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(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) Rotational spectra lie on the

(i) microwave region

(ii) infrared region

(iii) ultraviolet region

(b) In the He-Ne LASER, action occurs between two excited states of

(i) the He atom

(ii) the Ne atom

(iii) both the He and Ne atoms

- (c) ${}^2D_{5/2}$ term will split into which of the following components in magnetic field?
- (i) 3
 - (ii) 6
 - (iii) 5
- (d) For a given set of values of n and l , the possible number of electrons in a closed shell is
- (i) $2(2l+1)$
 - (ii) $2(2l+2)$
 - (iii) $2(2l-1)$
- (e) The selection rule for L is $\Delta L =$
- (i) ± 1
 - (ii) $+1$
 - (iii) -1
- (f) The energy of a hydrogen atom in the first excited state is
- (i) 13.6 eV
 - (ii) -13.6 eV
 - (iii) -1.36 eV

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

- (a) In what respect did classical physics fail to account for the structure of the atom?
- (b) Discuss Bohr's correspondence principle.
- (c) Write the importance of Raman effect.
- (d) Mention the methods of pumping for creating population inversion. What is population inversion?
- (e) On the basis of vector atom model, find the possible values of the total angular momentum of an f electron.
- (f) Describe two essential features that characterise the vector atom model.
- (g) Calculate the short and long wavelength limits of Lyman series.
[Rydberg constant = 10967700 m^{-1}]

3. (a) Derive an expression for the gyromagnetic ratio of an electron revolving in a circular orbit.

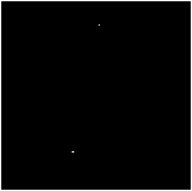
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Or

Give a brief account of Bohr-Sommerfeld model of elliptical orbit for hydrogenation.

- (b) What is Raman effect? Describe the quantum explanation of Raman effect.

1+4=5



4. (a) Explain the action of He-Ne LASER. Distinguish between spontaneous and stimulated emission processes. 4+2=6

Or

What are Einstein A and B coefficients? Obtain a relation between them. 1+5=6

- (b) Obtain an expression for the vibrational energy of a diatomic molecule and hence prove that vibrational energy levels are equally spaced under harmonic oscillator approach. 5+1=6
5. (a) What is Zeeman effect? Use classical ideas to explain Zeeman effect. Show that Zeeman shift is

$$\Delta\lambda = \pm Be\lambda^2 / 4\pi mc \quad 1+4+2=7$$

Or

State two basic difference between Zeeman and Stark effects. The Zeeman components of a 500 nm spectral line are 0.0116 nm apart when the magnetic field is 1 T. Find e/m for the electron from these data. 4+3=7

- (b) Discuss the pure rotation spectra of a heteronuclear diatomic molecule and show that the pure rotation spectrum of such a molecule consists of a series of equally spaced lines separated by a constant wave number difference $2B$. 2+5=7

Or

Explain Russell-Saunders ($L-S$) and ($J-J$) couplings of orbital and spin angular momenta. Explain D_1 and D_2 doublet of Na-spectra on the basis of electron spin.

4+3=7

6. Write short notes on any three of the following :

3×3=9

- (a) Space quantization
- (b) Larmor precession
- (c) Lande g-factor
- (d) Spatial and temporal coherence
- (e) Population inversion
- (f) Raman scattering vs. Rayleigh scattering
