U.G. 6th Semester Examination-2022
PHYSICS
[HONOURS]
Discipline Specific Elective (DSE)
Course Code : PHY-H-DSE-T-04
(Biophysics)

Full Marks : 60   Time : $2\frac{1}{2}$ Hours

The figures in the right-hand margin indicate marks.
Candidates are required to give their answers in
their own words as far as practicable.

1.   Answer any **five** questions: 3×5=15

   a)   What are the characteristics of amino acids?

   b)   What is the function of protein channels? Illustrate it with an example.

   c)   How does diffusion constant depend on (i) temperature, (ii) viscosity, and (iii) characteristic length of a body?

   d)   What is cytoplasmic streaming? Explain it with a schematic diagram.

   e)   State and explain Fick's first law of diffusion.

   f)   Write down the equation that relates relative permittivity to the polarizability of a medium.

[Turn Over]

Mention the meaning of each term of the expression.

   g)   Does relative permittivity depend on temperature? Justify your answer.

   h)   Is the 'trans' configuration is more stable than the '*cis*' configuration of protein? Justify your answer.

2.   Answer any **five** questions: 5×5=25

   a)   i)   What are the general features of active transport of Na^+/K^+ in the cell?

   ii)   Fluid pressures in the human cranial cavity and spinal column range between 100 and 200 mm Hg above atmospheric pressure. A spinal-tap procedure is conducted by inserting a hollow tube into the spinal cavity to measure the fluid pressure. To what range of heights will the fluid rise if the density of the spinal fluid is the same as that of water: $\rho w = 10^3$ kg/m³.

                                        2+3=5

   b)   What is aneurysm? How does blood pressure change in the aneurysm? How does gravity effect blood pressure in ourbody'?

                                        1+2+2=5

c) Derive the Henderson-Hasselbalch equation $pH = pK_a + \log x$ for the dissociation of the weak acid HA

$$HA \rightleftharpoons H^+ + A^-$$
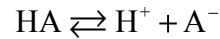
with equilibrium constant K_a, where,

$x = \frac{[A^-]}{[HA]}$, $pH = -\log[H^+]$, and $pK_a = -\log K_a$.

5

d) Calculate the coasting distance of a bacterium in a viscous medium. 5

e) How does time-independent concentration of a diffusive system change in space? Derive necessary mathematical expression in support of your claim. 5

f) Derive the expression of change in entropy of an ideal gas undergoing a free expansion. 5

g) What are the basic properties of α-helix and β-sheet structure of protein? 5

h) Calculate the conductive rate of heat flow through the plasma membrane of a living cell.

5

3. Answer any **two** questions: $10 \times 2 = 20$

a) i) Describe the light absorption process in biomolecules with the help of an electron in a one-dimensional well of length L equal to the length of biomolecules.

ii) What is Lennard-Jones potential?

iii) What are the differences between closed and open system? $5+2+3=10$

b) i) How does flow rate in a cylindrical blood vessel change with the radius of the vessel? Derive necessary mathematical expression in support of your answer.

ii) What is myoglobin? What is the main function of it? Does it have α-helix structure?

iii) What should be the value of change in Gibb's free energy to initiate a spontaneous reaction?

$6+(1+1+1)+1=10$

c) Write a short note on: $5+5=10$

i) enzymatic reaction, and

ii) Joule heating of tissue.

d)   i)   Calculate the vibrational contribution of atoms and molecules to the free energy and heat capacity by considering particles confined to a square well potential with linear restoring force.

     ii)   How is the Reynolds number related to the laminar or turbulent flow of a liquid?

     iii)   'Turbulent flow is dominated by inertial force' - Explain. $7 + 1\frac{1}{2} + 1\frac{1}{2} = 10$

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