UNIVERSITY OF RUHUNA

BACHELOR OF SCIENCE SPECIAL DEGREE (LEVEL II) SEMESTER-I EXAMINATION JULY 2 016

SUBJECT : CHEMISTRY

COURSE UNIT : CHE 4482 **TIME : Two (02)** hours

Answer **three (03)** questions only

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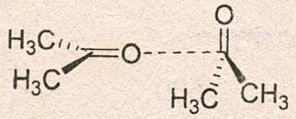
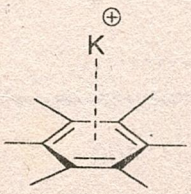
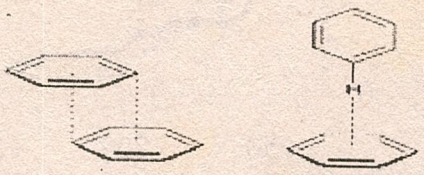
(01). Answer **all** parts

(a) Illustrate possible supramolecular interactions that can be found in following systems. Discuss their relative importance in supramolecular chemistry.

(i) 

(ii) 

(iii) 

(24 marks)

(b)Explain the following terms pertaining to supramolecular chemistry.

(i) cooperativity

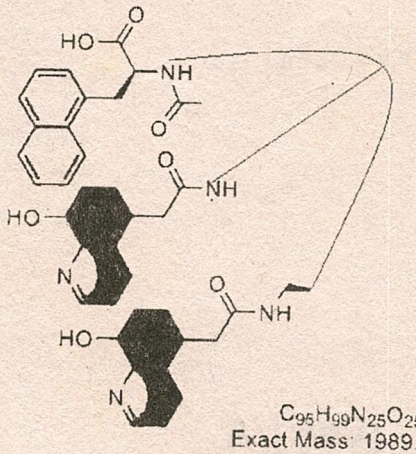
(ii) complementarity

(iii) allosteric effect

(18 marks)

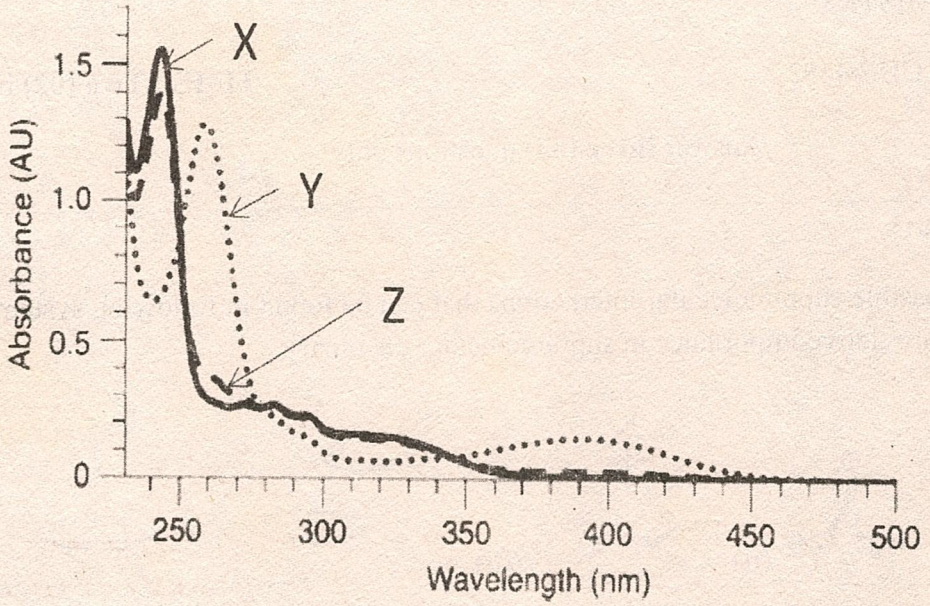
(c) The structure of a novel bis(peptide) based molecular actuator **A**, is given below.

