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PG CBCS
M.SC. Semester-III Examination, 2021
PHYSICS
 PAPER: PHS 302
(MOLECULAR SPECTROSCOPY AND LASER PHYSICS
& NUCLEAR PHYSICS)

Full Marks: 40**Time: 2 Hours****Write the answer for each unit in separate sheet**

The figures in the right-hand margin indicate full marks.
 Candidates are required to give their answers in their own words as far as practicable

PHS 302.1: MOLECULAR SPECTROSCOPY AND LASER PHYSICS**Marks: 20**

Data: ($h = 6.62 \times 10^{-27}$ erg sec, $C = 3.0 \times 10^8$ m/sec, $N_A = 6.023 \times 10^{23}$, Atomic no. of Cl =17, F=9)

Answer any TWO questions of the following:**2X10=20**

1. Explain why 2 level energy system is not sufficient for laser emission? Explain a 4 level laser with an example of construction of different parts. 2+2+6
2. Derive the relation of J (rotational quantum number) with intensity of pure rotational spectral lines of a diatomic molecule, draw the corresponding curve, and derive the condition for maximum intensity. 6+1+3
3. Why coherency is important for laser action, state at least two different phenomenons. Explain the procedures to create population inversion conditions. Which type of luminescent material is preferable for dye laser and why? Explain with examples active and passive laser resonator. 2+4+2+2
4. The transition $J = 3$ to $J = 4$ in HCL is associated with radiated spectra of 83.03 cm^{-1} . Use the rigid rotator approximation to calculate the moment of inertia and inter nuclear distance of HCl. What are the vibration modes of water and carbon-di-oxide molecules? What are hot bands explain with proper figures? When Born-Oppenheimer approximation will not hold well? 4+2+2+2
5. Explain Frank Condon principle and its outcome in details. Explain fine spectra of a non-linear molecule and derive the conditions for different band heads. 4+6

(P.T.O.)

(2)

PHS 302.2: NUCLEAR PHYSICS-I**Marks: 20****Answer any TWO questions of the following:****2X10=20**

1. a) Prove that the electric quadrupole moment of a nucleus of atomic number Z is given by $Q = e/2 (3Z^2 - r^2)$ where all symbols have their usual meaning. 5
- b) Binding energy $B(A, Z)$ of nucleus depends on which factors? Write Weizscker's semi-empirical mass formula. 2+2
- c) Nucleus X is three times larger than nucleus Y . What is the ratio of their atomic mass? 1
2. a) What do you mean by double focussing mass spectrometer?
- b) Give the theory and construction of double focussing mass spectrometer.
- c) What is the application of mass spectrometer in nuclear physics?
- d) Assuming that the protons and neutrons of equal mass, calculate how many times the nuclear matter is denser than water. 1+3+1+5
3. a) Explain the interaction of gamma radiation with matter and discuss the pair production. 5+3
- b) In the β -decay if a $3/2^+$ nuclear state decays by a first-forbidden transition. What will be the possible spin-parity state for the final nuclei? 2
4. a) Examine critically the different physical processes resulting from the interaction of Gamma-rays with matter and the relative importance of these processes at different energies of radiation. Discuss the Gamow's theory of alpha-decay in detail with diagram. 5+5
5. a) Which hypothesis was given to explain the continuous β -decay spectrum? Describe the Fermi theory of β -decay. 5
- b) Write a short note on Pauli's neutrino hypothesis and list the properties of the neutrino. 2+3
