00152

The Open University of Sri Lanka
Faculty of Natural Sciences
B.Sc/ B. Ed Degree Programme

Department	: Physics
Level	: 5
Name of the Examination	: Final Examination
Course Code and Title	**: PHU5304/PYU3165 Bio Physics**
Academic Year	: 2019/2020
Date	: 29.12.2019
Time	: 9.30 am – 11.30 am
Duration	: 2 hrs

General Instructions

1. Read all instructions carefully before answering the questions.
2. This question paper consists of 0**6** questions in **03** pages.
3. Answer any **04**questions only. All questions carry equal marks.
4. Answer for each question should commence from a new page.
5. Draw fully labelled diagrams where necessary
5. Relevant log tables are provided where necessary.
6. Having any unauthorized documents/ mobile phones in your possession is a punishable offense
7. Use blue or black ink to answer the questions.
8. Circle the number of the questions you answered in the front cover of your answer script.
9. Clearly state your index number in your answer script

1. The Bohr model applies to atoms or ions that have only a single electron orbiting a nucleus containing Z protons. This model assumes that the electron exists in circular orbits that are called stationary orbits. The model also assumes that the orbital angular momentum L_n of the electron can only have values that are integer multiples of Plank's constant divided by 2π;

$$L_n = \frac{nh}{2\pi}, n = 1,2,3.....$$

With the assumption above, it can be shown that the n^{th} Bohr orbit of an electron has the total energy associated with orbit is,

$$E = -(13.6\ eV)\frac{Z^2}{n^2}$$

The Bohr model predicts that the wave length comprising the line spectrum emitted by a hydrogen atom is given by

$$\frac{1}{\lambda} = \frac{2\pi^2 mk^2 e^4}{h^3 c}\left(\frac{1}{n_j^2} - \frac{1}{n_i^2}\right)$$

Where m is the electron mass $9.11\text{x}10^{-31}$ kg, e is the electronic charge $-1.6\text{x}10^{-19}$ C, k=$8.988\text{x}\ 10^9$ Nm^2/C^2, n_j is the principal quantum number of the final state to which a transition is made, n_i is the principal quantum number of the initial state, h is the Plank's constant $6.63\text{x}10^{-34}$ Js and c is the velocity of light $3\text{x}10^8$ ms^{-1}.

(i) Draw a diagram which represents
- **(a)** Lyman series (10 marks)
- **(b)** Blamer series (10 marks)

(ii) Calculate the wavelength of the photon emitted in the $4 \rightarrow 3$ transition in Hydrogen atom. (20 marks)

(iii) A wave function for an electron in an atom is called an atomic orbital; this atomic orbital describes a region of space in which there is a high probability of finding the electron. Each electron in an atom is described by four different quantum numbers.
- **(a)** Name the above four quantum numbers (20 marks)
- **(b)** Write down the characteristics described by each quantum number. (20 marks)
- **(c)** Draw the shapes of the orbitals *s* and *p*. (20 marks)

2. **(a)** Thermodynamics is essential in dealing with inter-conversion of various forms of energy and work. Living systems are complex arrangements. Therefore, the application of equilibrium thermodynamics in living system are limited. However, there are some instances that we still have good used of equilibrium thermodynamics in investigation of living process.
- **(i)** Define a closed system (10 marks)
- **(ii)** Define an open system (10 marks)
- **(iii)** Write down the 1st law of thermodynamics (20 marks)

(b)A system undergoes a process A from state 1 to state 2 during which the heat and work interactions are 290 kJ and 250kJ, respectively. If the system is taken to state 2 from state 1 through a different path B, the work done by the system is found to be 80kJ. Determine the heat interaction along the path B and the change in the internal energy $U_2 - U_1$.Suppose the system is returned from state 2 to state 1 through a third path C, during which 125 kJ work is done on the system, determine the heat interaction along this path. (60marks)

3 The muscular- skeletal system of the body is a complex system of levers. When muscle contracts, it exerts a force on the bone at the point where it is attached to it by the tendon producing a turning moment about the joint. The system acts as a lever.

