PHY-552

Electromagnetic Theory and Spectroscopy M. Sc. PHYSICS (MSCPHY–12/13/16/17) Second Year, Examination, 2018

Time : 3 Hours

Max. Marks : 80

Note: This paper is of eighty (80) marks containing three (03) Sections A, B and C. Learners are required to attempt the questions contained in these Sections according to the detailed instructions given therein.

Section-A

(Long Answer Type Questions)

- **Note :** Section 'A' contains four (04) long answer type questions of nineteen (19) marks each. Learners are required to answer *two* (02) questions only.
- 1. State and prove Maxwell's Ampere law and describe the physical significance of displacement current.
- Discuss the energy, vibrational terms and selection rules for transition in case of harmonic oscillator. Compare these values with a diatomic molecule which acts as anharmonic oscillator. Also discuss, how the spacing between rotational levels corresponding to different vibrational level changes.

- 3. Write all the possible multiplet terms for two equivalent *p*-electrons (p^2) . Arrange these terms in order of their increasing stability. Also discuss which configuration of *p*-electron $(p^1, p^3, p^4, p^5 \text{ and } p^6)$ has exactly same set of multiplet terms as p^2 .
- 4. What is the conservation of energy in electrodynamics ? State and prove related theorem.

Section-B

(Short Answer Type Questions)

- **Note :** Section 'B' contains eight (08) short answer type questions of eight (08) marks each. Learners are required to answer *four* (04) questions only.
- 1. State the Franck-Condon principle and briefly explain the *three* typical situations of intensity distribution in absorption band.
- 2. Can homonuclear molecules show Raman spectra. Briefly discuss your view.
- 3. Derive Electromagnetic equations for E and B.
- 4. What is gauge transformation ? Define the conditions for Colomb and Lorentz gauge .
- 5. Explain how atomic states are represented in L-S and J-J coupling scheme.
- 6. Distinguish between normal and anamolous Zeeman effect. Is the word 'normal' in normal Zeeman effect a misnormer. Discuss your views.
- 7. What are the possible values of *n*, *l* and m_s if a hydrogen atom has $m_l = -2$?
- 8. Illustrate, with a suitable energy diagram, the Paschen-Back effect for the D_2 lines of sodium.

Section-C

(Objective Type Questions)

Note : Section 'C' contains ten (10) objective type questions of one (01) mark each. All the questions of this Section are compulsory.

Choose the correct alternative :

- 1. The transition zone for Raman spectra is :
 - (a) between vibrational and rotational level
 - (b) between electronic level
 - (c) between magnetic levels of nuclei
 - (d) between magnetic levels of unpaired electron
- 2. Value of Larde's *g*-factor for ${}^{3}p_{1}$ is :
 - (a) 5/2
 - (b) 3/2
 - (c) 1/2
 - (d) 7/2
- 3. The correct sequence of energies is :
 - (a) $E_{el} >> E_{vib} >> E_{rot} >> E_{tr}$
 - (b) $E_{el} >> E_{rot} >> E_{vib} >> E_{tr}$
 - (c) $E_{el} >> E_{vib} >> E_{tr} >> E_{rot}$
 - (d) $E_{tr} >> E_{vib} >> E_{rot} >> E_{el}$
- 4. The correct term for a closed sub-shell (like s², p⁶, d¹⁰) in :
 (a) ³S.

- (b) ${}^{1}S_{0}$
- (c) ${}^{3}P_{0}$
- (d) Not defined
- 5. During the motion if the center of gravity of molecule changes, then which one of the following changes ?
 - (a) Electronic energy
 - (b) Potential energy
 - (c) Translational energy
 - (d) Vibrational energy
- 6. Electric field inside a spherical shell of uniform surface charge density :
 - (a) Directly proportional to distance from centre
 - (b) Inversely proportional to distance from centre
 - (c) Zero
 - (d) Non-zero constant
- 7. Rotational transition in which $\Delta J = -2$ is known as :
 - (a) Q-type
 - (b) O-type
 - (c) R-type
 - (d) S-type
- 8. Power radiated by electric dipole is proportional to the frequency as :
 - (a) ω
 - (b) ω^2
 - (c) ω^3
 - (d) ω^4

- 9. The process by which the photo excitation yields a molecular carbon is an excited vibrational state as directed by the Franck-Condon principle is known as :
 - (a) Adiabatic ionization
 - (b) Vertical ionization
 - (c) The Born-Oppenheim approximation
 - (d) Photodissociation
- 10. Flux density is related to the electric field :
 - (a) $D = \in + E$
 - (b) $D = \in -E$
 - (c) $D = \in /E$
 - (d) $D = \in E$