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PG CBCS

M.Sc. Semester-III Examination, 2022

PHYSICS

PAPER: PHS 302

(MOLECULAR SPECTROSCOPY AND LASER PHYSICS & NUCLEAR PHYSICS – I)

Full Marks: 40 **Time: 2 Hours**

Write the answer for each unit in separate sheet

UNIT: PHS 302.1

MOLECULAR SPECTROSCOPY AND LASER PHYSICS

GROUP-A

1. Answer any TWO from the following questions: **2×2=4**

a) Why is a two-level laser not possible?

b) Which type of lasers out of dye, solid state and gas has a better line width?

c) A space probe was deigned to seek CO in the atmosphere of Saturn by looking for lines in its rotational spectrum, if the bond length of CO in 112.8 pm, at what wavenumbers do the first rotational transition lines appear?

d) Describe excimer laser with examples.

GROUP-B

2. Answer any TWO from the following questions: **2×4=8**

a) What do you mean by Q-switching? How it will help to produce high photon flux?

b) Describe different types of effects of nuclear spin on vibrational spectra.

c) The rotational spectrum of $^{79}Br^{19}F$ shows series of equidistance lines 0.71433 cm^{-1} apart. Calculate the rotational constant B, and hence the moment of inertia and bond length of the molecule.

d) Draw molecular orbitals of N_2 and O_2, hence tell which one will shows most unusual magnetic properties?

GROUP-C

3. Answer any ONE from the following questions: **1×8=8**

a) With detailed mathematical expression, explain the origin of unequal spacing in spectral lines of P and R branch of vibration spectra of CO molecules.

b) Which laser has better efficiency and why, a three level or four level? Explain with proper diagram a typical four level laser. (4+4)

P.T.O.

UNIT: PHS 302.2
NUCLEAR PHYSICS - I

GROUP-A

1. Answer any TWO of the following questions: **2×2=4**

a) Draw a block diagram presenting in each block of Rabi's method for determination of magnetic moments of nuclei.

b) In a mass spectrometer, a single positive charged ion is accelerated through a potential difference 1 kV. It then travels through a uniform magnetic field for which B =1 k Gauss and is detected into a circular path of radius 18.2 cm. Calculated the mass of then ion in unit of "u".

c) The quadrupole moment for $^{155}Gd_{64}$ is 130 fm^2. Show that the $^{155}Gd_{64}$ nucleus is almost spherical.

d) What is inverse beta decay?

GROUP-B

2. Answer any TWO of the following questions: **2×4=8**

a) Using semi-empirical binding energy formula, find the atomic number of the most stable nucleus for the given mass number A. Hence explain which is the most stable among $^6He_2$, $^6Be_4$ and $^6Li_3$ nuclides.

b) Show that the ratio of the average beta energy of a week β-emitter (K.E. $T_o << m_eC^2$) is 1/3, assuming that the fermi function is approximately constant over the energy interval in question. Calculate the average energy carried away by neutrons in the β-decay process which has an end-point energy of 18.1 keV.(3+1)

c) Which energy level diagram show the isobaric transition schemes of $^{80}Br_{35}$ for γ, β-particles and k-captures. What is recoil free γ-spectroscopy? (3+1)

d) What are the expected types of γ-ray transitions between the following states of odd A nuclei: $g_{9/2} \rightarrow p_{1/2}$, $f_{5/2} \rightarrow p_{3/2}$, $h_{11/2} \rightarrow d_{5/2}$ & $h_{11/2} \rightarrow d_{3/2}$.

GROUP-C

3. Answer any ONE of the following questions: **1×8=8**

a) Find the probability rate of electron capture (of k-capture) during β-decay.

b) Assuming the barrier transformation coefficient for a rectangular barrier, find and expression for the α-decay constant for the potential barrier faced by an α-particle while it is emitted from a nucleus. ^{237}Ba emits a γ-ray photon of 0.66 MeV during an isomeric transition. Calculate the recoil kinetic energy of the atom in eV.

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