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MSCPHY-12 (M.Sc. PHYSICS)

Second Year Examination-2014

PHY 552

Electromagnetic Theory and Spectroscopy

Time Allowed : Three Hours

Maximum Marks : 60

Note : This paper is of sixty (60) marks divided into three (03) sections. 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 fifteen (15) marks each. Learners are required to answer any two (02) questions only. (2×15=30)

1. Write down Maxwell's field equation and prove Poynting's Theorem relating to flow of energy at a point in space in an electromagnetic field. Explain the various terms involved in it.

2. What are retarded potentials ? Explain physically the concept of retardation and the origin of potential functions ϕ and A. Justify the name electrodynamic or electromagnetic potential given to them. How do you get Lienard-Wiechert potential from retarded potential ?

3. What are normal and anomalous Zeeman effects ? Discuss the Zeeman pattern of the resonance (D_1, D_2) lines of sodium.

4. Discuss the principle feature of the electronic specturm of a diaatomic moleucle. State Frank-Condon principle and give its wave-mechanical interpretation.

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 any four (04) questions only. (4×5=20)

1. Show that the potential at a point distant r_2 and r_2 respectively from centre of a long parallel pair of wires of negligible cross-section and having equal and opposite linear charge density & coulomb per meter is given by

$$\phi = \frac{\alpha}{2\pi \in_0} \log \frac{r_2}{r_1}$$

2. Calculate the magritic induction at a distance d from an infinitely long straight wire in which flows a current 1 using biot - Savart law.

3. Calculate the value of Poynting's vector at the surface of sun if the power radiated by sun is 3.8×10^{26} watts while its radius is 7×10^8 m.

4. In an atom, obeying L-S coupling, the components of a normal triplet state have separations 20 and 40 cm^{-1} between adjacent components. There is a higher state for which the separation are 22 and 33 cm^{-1} respectively. Determine the terms for the two states and show with the help of an energy level diagram the allowed transitions and the pattern of spectrum.

5. Obtain expression for Lande's 'g' factor in L-S and J-J coupling scheme.

6. Discuss the principal features of the rotational band spectrum of a diatomic molecule.

7. Give the theory of a vibrational rotational spectrum of diatomic molecule.

8. What is the principle of IR spectroscopy. Explain the working of double beam IR spectro-photometer.

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. (10×1=10)

1. The radius of hydrogen atom in its ground state is :

   (a) 10^{-4} cm (b) 10^{-6} cm

   (c) 10^{-8} cm (d) 10^{-10} cm

2. When an electron jumps from fourth orbit to second orbit of hydrogen atom, one gets :

   (a) The first line of Pfund series

   (b) Second line of Lyman series

   (c) Second line of Paschen series

   (d) Second line of Balmer series

3. Which of the interactions cause the non conservation of orbital angular momentum of the electrons in an atom.

   (a) Spin of orbital interaction

   (b) Spin-spin interaction

   (c) Electrostatic interaction between electrons

   (d) Electrostatic interaction between electrons and nucleus.

4. L value of state $^2D_{3/2}$ is given by :

   (a) 0 (b) 1

   (c) 12 (d) 3

5. The L, S and J quatum numbers corresponding to the ground state electronic configuration of Boron (Z = 5) are :

(a) $L = 1, S = \frac{1}{2}, J = \frac{3}{2}$ (b) $L = 1, S = \frac{1}{2}, J = \frac{1}{2}$

(c) $L = 1, S = \frac{3}{2}, J = \frac{1}{2}$ (d) $L = 1, S = \frac{3}{2}, J = \frac{3}{2}$

6. Pure rotational spectrum of a diatomic molecule consists of :

(a) Two equally spaced lines (b) Three equally spaced lines

(c) Many equally spaced lines (d) No regular pattern

7. The Larmar formula for the power radiated by a non relativistically accelarated charged particle is given by :

(a) $\frac{1}{4\pi \in_0} \frac{2}{3} \frac{e^2 a^2}{c^3}$ (b) $\frac{1}{3} \frac{e^2 a^2}{c^3}$

(c) $\frac{1}{4\pi \in_0} \frac{2}{3} \frac{e^2 a}{c^2}$ (d) $\frac{1}{4\pi \in_0} \frac{2}{3} \frac{e^2 a^2}{c^2}$

8. A change q is located at the centre of a hypothetical cube. The electric flux through any face of the cube :

(a) $\frac{q}{2 \in_0}$ (b) $\frac{q}{4 \in_0}$ (c) $\frac{q}{\in_0}$ (d) $\frac{q}{6 \in_0}$

9. The potential which exhibit the dependence of the potential on the velocity of particle is known as :

(a) Scalar protential (b) Vector potential

(c) Lienard-Wiechert Potential (d) Retarded potential

10. The ratio of the intensity of magnetic field at the centre of a very long volenoid to that at the extreme ends is :

(a) 2 (b) $\frac{1}{2}$ (c) 4 (d) $\frac{1}{4}$