(*Chem. Eur. J.* **2008**, *14*, 6406 – 6412)



$C_{95}H_{99}N_{25}O_{25}$
Exact Mass: 1989.7244

The UV-visible spectrum of 20 μM of **A** is given by **X**. After the addition of 1 equivalent of $CuCl_2$ to the 20 μM solution of **A** the UV-visible spectrum was changed to **Y**. To the same mixture 3 equivalent of EDTA was added and spectrum **Z** was obtained.



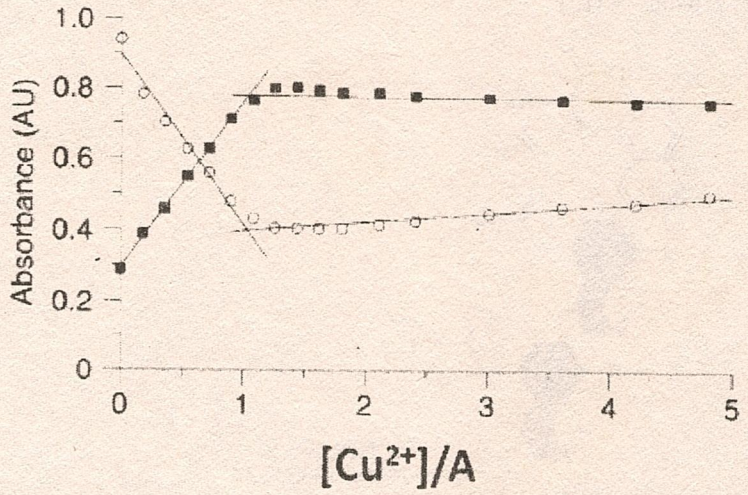
(i) Explain the reason for the spectral change from **X** to **Y**.

(ii) Explain the reason for the spectral change from **Y** to **Z**.

(iii) What can you deduce about the reaction between **A** and Cu^{2+} from these results?

(36 marks)

(iv) The variation of absorbance at 244 nm (o , spectrum **X**) and 259 nm (■, Spectrum **Y**) in the spectrophotometric titration of 17 μm solution of **A** with 150 μm $CuCl_2$ at pH 7.0 and T= 258 °C is given below.



(I) Explain the variation in absorbance at 244 nm and 259 nm.

(II)Determine the stoichiometry between Cu^{2+} and **A.**

(22 marks)

(02). Answer **all** parts

(a) Heterogeneous catalysts are important in many chemical industrial processes.

(i) State chemical equations pertaining to **two** industrial processes which use heterogeneous catalysts and name the catalysts used.
(ii) Explain advantages and disadvantages of heterogeneous catalysis.
(iii) Explain **three** factors, other than those already mentioned in part (ii) and cost, that must be taken into account when choosing a catalyst for a particular reaction.

(40 marks)

(b) Heterogeneous reactions occur at the gas/solid or solid/liquid interface.

(i) Assume that ozone is adsorbed on to a Ni surface in accordance with a Langmuir isotherm. How could you use the pressure dependence of the fractional coverage under following condition?
(I) without dissociation of O_3
(II) dissociation of O_3 into O and O_2
(III) dissociation of O_3 into 3O atoms

(15 marks)

(ii) The rate law for the Pt catalyzed decomposition of NO into N_2+O_2 is given below.

$$\text{Rate} = \frac{kp_{NO}}{p_{O_2}}$$

Where k is a constant, p_{NO} and p_{O_2} are partial pressures of NO and O_2 respectively.

Derive the above rate law considering that the Pt catalyzed decomposition is a surface catalysis process and it follows Langmuir adsorption isotherm.

(20 marks)

(c)

(i) The decomposition of phosphine PH_3 on tungsten catalysts is first order at low pressures but zero order at high pressures. Interpret these findings in terms of adsorption of PH_3 on the surface.

(15 marks)

(ii) Maleic anhydride is industrially produced by selective oxidation of *n*-butane in the presence of metal oxide catalysts. In this reaction butane behaves as a weak base. In order to act as a catalyst in the above process, which properties should be exhibited by the metal oxide?

