Roll No

PHY-552

Electromagnetic Theory and Spectroscopy

M. Sc. PHYSICS (MSCPHY-12/13/16)

Second Year, Examination, 2017

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. Give that :

$$P = P_0 \left(1 - \frac{r^2}{R^2} \right) \quad r \le R$$
$$= 0 \qquad r > R$$

Find E_{in} , E_{out} and show that electric field is max at r = 0.745 R, where R is radius of the sphere.

2. State Gauss's theorem in electrostatics. Apply it to find the electric field strength at a point near an infinite uniform flat sheet of charge.

- 3. Explain Zeeman splitting for ${}^{2}P_{3/2} \rightarrow {}^{2}S_{1/2}$ and ${}^{2}P_{1/2} \rightarrow {}^{2}S_{1/2}$ and explain what happen to these lines when placed in strong magnetic field.
- 4. Give a brief description of different molecular spectra. Explain the potential energy behaviour of diatomic molecule.

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. Explain the Larmor Precession.
- 2. Comment is Lande g factor same as gyromagnetic ratio.
- 3. Draw the energy levels of hydrogen atom, including spin-orbit interactions for n = 3 and n = 2 states. Also indicate the possible transitions.
- 4. The wavelength of the H_{α} lines for hydrogen is 656.28 nm. What is the wavelength of H_{α} lines for deuterium ?
- 5. Show that the observation spectrum of rigid rotator consists of equidistant lines with constant separation.
- 6. Write an expression for energy of an harmonic oscillator and explain zero point energy.
- 7. Derive continuity equation, starting from Maxwell's equation.
- 8. The electric field of an EM wave is given by :

$$E = E_0 \cos(0.3x + 0.4y - 1000t) \hat{k}$$

Find the associated magnetic field.

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. For which of the following molecules a pure rotational spectrum cannot be observed in gas phase :
 - (a) N₂
 - (b) NO
 - (c) HCl
 - (d) CO
- 2. Which of the following transitions is not allowed between rotational energy level ?
 - (a) $J=1 \leftarrow J=2$
 - (b) $J=0 \leftarrow J=1$
 - (c) $J=1 \leftarrow J=3$
 - $(d) \quad J = 1 \longrightarrow J = 0$
- 3. Raman spectra is observed in :
 - (a) Polar molecules
 - (b) Non-polar molecules
 - (c) Both of the above
 - (d) None of the above
- 4. The vibrational frequency of a diatomic molecule is given by :

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(a)
$$\frac{1}{\sqrt{2\pi}} \frac{K}{\mu}$$

(b)
$$\frac{1}{2\pi} \sqrt{\frac{K}{\mu}}$$

(c)
$$\frac{1}{2\pi} \frac{K}{\sqrt{\mu}}$$

(d)
$$\frac{1}{2\pi} \frac{\sqrt{K}}{\mu}$$

- 5. The electric dipole selection rule is :
 - (a) $\Delta l = 0$
 - (b) $\Delta l = +1$
 - (c) $\Delta l = \pm 1$
 - (d) $\Delta l = \pm 2$
- 6. Lamb shift arises for H-like atom having :
 - (a) Same n, l and different j
 - (b) Same n, j and different l
 - (c) Same l,j and different n
 - (d) Same n, but different l and j
- 7. Poynting theorem is a mathematical statement for the conservation of :
 - (a) Momentum
 - (b) Electromagnetic energy
 - (c) Charge
 - (d) States

- 8. The electric and magnetic fields share the energy of EM wave in the ratio :
 - (a) 1:2
 - (b) 2:1
 - (c) 1:1
 - (d) 1:4
- 9. The terms for configuration p^2 will be same as for :
 - (a) *p*¹
 - (b) *p*³
 - (c) *p*⁴
 - (d) *p*⁶
- 10. The selection rule for pure rotational fine structure of electronic-vibration spectra for P and R branch is :
 - (a) $\Delta J = \pm 1$
 - (b) $\Delta J = 0$
 - (c) $\Delta J = \pm 2$
 - (d) $J = 0 \iff J = 0$

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