c) Taking a suitable example of your choice, demonstrate the function of a photo-chemically driven molecular machine. 3

d) How will you classify a complex chemical species as a supramolecular species or as a large molecule by using its photochemical and electrochemical criteria? 2

M. Sc. (Chemistry) Examination, 2022

(4th Semester, CBCS)

Inorganic Chemistry Special

Paper – XV-I

Time : Two hours Full Marks : 40

(20 marks for each unit)

Use a separate answer script for each Unit.

UNIT: I-4151

1. a) Find the range of electromagnetic radiation required for the NMR and ESR transition. Why do they differ?

   b) What is the nuclear gyromagnetic ratio? How does it control the resonance frequency of an NMR transition?

   c) The reaction between PI_3, $PSCl_3$ and zinc powder gives P_3I_5 as one of the product. The solution state ^{31}P spectrum of P_3I_5 shows a doublet and a triplet. Write the structure of the compound with proper explanation.

   d) Sketch the expected number of ^{19}F NMR spectral lines, including satellites, for $[XeF_5]^-$. [Abundance of ^{129}Xe(I=1/2 for 26%).

   e) Compare the characteristics of NMR and NQR spectroscopy. 2+2+2+2+2

2. a) What do you mean by recoilless nuclear transition? What are the conditions necessary to satisfy recoilless nuclear transition?

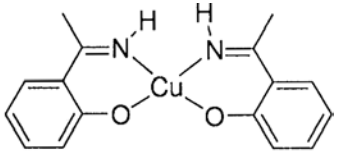
   b) A Mössbauer nuclear ^{57}Fe makes the transition from the excited state of energy 14.4 keV to the ground state. What is its recoil velocity?

   c) A particular Mössbauer nucleus has spins I_g=7/2 and I_e=5/2. How many lines will the γ-ray spectrum split, if the nucleus is under the influence of an internal electric field gradient? Draw the energy levels and transitions for the same.

   d) Discuss different factors that control the intensity and bandwidth of an ESR signal?

   e) For complex **A**, deuteration of NH protons does not alter the ESR spectrum. Discuss the hyperfine lines in the EPR spectrum of **A**. [^{63}Cu(I=3/2)].

2+2+2+2+2



A

UNIT: I-4152

*Answer **all** the questions.*

3. a) "Chemiluminescence processes can be considered as the reverse of photochemical processes". Evaluate the correctness of the statement. 2

   b) What do you mean by photosensitizer? Discuss the role of $[Ru(bpy)_3]^{2+}$ as sensitizer in photodecomposition of water. 2+2

   c) What happens if photo-excited $*[Ru(bpy)_3]^{2+}$ complex is treated with $[Cr(CN)_6]^{3-}$ and $Cr(bpy)_3]^{3+}$? 2

   d) Calculate the excited state redox potentials for the following couples:

      i) $[Ru(bpy)_3]^{3+}$ / $*[Ru(bpy)_3]^{2+}$ and

      ii) $*[Ru(bpy)_3]^{2+}$ / $[Ru(bpy)_3]^{+}$

      [Given: $E_{1/2}([Ru(bpy)_3]^{3+}$ / $[Ru(bpy)_3]^{2+}$ = +1.26 V; $E_{1/2}([Ru(bpy)_3]^{2+}$ / $[Ru(bpy)_3]^{+}$ = –1.28V and E_{0-0} = 2.12 ev). 2

4. a) Discuss the relative merits and demerits of "top-down" and "bottom-up" approaches for the construction of nanoscale devices. 2

   b) What do you mean by Photochemical Molecular Device (PMD)? State the most important functions exhibited by PMD. 1+2