(10 marks)

(03) Answer **all** parts

(a) What do you mean by 'micropollutants' in water?

(10 marks)

(b) Give **three** categories of micropollutants, examples for each and impacts of them on human and environment?

(15 marks)

(c) Ozonation is one of most effiecent treatment methods to remove micropolutants from water

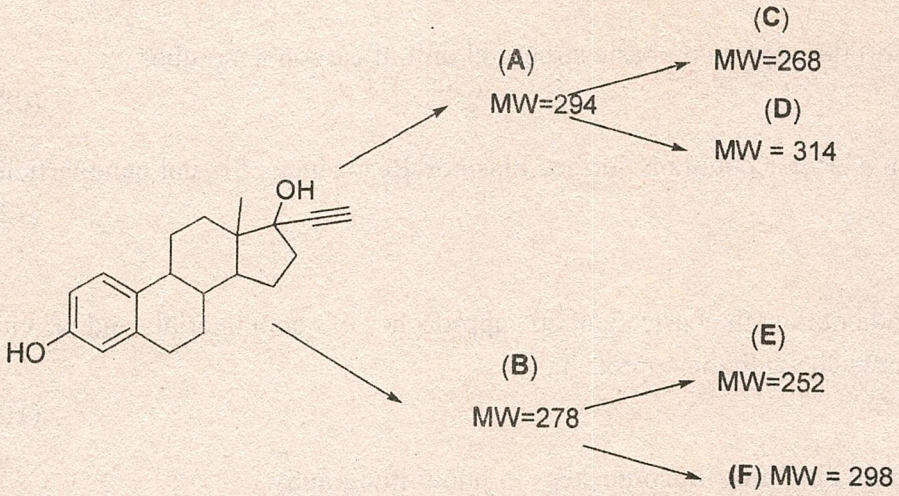
(i) Draw a simple diagram to illustrate the ozonation pilot plant and explain briefly how the ozonation pilot plant operate.

(20 marks)

(ii) Give **three** major types of ozonation reactions of aromatic compounds occurring in the above process. Give equations whenever necessary

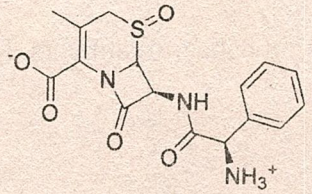
(15 marks)

(iii) The following reaction sequence is given for ozonation of Ethinylestradiol(EE2) in waste water treatment process. Molecular weight of ozonolysis products are obtained from LC-MS given. Identify each of the fragments **A-F** (Huber et al., *Env. Sci. Tech.*, 2004)



(30 marks)

(iv) Structure of cephalexin-(R)-sulfoxide is shown below. Explain how it losses the biological activity upon ozonation.?



cephalexin-(R)-sulfoxide

(10 marks)

(04) Answer **all** parts

(a) Nobel Laureate Dr. Richard Feynman conceived the idea of molecular manufacturing during his historical speech titled "There is plenty of room at the bottom" which considered as the birth of the nanotechnology.

(i) Define the term 'Nanotechnology'.

(10 marks)

(ii) 'Properties of materials are different at the nanoscale'. What are the factors causing these differences? Explain

(10 marks)

(iii) Giving suitable examples, classify the nanomaterials based on their structural dimensions. Clearly indicate the basis of the classification.

(14 marks)

(iv) Write a short description on basic structural unit of carbon nanotubes .

(08 marks)

(v) Write down a brief account on Surface Plasmon Resonance of metal nanoparticles.

(12 marks)

(b)

(i) Compare and contrast the basic synthetic approaches of nanomaterials and provide **two** examples for each synthetic approach.

(10 marks)

(ii) Using suitable diagrams illustrate steps in photolithography.

(12 marks)

(c) Describe the basic principle of scanning tunneling microscope that is used for characterization of nanomaterials.

(12 marks)

(d) Dendrimers are used as 'nanodevices' in cancer treatments. Explain.

(12 marks)

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