

PHYS6014

**3 Yr. Degree/4 Yr. Honours 6th Semester Examination, 2026 (CCFUP)**

**Subject : Physics**

**Course : PHYS 6014 (MAJOR)**

**Time: 2 Hours**

**Full Marks: 40**

*The figures in the margin indicate full marks.*

*Candidates are required to give their answers in their own words  
as far as practicable.*

*Symbols have their usual meaning:*

2×5=10

**1. Answer any five questions:**

- (a) What are the possible quantum numbers for the state  $n = 4$  in atomic hydrogen?
- (b) What is Bohr magneton ( $\mu_B$ )? Write its value with unit.
- (c) Calculate the Lande g-factor for the state  $2P_{3/2}$  term.
- (d) Name the three types of molecular spectra and mention the regions of the electromagnetic spectrum in which they occur?
- (e) What are the differences between the spectra of alkali atoms and those of hydrogen?
- (f) A many electron atom has  $L = 2$ , and  $S = 1$ . What are the possible values of  $J$ ?
- (g) What is normal Zeeman effect? Which concept of quantum mechanics does it confirm?
- (h) Carbon monoxide (CO) molecule has moment of inertia  $1.46 \times 10^{-46} \text{ kg.m}^2$ . Find the energy in eV of CO molecule when it is in its lowest rotational energy state. ( $\hbar = 1.05459 \times 10^{-34} \text{ Js}$ )

5×2=10

**2. Answer any two questions:**

- (a) State Pauli's exclusion principle. Show that in any state of principal quantum number  $n$ , maximum number of electrons which can be accommodated is  $2n^2$ . 2+3
- (b) Consider  $L$ - $S$  coupling scheme for helium atom. Show that:
  - (i)  $1s^1 2s^2$  configuration leads to the term  $^1S_0$  and  $^3S_1$ .
  - (ii)  $1s^1 2p^2$  configuration leads to the term  $^1P_1$ ,  $^3P_0$ ,  $^3P_1$ , and  $^3P_2$ . 2+3
- (c) What are Einstein's coefficients  $A$  and  $B$ ? Derive the ratio between them in general  
$$\frac{A_{nm}}{B_{nm}} = \frac{8\pi h \nu^3}{c^3}, (n > m).$$
 2+3
- (d) Explain the term spontaneous emission and stimulated emission. Why four-level laser is better than three-level laser? 2+3

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3. Answer any two questions:

(2)

10×2=20

(a) Obtain the following expression for rotational energy levels of a diatomic molecule

$$E_r = \frac{h^2}{8\pi^2 I} J(J+1)$$

and obtain frequency of the rotational spectra. State clearly the selection rules. Show the rotational energy levels and the rotational spectrum of a diatomic molecule. 7+1+2

(b) What is Raman effect? Discuss the quantum mechanical theory of Raman effect. Mention any two applications of Raman effect. Why Stokes lines are more intense than anti-Stokes lines? 2+5+2+1

(c) Explain the construction and working principle of a He-Ne laser with a neat energy level diagram. What are the advantages of He-Ne laser in comparison to a solid state laser? 7+3

(d) What is anomalous Zeeman Effect? Show the effect of weak magnetic field on the doublet ( $D_1$  &  $D_2$ ) lines of sodium. Why anomalous Zeeman Effect more commonly observed than normal Zeeman Effect? 2+5+3