RAJIV GANDHI INSTITUTE OF PETROLEUM TECHNOLOGY, JAIS AMETHI

B. Tech. – Ist Year (Even Semester)

End Semester Examination

Question Paper for Modern Physics (PY-112)

SECTION - B

TIME: 1 hour **[MAX. MARKS: 30]**

- **Instructions: Attempt all questions**

1. The normalized ground state wavefunction of the electron in the hydrogen atom is

$$\psi(r\theta\Phi) = \frac{1}{\sqrt{\pi}}\left(\frac{1}{a_0}\right)^{3/2} e^{-r/a_0}$$

(a) Calculate the probability of finding the electron in the range $a_0/2 < r < 3a_0/2$.

(b) Sketch the probability density as a function of r. At what value of r, it is maximum. What would be the corresponding probability for a classical orbit?

(c) Calculate the average radius of hydrogen atom? **[10 MARKS]**

2. The $J = 0 \rightarrow J = 1$ rotational absorption line occurs at 1.153×10^{11} cycles/sec in $^{12}C\ ^{16}O$ and at 1.102×10^{11} cycles/sec in $^{x}C\ ^{16}O$. Calculate the mass number **(*x*)** of the unknown carbon isotope. (Consider that the internuclear distance remains unchanged on the isotopic substitution).

[6 MARKS]

3. (a) Calculate the uncertainty in the measurement of momentum of an electron if the uncertainty in its location is 1 Å. **[4 MARKS]**

(b) What is the de Broglie wavelength of thermal neutron at 300 K? **[4 MARKS]**

4. Sketch the wavefunction $\psi(x)$ and probability density $P(x)$ of the particle of energy ($E < V_0$) penetrating through the barrier (V_0) in region I, region II & region III as shown in figure below:

[6 MARKS]