

**5 SEM TDC PHY M 3**

**2015**

( November )

PHYSICS

( Major )

Course : 503

( Atomic and Molecular Physics )

Full Marks : 60

Pass Marks : 24

Time : 3 hours

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

1. Choose the correct option (any five) :  $1 \times 5 = 5$

(a) According to Bohr's theory of hydrogen atom, the radii  $r_n$  of stationary electron orbits are related to principal quantum number  $n$  as

(i)  $r_n \propto n^2$

(ii)  $r_n \propto \frac{1}{n^2}$

(iii)  $r_n \propto \frac{1}{n^3}$

(iv)  $r_n \propto \frac{1}{n}$

(h) Stokes and antiStokes lines in Raman spectra are

- (i) equally spaced
- (ii) unequally spaced
- (iii) mixture of both
- (iv) None of the above

2. Answer any five of the following :  $2 \times 5 = 10$

- (a) "Change in molecular polarizability is essential for Raman effect." Explain.
- (b) Calculate the energy of an electron in the 3rd Bohr orbit.
- (c) If the wavelength of the first line of hydrogen spectrum in Lyman series is  $1215 \text{ \AA}$ , then calculate the wavelength of the first line in Paschen series.
- (d) "Homonuclear molecule does not exhibit rotational spectra." Explain.
- (e) Write down the spectral notation for the ground state of H-atom.
- (f) Explain, what is meant by stimulated emission of radiation.
- (g) Mention shortcomings of Bohr's theory.

3. (a) State and prove Bohr's correspondence principle. Establish the truthfulness of the statement, "the greater the quantum number closer the quantum physics approaches classical physics".  $1+3+1=5$

Or

The experimental value of Bohr magneton is  $9.21 \times 10^{-24}$  SI units and Planck's constant  $h = 6.6 \times 10^{-34}$  joule-second. Calculate the value of  $e/m$  of an electron. 5

- (b) Calculate Landé  $g$ -factor for (i)  ${}^2D_{3/2}$  states and (ii)  ${}^2P_{3/2}$  states.  $2\frac{1}{2}+2\frac{1}{2}=5$

- 4 What is meant by fine structure of hydrogen spectra? How is it explained on the basis of vector atom model?

$2+4=6$

Or

What is gyromagnetic ratio? Calculate its orbital and spin value.  $2+2=2=6$

$2+2=2=6$

5. Describe the main features of the vector atom model. Explain various quantum numbers associated with it.  $2+5=7$

$2+5=7$

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. Calculate the rate of precession when an atom is placed in a magnetic field of strength  $0.1 \text{ T}$ . 1+5+1=7

6. Obtain an expression for the rotational energy levels of a diatomic molecule taking it as a rigid rotator. Discuss its spectrum and the relevant selection rules. 6

Or

Explain the origin of Stokes and antiStokes lines in Raman spectrum. Discuss the classical theory of Raman effect. 2+4=6

7. Explain the action of He-Ne laser. What are the characteristics that make a laser light different from ordinary light? 5+2=7

Or

What are Einstein  $A$  and  $B$  coefficients? Obtain a relation between them. 2+5=7

8. Write short notes on (any three) :

3×3=9

- (a) Coupling scheme
- (b) Spatial and temporal coherence
- (c) Application of Raman effect
- (d) Origin of fine structure of spectral lines
- (e) Stark effect
- (f) Properties of laser

\*\*\*