra-red absorption bands, the vibrational constants w_e and $w_e x_e$ of the molecule can be determined. 10