The Open University of Sri Lanka
B.Sc. Degree Programme (Level 05) 2011/12

Final Examination –Biophysics –PHU3152/PHE5152

Duration: Two Hours (2 hrs)

Date 28th December 2011 **Time 9.30 am – 11.30 am**

Answer Four (4) questions only

Use the following values when necessary,
Plank's constant = 6.63 x 10^{-34} J S, charge of an electron = 1.6 x 10^{-19} C, mass of the electron = 9.1 x 10^{-31} kg , 1eV=1.6 x 10^{-9} J and 1J =1 kg m^2 s^{-2}.
Universal gas constant =R = 8.3 J mol^{-1} K^{-1}

1.The Bohr model for Hydrogen atom assumes that the orbital angular momentum of the electron is quantized, i.e.,

$$mV_n r_n = \frac{nh}{2\pi}$$

where

m= mass of the electron
V_n = Orbital speed of the electron
r_n= Orbital radius of the electron
n= 1,2,3..... Principal quantum number
h= Plank's constant

(a) Show that the radii of the Bohr orbits obey

$a_n = n^2 a_o$ Where, $a_o = \frac{\varepsilon_o h^2}{\pi m e^2}$ is the Bohr radius.

(b) Show that the total energy of the Bohr atom obeys

$$E_n = \frac{-me^4}{8\varepsilon_o h^2 n^2}$$

(c) A doubly ionized Lithium atom is Hydrogen like atom with atomic number 3.

Find the wavelength of the radiation required to excite the electron in Li^{2+} from the first to the third Bohr orbit ?.

(Ionization energy of the H_2 atom is equal to, -13.6 eV) *Ctd...*

2. (a) Explain the terms briefly (i) Constructive interference, (ii) Destructive interference and (iii) diffraction of light.

(b) With the aid of a labeled diagram, obtain an expression for the spacing of fringes on a screen at a distance in Young's double slits experiment.

(c) Young's double slits experiment was performed with orange light from a Krypton arc. If the fringes are measured with a micrometer eyepiece t a distance of 1 m from the double slit. It is found that 25 of them occupy a spacing of 1.287×10^{-2} m. Find the distance between the centers of the two slits. (Given wavelength of the Krypton orange light is 6058 Å).

3.(a) There are different kinds of interactions that keep atoms together when forming a molecule. List three types of interactions and compare two types of them giving an example for each case.

(b) What is meant by bond energy. ?

(c) When water molecules are placed with non-polar molecules (such as hydrocarbons), would the water molecules experience any hydrogen bonding with the non polar molecules with each other ? Why? Give your answer briefly.

(d) Why ionic solutes such as sodium chloride (NaCl) generally dissolve in polar solvents but not in non-polar solvents. Give brief explanation.

4. (a) State briefly 1st and 2nd laws of thermodynamics with their differential forms.

(b) Explain following terms and draw the *P-V* graphs for each
- (i) An isothermal expansion
- (ii) An adiabatic expansion
- (iii) An isobaric compression

(c) One mole of an ideal monatomic gas, initially at a volume of 0.05 m^3 and a pressure of 1.0×10^5 Pa, is taken through a reversible cycle that consists of three processes:

a-->*b*: An isobaric compression that decreases the volume from 0.05 m^3 to 0.01 m^3
b-->*c*: An isochoric process where the pressure goes from 1.0×10^5 Pa to 5.0×10^5 Pa
c-->*a*: An isothermal expansion that returns the system to its original state.

(i). Show the cycle on a *P-V* graph, labeling all three processes. Be sure to label the axes with appropriate scales, units, etc.

(ii). Find the net work done by the gas per cycle?.

(iii). Find the heat added to the gas per cycle?. *Ctd...*

5. (a) What is Sedimentation ?. Name one of the well known experiments done in the lab which tests the rate of sedimentation of erythrocytes in blood.

(b) A blood cell having a density ρ_B and a radius r falls with a terminal velocity, V_t through a liquid of viscosity η and the density ρ_L . Derive an expression for the terminal velocity V_t with the help of a Stokes formula for the drag of a blood cell in a liquid.

(c) Calculate the terminal settling velocity V_t of a 70 micrometer diameter sphere of density 2600 kg m^{-3} in water (Density of water: 1000 kg m^{-3} and the viscosity: $1x10^{-3}$ N s m^{-2}.)

(ii) What is the new terminal velocity for a sphere of twice this diameter ?

6. (a) An electron is accelerated through a potential difference of 64 volts. What is the ***de Broglie*** wavelength associated with it.? To which part of the electromagnetic spectrum does this value of wavelength corresponds?.

(b) Draw a cubic unit cell indicating the locations of (011) (111) and (010). Label the axes.

(c) *X*-rays of wavelength 0.0153 nm are scattered from the (211) plane of a sample of protein, which has a simple cubic structure. Adjacent diffraction peaks are observed at scattering angles of 28° and 45°. Calculate the lattice constant of the protein.

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