

**B.Sc. CHEMISTRY  
FIFTH SEMESTER  
PHYSICAL CHEMISTRY-III  
BSC – 502  
[USE OMR FOR OBJECTIVE PART]**

**SET  
A**

Duration: 1:30 hrs.

Full Marks: 35

Time: 15mins.

Marks: 10

**( Objective )**

$1 \times 10 = 10$

*Choose the correct answer from the following:*

1. If  $\phi_m(\phi) = \frac{1}{\sqrt{2}} e^{2i\phi}$ , what will be the value of  $m$ ?  
a. 1  
b. 0  
c. -1  
d. 2
2. The zero-point energy of a simple harmonic oscillator in a 2D box is  
a.  $\frac{3}{2} h\nu$   
b. 0  
c.  $\frac{1}{2} h\nu$   
d.  $h\nu$
3. The Born-Oppenheimer approximation is based on the assumption that:  
a. Electrons and nuclei move with the same velocity  
b. Electrons move much faster than nuclei  
c. Nuclei move much faster than electrons  
d. Both electrons and nuclei move with the same mass
4. If  $\hat{H}\psi = E\psi$ , then  $E$  is called the:  
a. Expectation value  
b. Probability amplitude  
c. Wavefunction constant  
d. Eigenvalue of energy operator
5. If  $R = r(1 - r)e^{-\frac{r}{\lambda a_0}}$ , the value of  $l$  is  
a. 0  
b. 1  
c. 2  
d. 3
6. The interaction between electromagnetic radiation and matter primarily depends on  
a. Frequency of radiation  
b. Energy gap between molecular energy levels  
c. Polarizability of the molecule  
d. All of these
7. The ratio of rotational constants for two isotopic molecules  $B_1/B_2$  is equal to:  
a.  $\mu_2/\mu_1$   
b.  $I_2/I_1$   
c.  $\mu_1/\mu_2$   
d.  $I_1/I_2$



- b. Derive the average distance of electron from nucleus for hydrogen atom 1s orbital.
- c. Draw the radial wave function plot for 3s and 3p orbital.
- d. What are the degeneracies of the 11<sup>th</sup> and 12<sup>th</sup> excited states of a simple harmonic oscillator in a 3D box.
4. a. The rotational constant B of HCl is  $10.59 \text{ cm}^{-1}$ . Calculate the bond length. (Given:  $h = 6.626 \times 10^{-34} \text{ J s}$ ,  $c = 3 \times 10^8 \text{ m/s}$ ,  $\mu = 1.627 \times 10^{-27} \text{ kg}$ )  $3+2+3+2=10$
- b. Explain "hot bands" in vibrational spectra.
- c. Explain the effect of isotopic substitution on rotational spectra.
- d. What do you mean by rotationally active molecule? Explain by giving suitable example.
5. a. Calculate the number of vibrational degrees of freedom for  $\text{CO}_2$  and  $\text{H}_2\text{O}$   $2+3+2+3=10$
- b. Define and explain fundamental, overtone, and combination bands.
- c. Explain Beer-Lambert law and its limitations.
- d. Calculate the change in vibrational energy when a transition is taking place from ground state to 1<sup>st</sup> excited state for SHO.

== \*\*\* ==