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( Pre-CBCS )

( 5th Semester )

**PHYSICS**

EIGHTH (A) PAPER

**( Spectroscopy )**

( Revised )

*Full Marks : 55**Time : 2½ hours***( PART : A—OBJECTIVE )**

( Marks : 20 )

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

SECTION—A

( Marks : 5 )

Tick (✓) the correct answer in the brackets provided :

1×5=5

1. The possible quantum numbers  $n$ ,  $l$ ,  $j$  and  $m_j$  of the spectral notation  $2^2 p_{3/2}$  are

(a)  $n = 2, l = 0, j = 3/2, m_j = 3/2$  ( )

(b)  $n = 1, l = 1, j = 3/2, m_j = 1/2$  ( )

(c)  $n = 2, l = 1, j = 3/2, m_j = 1/2$  ( )

(d)  $n = 1, l = 0, j = 3/2, m_j = 3/2$  ( )

( $p$  in  $2^2 p_{3/2}$  should not be capitalized)

**2.** Sodium *D*-line arises due to transition

(a)  $3^2P_{3/2} \rightarrow 3^2S_{1/2}$  and  $3^2P_{1/2} \rightarrow 3^2S_{1/2}$  ( )

(b)  $3^2P_{3/2} \rightarrow 2^2S_{1/2}$  and  $3^2P_{1/2} \rightarrow 3^2S_{1/2}$  ( )

(c)  $3^2P_{3/2} \rightarrow 3^2S_{1/2}$  and  $3^2P_{1/2} \rightarrow 2^2S_{1/2}$  ( )

(d)  $2^2P_{3/2} \rightarrow 2^2S_{1/2}$  and  $2^2P_{1/2} \rightarrow 2^2S_{1/2}$  ( )

**3.** In normal Zeeman effect, a level of given  $l$  splits into

(a)  $l$  levels ( )

(b)  $2l$  levels ( )

(c)  $(2l + 1)$  levels ( )

(d)  $(2l - 1)$  levels ( )

**4.** The selection rule for transitions in rotational spectra is

(a)  $\Delta J = 0$  ( )

(b)  $\Delta J = 1$  ( )

(c)  $\Delta J = 2$  ( )

(d)  $\Delta J = 3$  ( )

**5.** Stokes' or anti-Stokes' lines in Raman spectra are

(a) equally spaced ( )

(b) unequally spaced ( )

(c) mixture of both ( )

(d) None of the above ( )

SECTION—B

( Marks : 15 )

Answer the following questions :

3×5=15

1. Show that the speed of orbiting electron is inversely proportional to the principal quantum number  $n$ .
2. Find the maximum number of electron with all the shells fill up to principal quantum number  $n = 4$ .
3. Explain the population inversion in LASER action.
4. Give the general idea of Born-Oppenheimer approximation.
5. The exciting line in an experiment is  $5460 \text{ \AA}$  and the Stokes' line is  $5520 \text{ \AA}$ . Find the wavelength of anti-Stokes line.

( PART : B—DESCRIPTIVE )

( Marks : 35 )

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

1. What are the assumptions made by Rutherford as to the atomic structure from his experimental observations? Show that an alpha particle moving in the field of nucleus according to Rutherford follows a hyperbolic path. 2+5=7

**OR**

2. State the postulates of Bohr regarding his atom model. Obtain the expression for the radius and electron energy of the  $n$ th orbit. 1+3+3=7
3. (a) State and prove Larmor's theorem. 1+3=4
- (b) What is the effect of space quantization introduced by vector atom model? Does it result in formation of new energy level? 2+1=3

**OR**

4. Discuss Stern-Gerlach experiment. How does it explain the vector atom model? 7
5. What are the normal and anomalous Zeeman effects? Explain anomalous Zeeman effect with vector atom model. 2+5=7

**OR**

6. (a) Explain X-ray fluorescent and an Auger effect. 4
- (b) What are Einstein's  $A$  and  $B$  coefficients? 3
7. Considering vibrating diatomic molecule as a harmonic oscillator, obtain the expression for frequency, energy levels and selection rules. 7

**OR**

8. Discuss the rotational spectra of polyatomic molecules. 7
9. What is a Fortrat diagram? Discuss how the band head is formed either in the  $P$ -branch or in the  $R$ -branch. 2+5=7

**OR**

10. What is Raman effect? Compare it with infrared transition. 1+6=7