

M.Sc. PHYSICS  
FIRST SEMESTER  
ATOMIC & MOLECULAR PHYSICS  
MSP – 105  
(USE OMR SHEET FOR OBJECTIVE PART)

**SET  
A**

Duration : 1.30 hrs.

Full Marks : 35

( Objective )

Time: 15 min.

Marks: 10

Choose the correct answer from the following:

1X10=10

1. The eccentricity of Sommerfeld elliptical orbit is given by

a.  $\sqrt{1 - \frac{K^2}{n^2}}$

b.  $\frac{K}{n}$

c.  $\frac{K^2}{n^2}$

d.  $1 - \frac{K}{n}$

2. The Ground state of Helium atom is

a.  $^2S_{1/2}$

b.  $^1S_0$

c.  $^3S_0$

d.  $^3S_1$

3. The ratio of the frequencies of the first spectral line of Lyman series of hydrogen atom and that of Balmer series is

a. 5/27

b. 8/27

c. 27/5

d. 4/27

4. According to Bohr's model, the ionization energy of  $\text{Li}^{2+}$  ion in electron volt is

a. 13.6

b. 27.2

c. 40.8

d. 122.4

5. For a definite frequency, Doppler broadening is proportional to

a.  $\sqrt{\frac{T}{M}}$

b.  $\sqrt{\frac{M}{T}}$

c.  $\frac{\sqrt{T}}{M}$

d.  $\frac{T}{\sqrt{M}}$

6. For allowed rotational transitions, the change of rotational quantum number in microwave region is

a. +1 only

b.  $\pm 1$

c.  $\pm 2$

d. +2 only

7. The microwave active molecule is

a.  $\text{N}_2$

b.  $\text{O}_2$

c. CO

d.  $\text{Cl}_2$

8. The natural broadening  $\Delta\nu$  for the transition from the ground state to a state of life time  $\tau$ , is
- |    |                     |    |                      |
|----|---------------------|----|----------------------|
| a. | $\frac{\tau}{2\pi}$ | b. | $\frac{2\pi}{\tau}$  |
| c. | $2\pi\tau$          | d. | $\frac{1}{2\pi\tau}$ |
9. In a weak magnetic field, the number of permitted transition from  $2P_{1/2}$  to  $2S_{1/2}$  state (assuming the validity of L-S coupling is)
- |      |      |
|------|------|
| a. 4 | b. 6 |
| c. 2 | d. 3 |
10. The selection rule for P and R branches of the rotational spectral lines is respectively
- |                             |                             |
|-----------------------------|-----------------------------|
| a. $\Delta J = 0$ and $+1$  | b. $\Delta J = -1$ and $+1$ |
| c. $\Delta J = +1$ and $-1$ | d. $\Delta J = -1$ and $0$  |



( Descriptive )

Time : 1 hr. 15mins.

Marks : 25

[ Answer question no.1 & any two (2) from the rest ]

1. Write the relativity of correct term value due to Sommerfeld and explain the fine structure of  $H_{\alpha}$  line of hydrogen atom stating the selection rule. 5
  
2. a. What do you mean by orthohelium and parahelium? State the multiplicity of the states of these two types of helium. What are different series lines of helium atom? Give the transition rule of series lines of helium atom. 7+3=10  
b. State and explain Lande interval rule.
  
3. a. What is normal and anomalous Zeeman effect? Mention the spectral difference between these two. Write the expression of Lande's g factor. Show the anomalous Zeeman splitting of  $D_1$  line of Sodium (Na) atom. 7+3=10  
b. Draw the vector diagram of L-S coupling.
  
4. a. Write the expression of term values of a vibrating rotating molecule. Calculate the frequencies of fundamental, first overtone, second overtone and first hot band transitions. 5+5=10  
b. Define the breadth of the spectral line. What are the factors on which intensity of rotational spectral line depend? Show the variation of intensity of rotational spectral line with rotational quantum number.
  
5. a. Write the expression of rotational energy of a non-rigid rotator. Calculate the value of rotational quantum number at which intensity of rotational spectral line is maximum. 5+5=10  
b. Write down the potential used in anharmonic oscillator. Why harmonic oscillator model is not suitable to explain the vibration of a diatomic molecule. State and explain Born-Oppenheimer approximation.

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