ELIZADE UNIVERSITY, ILARA-MOKIN, ONDO STATE
FACULTY: BASIC AND APPLIED SCIENCES
DEPARTMENT: PHYSICAL AND CHEMICAL SCIENCES
SECOND SEMESTER EXAMINATIONS: 2015/2016 ACADEMIC SESSION
COURSE CODE: CHM 206   COURSE TITLE: BIOPHYSICAL CHEMISTRY
DURATION: 2.5 HOURS   HOD's SIGNATURE

TABLE OF CONSTANTS:
Speed of light c, $2.997 \times 10^8 m/s$ Elementary charge e, $1.602 \times 10^{-19} C$
Faraday constant F, 96500/mol   Boltzmann constant k, $1.38 \times 10^{-23} J/K$
Gas constant R, $8.314 JK^{-1} mol^{-1}$ Planck's constant h, $6.626 \times 10^{-34} Js$,
Gas constant R, $8.314 \times 10^{-2} L bar\ K^{-1} mol^{-1}$ Acceleration due to gravity g, $9.81 ms^{-1}$
Avogadro's constant N_A, $6.022 \times 10^{23} mol^{-1}$ Atomic mass unit u, $1,661 \times 10^{-27} kg$

INSTRUCTIONS: ATTEMPT FOUR QUESTIONS

1. **QUESTION ONE**
   a. The partial thermodynamic parameter obtained for the unfolding of a protein in an aqueous solution at pH 7.4 is given below,

T/ K	K	$\Delta G^0/kJ\ mol^{-1}$	$\Delta H^0/kJmol^{-1}$	$\Delta S^0/JK{-1}mol^{-1}$
318	0.135	5.33	105	
328		3. 86	140	
338		0	185	609.8
343	3.22		215	

   i.   State the relationship between G, K, H and S and use this relationship to fill in the gaps. Under the conditions stated conditions above,
          [5marks]
   ii.   What fraction of the protein molecules will unfold at 328K and 343K
          [2marks]
   iii.   What does the temperature dependence of the unfolding enthalpy suggest about the forces responsible and the forces responsible for stabilizing the folded protein conformation?
          [2mark]

   b. The sedimentation coefficient of lysozyme in water is at 20°C is $1.91 \times 10^{-13} s$ and its viscosity is $1.002 g^{-1} m^{-1} s^{-1}$ .Assuming lysozyme is spherical, calculate its radius given that its molecular weight is $14500 g\ mol^{-1}$, specific volume is $0.703 cm^3 g^{-1}$ and the density of water at 20 °C is $0.998\ gcm^{-3}$.

   c. Give plausible reasons why the partial specific volume of a protein decreases with unfolding. [2marks]

2. **QUESTION TWO**
   a. Describe how you will separate a protein with a sequence of histidine residue at its end terminal from a mixture obtained from a bacterial cell.   [5marks]
   b. Tilewa and Chioma identified a protein from a nematode that might have metal binding properties. Suggest and describe two biophysical techniques that might be employed to investigate the binding of metals to this protein in solution.   [10marks]

3. **QUESTION THREE**
   a. Determine the molar mass of a macromolecule in cyclohexane at 298K using the osmotic pressures expressed in terms of the heights of solutions tabulated below (mass density $\rho =$ 0.980g/cm^{-3}) [6marks]

$C(gdm^{-3})$	1.00	2.00	4.00	7.00	9.00
$H(cm)$	0.28	0.71	2.01	5.10	8.00

   b. Evaluate the absorbance cross section of a chromophore at 280nm given that the molar absorptivity 7600moldm^{-3}cm^{-1}. What information on the chromophore can you deduce from your calculations? [3marks]
   c. What is the energy of a single photon of light of wavelength 450nm? Give your answer in kJ/mol [4marks]

   d. Write the structure of the zwitterion for the amino acid shown below

[2marks]

4. **QUESTION FOUR**
   The DNA and amino acid sequence of a protein cloned by recombinant DNA method gives a relative molecular mass of 15000 for the polypeptide chain. If the protein is predicted to possess a dimer in its native state, describe a named
   a. Method of electrophoresis [8marks]
   b. Method of chromatography to validate the prediction. [7marks]

5. **QUESTION FIVE**
   a. Define the following terms [6marks]
      i. Chromophore
      ii. Prosthetic groups
      iii. Bathochromic and Hypsochromic shifts
      iv. Osmotic pressure
      v. Isoelectric pH
      vi. Melting temperature
   b. Which chemical groups are responsible for the absorption of ultra-violet radiation in proteins? Are proteins able to absorb visible light? [1marks]
   c. Which chemical groups absorb UV light in nucleic acids [1mark]
   d. Figure 1 below is L - Tryptophan,
      i. What part of the molecule will absorb uv/vis light [1mark]
      ii. Which atoms and bonds are responsible for the n→π* and π→ π* transitions [2marks]
      iii. Discuss the effect of changing the solvent polarity on the electronic absorption spectra of L- Tryptophan. [4marks]
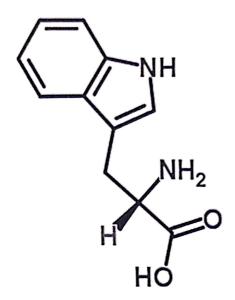
Figure 1: L- Tryptophan

6. **QUESTION SIX**

The membrane potential $\Delta\psi = \frac{RT}{Z_iF} \ln \frac{C_i^0}{C_i^P} = \psi_\beta - \psi_0$

    i.   Define all symbols in the equation   **[3marks]**

    ii.   State the thermodynamics interpretation of this equation   **[5marks]**

    iii.   Explain how ion pumps maintain ionic concentration difference and generate membrane potential.   **[5marks]**

    iv.   Explain why electrophoretic method involving SDS-PAGE has to be heated. What is the condition for heating?   **[2marks]**