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PKC/PG/IIIS/PHS-302/22

2022

M.Sc.

3rd Semester Examination

PHYSICS

PAPER – PHS-302

Full Marks: 50

Time: 2 Hours

(PHS 302.1-Molecular Spectroscopy and Laser Physics)

1. Answer any ***two*** bits: $2\times2 = 4$

(a) What is the change in the rotational constant B when hydrogen is replaced by deuterium in the hydrogen molecule?

(b) What is the Born-Oppenheimer approximation?

(c)Draw the *Morse curve* for a diatomic molecule undergoing an-harmonic oscillations

(d) Which among the following molecule will show vibrational spectra: CO, CO_2, NO, NH_3, H_2

2. Answer any ***two*** bits: $2\times4 = 8$

(a) What are hot bands? Why are they called so?

(b) The frequency of stretching vibration in CH_3OH is 3300 cm^{-1}. Estimate the frequency of OD stretching vibration in CH_3OD?

(c) Deduce the relation between Einstein's A, B coefficients.

(d) How many revolutions per second does a CO molecule make when in $J=3$ state?

3. Answer ***any one*** of the following: $1\times8 = 8$

(a) Deduce the expression for the rotational energy levels in a rigid diatomic molecule. Schematically show the energy levels. Explain the effect of isotopes in the absorption bands in such molecules.

(Turn over)

(b)Deduce the expression for the vibrational energy levels in a diatomic vibrating rotator and schematically show the energy levels showing the P and R branches. Find the state for which the molecular population will be maximum.

Internal Assessment-05

(PHS 302.2 - NUCLEAR PHYSICS - I)

1. Answer any ***two*** bits: $2\times2 = 4$

(a) Explain the pairing energy term in semi-empirical mass formula.

(b) What is α-particle range? Write down its expression.

(c) Calculate the kinetic energy of α-particle emitted in the following α-decay process: $^{238}U \rightarrow ^{234}Th + ^{4}He$. Given: Q-value = 4.28 MeV.

(d) Find the type (E/M) and multi-polarity of γ-ray emitted from $\left(\frac{1}{2}^{-}\right)$ state to $\left(\frac{9}{2}^{+}\right)$ state.

2. Answer any ***two*** bits: $2\times4 = 8$

(a) What is electric quadrupole moment? Explain the nuclear shape based on it. [2+2]

(b) What is mass parabola? Draw mass parabolas for odd-A and Even-A nuclei. [2+2]

(c) Find the expressions of Q-values for β-decays. Show that electron capture process is energetically more possible than β^{+}-decay process. [3+1]

(d) Explain the experimental set-up for measuring nuclear magnetic moment using Rabi's method. [4]

3. Answer ***any one*** of the following: $1\times8 = 8$

(a) (i) Discuss the correction factor in the Fermi's theory of β-decay.

(Continued)

(ii) What is Kurie Plot? Write down its significance.

(iii) ^{14}C decays by β^{-} emission. The end-point energy of β^{-} -particles is 0.156 MeV. The mass of ^{14}C is 14.007685 amu. Find the mass of the daughter nucleus. [3+(1+1)+3=8]

(b) (i) Discuss the Gamow's theory of α-decay.

(ii) Derive the emission probability of 5 MeV α-particle from a nucleus of diameter 2×10^{-14} m and height of the potential barrier of 15 MeV.

(iii) For isobaric family with A = 39, estimate the atomic number of the most stable nucleus

[4+2+2=8]

(All the symbols have their usual meanings)

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Internal Assessment-05