UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination (Online Mode), Dec 2020

Course: Physical Chemistry V   **Semester:** V

Program: B. Sc. (H) Chemistry   **Time:** 3 hrs

Course Code: CHEM3002   **Max. Marks:** 100

	SECTION - A $\quad$ **6 x 5 = 30 Marks**	
1. Each Question will carry 5 Marks **2. Instruction: Complete the statement / Select the correct and type answer(s)**	
Q 1	(a) A particle of mass "m" is confined to a one-dimensional box. From the Schrodinger equation, the energy is – (A) Continuous $\qquad$ (B) A constant for any state (C) Defined by a quantum number $\quad$ (D) Independent of the box (b) Justifications of the above correct answer:_____	CO1
Q 2	Fill in blanks: The characteristics of a well behaved wave function are (i)_____ (ii)_____ (iii)_____ (iv) _____ (v)_____	CO1
Q 3	The function of e^{-ikx} is an eigen function of $\frac{d^2}{dx^2}$, where $i = \sqrt{-1}$. The eigen value is _____.	CO1
Q 4	Fill in the Blanks: The differences between Raman and Rayleigh scattering are_____	CO1

Q 5	The bond length of H-I bond is 1.60 A^0. Which of the following is the correct value for its dipole moment (in deby units), if it were present in the completely ionic form (charge on the electron = 4.8 x 10^{10} esu).
	    a. 3.00 $\qquad\qquad$ c. 7.68
	    b. 6.40 $\qquad\qquad$ d. 9.28
		CO2

Q 6	(a) ^{1}H NMR spectrum of compound C contains a singlet, a triplet and a quartet. Which of the following compounds might C be?
	    a. $CH_3CH_2CH_2CHCl_2$
	    b. $CH_3CCl_2CH_2CH_3$
	    c. $CH_3CH_2CHClCHCl_2$
	    d. $CH_3CHClCHClCH_3$
	
	 (b) Justifications of the above correct answer:_____
		CO2

SECTION – B $\qquad$ **10 x 5 = 50 Marks** **1. Each question will carry 10 marks**	

2. Instruction: Write short / brief notes/upload file		
Q 7	(a) The minimum energy required to remove an electron from a rubidium metal surface is 20.0×10^{-19}J. Determine the minimum frequency of light that can produce a photoelectric current from Rb metal. (b) Assume that the rotation of HCl is treated as rigid rotor. The rotational energy difference between 2nd and 3rd energy level is 20×10^{-22} J. Calculate the rotational constant of HCl molecule.	CO1
Q 8	(a) What is the orbital with 2 radial nodes and one angular node? (b) (i) Draw the radial probability density plot of 1s orbital of H atom. (ii) Draw the wave function of 2s atomic orbital of H atom.	CO2
Q 9	Calculate the force constant of the molecule ($^{14}N^{16}O$) if the separation of its two lowest vibrational energy level is 3.313×10^{-20} J.	CO2
Q10	(a) Comment on the relative intensities of Stokes and anti-Stokes lines in Raman spectrum. (b) Sketch the potential energy curve of a vibrating molecule under simple harmonic motion.	CO2
Q 11	What are selection rules for rotational-vibration Raman spectra of diatomic molecules? Applying these rules explain what type of rotation-vibration Raman spectrum is obtained for a diatomic molecule.	CO2
Section – C 1 x 20 = 20 Marks		
1. Each Question carries 20 Marks. 2. Instruction: Write long answers /upload file.		

Q 12	(a) How will you arrive at the structure of (i) carbon dioxide, and (ii) water from dipole moment studies?
	                  OR
	 What is the effect on rotational energy of a molecule if an atom is replaced by its heavier isotope?
	
	 (b) The rotational constant for the ground vibrational state ($v = 0$) for $^{12}C^{16}O$ denoted B_0 is 19314 cm^{-1}. Using the rigid rotor approximation, calculate the equilibrium internuclear distance.
	                  OR
	 What do you understand by Electron Spin Resonance (ESR)? Explain the role of ESR for detection of sulfur radicals?
		CO3
		
		 CO3
		
		 CO3
		
		 CO3