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5 SEM TDC PHY M 3

2016

(November)

PHYSICS

(Major)

Course : 503

(Atomic and Molecular Physics)

Full Marks : 60

Pass Marks : 24 (Backlog) / 18 (2014 onwards)

Time : 3 hours

The figures in the margin indicate full marks for the questions

1. Fill in the blanks (any *five*) : 1×5=5

(a) The value of spin quantum number of an electron in hydrogen atom is _____.

(b) The *D*-lines of sodium originate from _____ transition.

(c) Normal Zeeman effect occurs only in atoms which have a total spin *S* equal to _____.

(d) For heavier atoms _____ coupling holds.

(e) The procedure to achieve population inversion is called _____.

(f) If $\Delta\nu = \frac{eB}{4\pi m}$ is the frequency shift in the Zeeman splitting of a spectrum, then the corresponding wavelength shift $\Delta\lambda =$ _____.

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

(a) Find the possible values of j and m_j for states $l = 3$ and $s = \frac{1}{2}$.

(b) State Bohr's postulates regarding the atomic model.

(c) Calculate the radius of the first Bohr orbit of hydrogen atom. Given $e = 1{\cdot}6 \times 10^{-19}$ C, $h = 6{\cdot}63 \times 10^{-34}$ joule-sec, $k = 9 \times 10^{9}$ N m^2/c^2 and $m = 9{\cdot}1 \times 10^{-31}$ kg.

(d) Discuss the essential requirements for producing laser action.

(e) Distinguish between Raman scattering and Rayleigh scattering.

(f) Calculate Lande's g-factor for s-electron.

3. (a) Describe the different types of coupling in atom. 5

Or

The first member of Balmer series of hydrogen has a wavelength of 6563 Å. Calculate the wavelength of its *(i)* second order and *(ii)* third order. In which region of the e.m. spectrum does this series lie? 2+2+1=5

(b) Describe the principle, construction and working of Ruby laser with necessary diagram. 5

4. Discuss the Sommerfeld theory of elliptical orbit of hydrogen atom and compare its results with those of Bohr's theory of circular orbits. 7

Or

What is Raman effect? Prove that to be Raman active, a molecular vibration or rotation must cause some change in molecular polarizability. Explain Raman lines intensity or polarization states from classical theory. 1+5+1=7

5. What are Stokes and anti-Stokes lines? In an experiment, the exciting line is at $\lambda = 5460$ Å and the Stokes line is at $\lambda = 5520$ Å. Find Raman shift and wavelength corresponding to anti-Stokes line. 2+5=7

Or

Discuss vibrational-rotational spectra of diatomic molecules with energy-level diagram. What are P and R branches in vibrational-rotational spectra? 5+2=7

6. What is anomalous Zeeman effect? In a normal Zeeman experiment, the Ca 4226 Å line splits into three lines separated by 0·25 Å in a magnetic field of 3 T. Determine e/m for the electron from these data. 2+4=6

Or

What are the drawbacks of Rutherford's atomic model? Discuss briefly the success and failure of Bohr's atomic model. 2+2+2=6

7. Derive an expression for magnetic moment of orbiting electron. Why is orbital magnetic momentum (μ_l) oppositely directed to orbital angular momentum (P_l)? 5+1=6

Or

What is Larmor precession? An atomic dipole is subjected to very strong magnetic field B so that it begins to precess about the field. Calculate the frequency of Larmor precession. 1+5=6

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

(a) Stark effect

(b) Population inversion

(c) Space quantization

(d) Bohr's correspondence principle

(e) Einstein's coefficients

(f) Vector atom model

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