5 SEM TDC PHY M 3

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(November)

PHYSICS

(Major)

Course : 503

(Atomic and Molecular Physics)

Full Marks : 60
Pass Marks : 24/18

Time : 3 hours

The figures in the margin indicate full marks for the questions .

1. Choose the correct option from the following :

   $1 \times 6 = 6$

   (a) The potential energy of the electron in the hydrogen atom is $-ke^2/r$. Its kinetic energy will be

   (i) $-ke^2/r$

   (ii) $-ke^2/2r$

   (iii) ke^2/r

   (iv) $ke^2/2r$

(b) The series limit of Balmer series for hydrogen atom is given by

(i) $1/R$

(ii) $4/R$

(iii) $9/R$

(iv) $16/R$

(c) A magneto-optical phenomenon in which spectral lines are affected by an applied magnetic field and split into several components is

(i) Stark effect

(ii) Zeeman effect

(iii) Compton effect

(iv) Raman effect

(d) A hydrogen atom is in P-state, for the values of j are

(i) 5/2, 3/2, 1/2

(ii) 3/2, 1/2

(iii) −1/2, +1/2, +3/2

(iv) −1/2, −3/2

(e) Every levels A, B, C of a certain atom correspond to increasing values of energy, i.e., $E_A < E_B < E_C$. If $\lambda_1, \lambda_2, \lambda_3$ are the wavelengths of radiations corresponding to the transitions C to B, B to A and C to A respectively, which of the following statements is obeyed?

(i) $\lambda_3 = \lambda_1 + \lambda_2$

(ii) $\lambda_3^2 = \lambda_1^2 + \lambda_2^2$

(iii) $\lambda_3 = \lambda_2 - \lambda_1$

(iv) $\lambda_3 = \dfrac{\lambda_1 \lambda_2}{\lambda_1 + \lambda_2}$

(f) Rydberg constant is

(i) same for all elements

(ii) a universal constant

(iii) different for different elements

(iv) different for lighter element but same for heavier element

2. Answer any *five* of the following : 2×5=10

(a) Discuss the origin of fine structure of H_α line of hydrogen atom from relativistic correction of Sommerfeld model.

(b) Evaluate Lande's g-factor for the state $^3P_1$.

(c) What are Larmor precession and Larmor frequency?

(d) Mention the essential elements that characterize the vector atom model.

(e) How is He-Ne laser superior to ruby laser?

(f) Explain the doublet structure of sodium lines.

3. (a) Discuss the limitations of Bohr's theory. 2

(b) Discuss Sommerfeld's modification of Bohr's theory. How far was the modification successful? 6

4. Describe the different types of coupling in atom. 6

5. (a) What is gyromagnetic ratio? Calculate its orbital and spin value. 6

   (b) Distinguish between normal and anomalous Zeeman effect. 4

6. What is Raman effect? Discuss the characteristics of Raman lines. Indicate the importance of Raman effect. 2+2+2=6

   Or

   Describe the theory and construction of ruby laser. Write down two main features of ruby laser. 4+2=6

7. Obtain an expression for energies of various vibrational levels. Why H_2 and N_2 do not show vibrational spectra? 3+2=5

   Or

   What are the characteristic properties of a laser beam? Describe some of the important applications. 3+2=5

8. Write short notes on (any *three*) : 3×3=9

   (a) The postulates of Bohr's atom model for H-atom

   (b) Fine structure of spectral lines

   (c) Stark effect

   (d) Selection rules

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