



FACULTY: BASIC AND APPLIED SCIENCES
DEPARTMENT: PHYSICAL AND CHEMICAL SCIENCES
SECOND SEMESTER EXAMINATIONS: 2016/2017 ACADEMIC SESSION
COURSE CODE: CHM 206 COURSE TITLE: BIOPHYSICAL CHEMISTRY

HOD's SIGNATURE

TABLE OF CONSTANTS:

Speed of light c , $2.997 \times 10^8 \text{ m/s}$

Faraday constant F , $96500/\text{mol}$

Gas constant R , $8.314 \text{ J K}^{-1} \text{ mol}^{-1}$

Gas constant R , $8.314 \times 10^{-2} \text{ L bar K}^{-1} \text{ mol}^{-1}$

Avogadro's constant N_A , $6.022 \times 10^{23} \text{ mol}^{-1}$

Elementary charge e , $1.602 \times 10^{-19} \text{ C}$

Boltzmann constant k , $1.38 \times 10^{-23} \text{ J/K}$

Planck's constant h , $6.626 \times 10^{-34} \text{ Js}$

Acceleration due to gravity g , 9.81 ms^{-2}

Atomic mass unit u , $1.661 \times 10^{-27} \text{ kg}$

INSTRUCTIONS:

- SECTION A - ATTEMPT ANY TWO QUESTIONS
- SECTION B - ATTEMPT ANY TWO QUESTIONS

DURATION: 2 HOURS

SECTION A

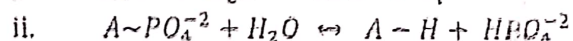
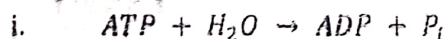
ATTEMPT TWO QUESTIONS FROM THIS SECTION

QUESTION ONE

1. A. What are chemotropic and phototropic organisms? [2marks]

B. Write an expression for the equilibrium constant and the free energy of the following reactions

[2marks]



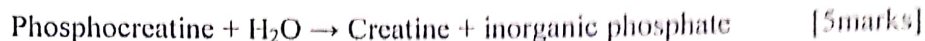
C. Comment on the ease of denaturation of the following proteins from the thermodynamic parameters tabulated below:

[6marks]

Sample / experimental conditions	ΔH° kJ mol ⁻¹	ΔS° J mol ⁻¹ K ⁻¹	ΔG° kJ mol ⁻¹	ΔC_p kJ mol ⁻¹ K ⁻¹
Chymotrypsinogen (pH 3, 298K)	164	0.440	31.0	10.9
β -Lactoglobulin (5M urea, pH 3, 298K)	-88	-0.300	2.5	9.0
Myoglobin (pH 9, 298K)	180	0.780	57.0	5.9

D. Given that the of physiological concentration of phosphocreatine and the inorganic phosphate obtained from the hydrolysis of phosphocreatine is 10mM at 37°C, calculate:

- The free energy of hydrolysis
- The standard reduction potential given that two electrons are transferred during the reaction.



QUESTION TWO

A. The venom of a poisonous lizard shows that one of the venom components is a protein that appears to be sensitive to temperature. A non-toxic form of the protein is obtained on heating. If the protein obtained from the lizard venom can only be used for two equilibrium measurements at 298K and 320K,

- i. Calculate the equilibrium constants for toxic to non-toxic at these temperatures when 98% of the protein is toxic at 298K and only 10% is non-toxic at 320K.
- ii. Determine the enthalpy, entropy and the free energy of the system
- iii. Comment on the magnitudes of ΔG obtained at the two temperatures



B. Ibukun believes that the protein she isolated bind to magnesium ions. Suggest and describe one biophysical technique she can employ to confirm if her conviction is right. [5marks]

QUESTION THREE

A. Show that the enthalpy of 1:1 protein – ligand binding is

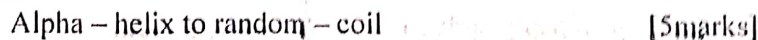
$$\frac{C_p}{[PL]} = 1 + \frac{1}{K[L]}$$

State all underlying assumptions and define all symbols. [5marks]

B. Define the following terms [5marks]

- i. Free energy
- ii. Melting of protein
- iii. Osmosis and Osmotic shock
- iv. Adiabatic system
- v. Entropy

C. Assuming that a polypeptide chain has only one alpha helical conformation and that there are three possible orientations for each amino acid residue in the random – coil state, calculate the change in entropy for the conformational change for a polypeptide of 100 residues and the enthalpy per residue required in making the melting point 323K.



(SECTION B)

CHE 206

QUESTION 1 (SECTION B)

- a) Discuss the principles and detection of gel electrophoresis as a technique for characterization of macromolecules (9 marks)
- b) Suppose at a given concentration of a macromolecule "Y" that 70% of the species are monomers with molecular mass 60×10^6 mg/mol and 30% are dimers whose

molecular mass is 120,000 g/mol. Calculate the M_n and M_w for the macromolecule.
(6 marks)

QUESTION 2

- a) Discuss the technique for the separation of macromolecules based on their molecular sizes (7 marks)
- b) Discuss two methods for the determination of molecular weight of a macromolecule (8 marks)

QUESTION 3

- a) What is a chemical shift? Briefly explain two types of standards employed in NMR spectrophotometer (5 marks)
- b) Briefly explain the principles of x-ray diffractometer. (5 marks)
- c) How can you identify an unknown sample by x-ray diffraction using Hanawalt method? (5 marks)