University Examinations 2023/2024

THIRD YEAR SECOND SEMESTER EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE IN CHEMISTRY

SCH 3357: RESEARCH METHODS

DATE: APRIL 2024   **TIME: 2 HOURS**

INSTRUCTIONS: *Answer question **one** and any other **two** questions*

QUESTION ONE (30 MARKS)

(a) Scientific research has been defined by several authors, with some shocking definitions given. Discuss at least three different definitions.   (6 marks)

(b) List four sources of research information (articles)   (4 marks)

(c) Define a null hypothesis   (4 marks)

(d) Discuss the difference between pure/basic scientific research and applied scientific research?   (6 marks)

(e) Discuss five reasons/purposes of a research proposal   (10 marks)

QUESTION TWO (20 MARKS)

List and discuss five general challenges/difficulties you are likely to encounter in research   (20 marks)

QUESTION THREE (20 MARKS)

a) In a schematic diagram, illustrate the process you would follow in scientific research

(10 marks)

b) Generally, there are many types of the authentic papers. Herein we focus on research paper and review paper, which many researchers usually publish for their experimental and/or theoretical works. List down and describe necessary information in all the parts of a paper format

(10 marks)

QUESTION FOUR (20 MARKS)

a) A list of references (Bibliography) must always be provided at the end of a research article. List down all the type of information contained in a single reference. (8 marks)

b) You are given the following abstract. Read and answer the questions

ABSTRACT

The steady-state and time-resolved absorption and fluorescence help to identify the steady-state products and transient intermediates, respectively, generated through photoinduced electron transfer (PET), which may be one of the plausible phenomena in drug–protein/DNA interactions. However, the importance of application of low magnetic field of the order of 0.01–0.02 T lies in its ability to identify initial spin state, one of the deciding factors for ultimate product formation, as well as to assess the intermediate distance in geminating spin-correlated radical ion pairs/radical pairs produced as transients, an useful technique to study "distance-dependent" interactions in biomacromolecules. We have synthesized and studied five new copper(II) Schiff base complexes with differently substituted heterocyclic ligands, $[CuL^1]\cdot2ClO_4$, $[CuL^2]\cdot2ClO_4$, $[CuL^3]\cdot2ClO_4$, $[CuL^4]\cdot2ClO_4$, and $[CuL^5]\cdot2ClO_4$, among which the first two metal complexes with N_2O_2 donor set of atoms and the other three metal complexes with N_4 donor set of atoms with different aliphatic substitutions, to understand their effect on interaction with calf thymus DNA (CT-DNA). Laser flash photolysis coupled with an external magnetic field has helped to assess the efficiency of PET from CT-DNA to the complexes. The possibility of PET in triplet state between CT-DNA and the metal complexes having N_2O_2 donor set of atoms, CuL^1 and CuL^2, is insignificant due to the presence of oxygen as ligand atom. However, the other three complexes with N_4 donor set atoms undergo PET with CT-DNA. The extent of PET is much more prominent with pyrrole containing complexes, CuL^4 and CuL^5, compared to pyridine-substituted complex, CuL^3. The increase in the yield of radical ions in the presence of magnetic field depicts the initial spin correlation of the geminate radical ion pair as triplet. The difference between experimental and calculated $B_{1/2}$ values that determines the extent of hyperfine interactions present in the system is much higher for unsubstituted pyrrole copper complex, CuL^4, compared to the substituted one, CuL^5, since the former due to its smaller structure can approach DNA with greater proximity which leads to much more "through-space" hole hopping for intrastrand and interstrand DNA bases. However, the superexchange interaction, which reduces the hole-hopping rate on increasing the size of the nucleobases' bridge, becomes much more prominent leading to a decrease in experimental $B_{1/2}$ value for methyl-substituted pyrrole–DNA system.

(i) Identify the research problem and rephrase it in a new sentence   (4 marks)

(ii) Identify at least two objectives in this study by writing possible states about them (6 marks)

(iii) Copy the statement that highlights the main difference between experimental results and theoretical model   (2 marks)