(i) Draw diagrams of three classes of levers used in the body including one example for each type. In your diagram, clearly mark Fulcrum (F), Load (L) and Effort (F) with the direction of the Load and Effort. (15 marks)

(ii) Define a free body diagram. (05 marks)

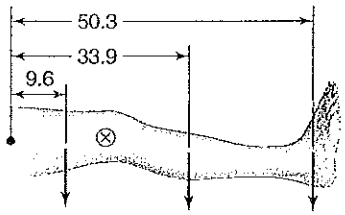

Figure 1

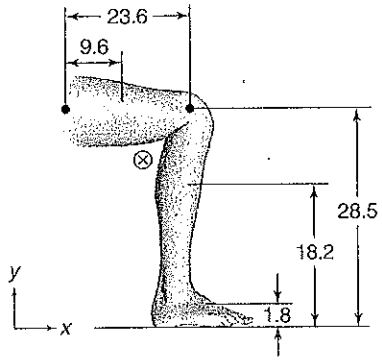

Figure 2

(iii) Determine the position of the center of mass of the whole leg,

a. When stretched out as in figure 1 and (30 marks)
b. When bent at 90^0 as shown in figure 2. (30 marks)

Assume the person is 1.70 m tall and acceleration due to gravity as 10 Nkg^{-1}.

Masses of leg Components in percentage units

Thigh	21.5
Knee	9.6
Ankle	3.4

(iv) The tensionT in the quadriceps tendon as it passes over the knee cap is 1500 N. What is the magnitude and direction of the resultant force F exerted on the femur by the cap for the configuration shown in the diagram in figure 3? (20 marks)

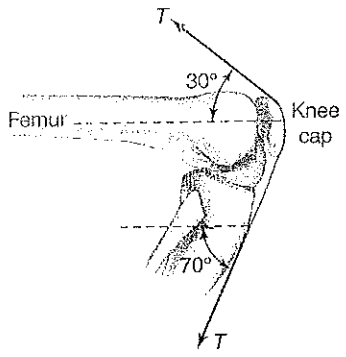

Figure 3

4 **(a)** Sketch a graph of the action potential as a function of time for a typical nerve axon, giving approximate scales on the axes. (20 marks)

(b) Electrodes are placed on the surface of the body to record the cardiac wave form in a healthy person.

(i) Sketch a graph of potential difference between the electrodes as a function of time during a single beat of the heart, giving approximate scales on the axis. (10 marks)

(ii) Mark on the time axis the approximate points when the sino-atrial node is triggered and when ventricular stimulation occurs. (10 marks)

(iii) What change would you expect to find in the electro cardiogram of a patient suffering from a heart attack? (10 marks)

(iv) Why should the person under examination be as quiet and relaxed as possible?(10 marks)

(c) During an action potential lasting one millisecond through a membrane wall area of 5.0×10^{-12} m^2, the average electric currentdensity associated with the ionic flow is $4.128 Am^{-2}$.Calculate the average electric current passes through the wall of the membrane and the number of moles of positive ions enter to the core of axon per square meter of the membrane area during an action potential. (20 marks)

Charge of an electron = $- 1.6 \times 10^{-19}$ C

The Avogadro constant = 6.0×10^{23} mol^{-1}

(d) Air breaks down so that a current flows when the electric field strength is 2.5×10^6 Vm^{-1}. If a typical axon has a membrane thickness of 10 nm state, giving your reasoning, whether air or the membrane is the better insulator. (20 marks)

5 (a)Explain with the aid of a diagram the term depth of focus applied to the human eye.

An object at a fixed distance from the eye is viewed when the pupil is

(i) Large and
(ii)Small.

State and explain which condition gives rise to the larger depth of focus, supporting your answer by means of a diagram. (40 marks)

(b)A person with normal eyesight observes a bright light which flashes for 0.020 s at intervals of10 s. Explain how the person's perception of the bright light changes as the intervals are progressively reduced and name the effect which is responsible. (20 marks)

(c) Draw a diagram to illustrate long sightedness (hypermetropia) and asecond diagram showing its correction by means of a suitable lens. (10 marks)

(d) Without Spectacles an elderly person has a normal farpoint but is unable toseeclearly objects closer than 200cm. (10 marks)

(i) Find power in diopters of the spectaclelens which alters the near point to 25 cm.(10 marks)
(ii)When the person is wearing the spectacles find the far point and calculate the range of distance of distinct vision. (10 marks)

6(a) Explain briefly three techniques used for X-ray Diffraction,
(i) The Laue method (20 marks)
(ii) The rotating Crystal method (20 marks)
(iii) The powder method(20 marks)

(b) A continuous X-ray beam containing wave lengths from 0.9 Å to 0.2 Å strikes a set of parallel planes with spacing 0.4 mm of a protein crystal at an incidence angle of 30^0.

(i)Deduce the wave lengths that will be reflected from this set of planes. (20 marks)

(ii) At what angle will the reflected X-rays emerge from the crystal relative to the transmitted beam? (20 marks)