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PHY–552

Electromagnetic Theory and Spectroscopy

M. Sc. Physics (MSCPHY–12/13/16)

Second Year, Examination, 2017

Time : 3 Hours **Max. Marks : 60**

Note : This paper is of **sixty (60)** marks containing **three (03)** sections A, B and C. 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 fifteen (15) marks each. Learners are required to answer *two* (02) questions only.

1. What is Raman effect ? Discuss how the change in polarizability leads to appearance of Stokes' and anti-Stokes' line. In what way does it differ from the infrared spectra ?
2. Determine the boundary conditions satisfied by B, H and E, D at the interface between two media of different permeabilities and dielectric constant.
3. What is Stark effect ? Discuss the weak-field Stark effect and the strong-field Stark effect in Hydrogen ?

4. Give the main features of pure rotational band spectrum of a heteronuclear diatomic molecule. Discuss rotational spectrum of a diatomic molecule, treated it as rigid and non-rigid rotator.

Section–B

(Short Answer Type Questions)

Note : Section 'B' contains eight (08) short answer type questions of five (05) marks each. Learners are required to answer *four* (04) questions only.

1. Explain L-S and J-J coupling with suitable example.
2. Write a note on Franck-Condon principle.
3. A plane electromagnetic wave is incident on a dielectric surface. Find the amplitudes of the reflected and refracted wave.
4. The force constant of the bond in CO molecule is 1870 Nm^{-1}. Find the energy of the lowest vibrational level. The reduced mass of CO is 1.14×10^{-26} kg.

   Given : $h = 6.63 \times 10^{-34}$ J-s, $eV = 1.60 \times 10^{-19}$ J.

5. State and prove Poynting theorem.
6. Briefly discuss the energy-level diagram of helium atom.
7. The ground state of chlorine atom is $^3P_{3/2}$. Find its magnetic moment. Into how many substates will the ground state split in a weak magnetic field ?
8. (a) Show that the magnetic field is given by curl of a vector potential.

   (b) Deduce Ampere circuital law from Biot-Savart law.

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.

1. In an electromagnetic wave, the direction of magnetic induction $\vec{B}$ is :

   (a) parallel to the electric field $\vec{E}$

   (b) perpendicular to the electric field $\vec{E}$

   (c) antiparallel to the Poynting's vectors $\vec{S}$

   (d) random

2. The normal Zeeman effect, viewed perpendicular to the magnetic field, shows a single line split into :

   (a) 4

   (b) 2

   (c) 3

   (d) 1

3. The Laplace equation in CGS Gaussian system is :

   (a) $\nabla^2 V = \frac{\rho}{\varepsilon_0}$

   (b) $\nabla^2 V = -4\pi\rho$

   (c) $\nabla^2 V = -4\pi r$

   (d) $\nabla^2 V = 0$

4. Zero point energy is associated with :

   (a) Rotational spectra

   (b) Vibrational spectra

   (c) Electronic spectra

   (d) All of the above

5. The electromagnetic field equation in terms of electromagnetic potential is represented by an equation :

   (a) $\nabla^2\phi + \frac{\partial}{\partial t}(\text{div}\,\vec{A}) = -\frac{\rho}{\varepsilon}$

   (b) $\nabla^2\vec{A} + \frac{\partial}{\partial t}(\text{div}\,\phi) = -\frac{\rho}{\varepsilon}$

   (c) $\nabla^2\phi + \frac{\partial}{\partial t}(\text{div}\,\vec{A}) = \frac{\rho}{\varepsilon}$

   (d) $\nabla^2\vec{A} + \frac{\partial}{\partial t}(\text{div}\,\vec{A}) = \frac{\rho}{\varepsilon}$

6. For total internal reflection, the coefficient of reflection R is given by :

   (a) $|R| = 0$

   (b) $|R| = 1$

   (c) $|R| = \infty$

   (d) None of these

7. At the interface of two non-conducing medium, the formula of reflection coefficent for normal incidence is given by :

(a) $\left(\frac{n_1 - n_2}{n_2 + n_1}\right)^2$

(b) $\frac{4 n_1 n_2}{(n_2 + n_1)^2}$

(c) $\frac{E_2 H_2}{EH}$

(d) None of these

8. Which of the following molecule will show microwave specta ?

(a) H_2

(b) O_2

(c) CO

(d) None of these

9. The effect used to study of the energy levels of homonuclear molecule is :

(a) Stark effect

(b) Raman effect

(c) Zeeman effect

(d) Paschen-back effect

10. The rotational energies of a diatomic molecules of rotational constant B joule are :

(a) B, 2B, 3B, ...

(b) 0, 2B, 6B, 12B, ...

(c) B, 4B, 9B, ...

(d) 0, 2B, 4B, 6B, ...