UNIVERSITY EXAMINATIONS 2018/2019 ACADEMIC YEAR

4th YEAR EXAMINATION FOR BACHELOR OF SCIENCE,BACHELOR OF SCIENCE (INDUSTRIAL CHEMISTRY) AND BACHELOR OF EDUCATION SCIENCE

(INSTITUTIONAL BASED PROGRAMME)

COURSE CODE/TITLE: SPH B203 MODERN PHYSICS

END OF SEMESTER II DURATION: 2HOURS

DAY/TIME:MONDAY:9.00-11.00 AM DATE:29/04/2019 (2nd F/EW)

INSTRUCTION: ANSWER ALL QUESTIONS.

QUESTION 1.

(a) (i) Explain what is meant by the Uncertainty Principle. [3points]

(ii)Consider a radio pulse lasting 0.0010 s. The position uncertainty of this pulse is $\Delta x = 3.0x10^{-5} m$. Determine the uncertainty in the momentum of the pulse and the uncertainty in the frequency of the pulse. [6points]

(b) State two of Bohr's postulates. [3points]

(c) From Bohr's theory of the atom, derive the expression for the Bohr radius of an atom. [6points]

(d) Compute the value of the energy for an electron in the ground state

$E = \frac{m_e e^4}{2(4\pi\varepsilon_0)^2 \hbar^2} \frac{1}{n^2}$. Give your answer in electron volts. where $n = 1$ [7points]

QUESTION 2.

A particle of mass m = 9×10^{-31} kg is confined to move in a one dimensional region of length 0<x<L. Inside the region the potential is zero, and outside the potential is infinite.

(a) Write down the Hamiltonian of the particle if its charge is e = 1.6×10^{-19} C. [3points]

(b)Write down the Schrodinger equation for the particle. [4points]

(c) Given that the solution of the Schrodinger equation is,

$$\Psi(x) = N \sin(kx)$$

(i) Determine the normalization constant N. [6points]

(ii) Determine the value of k. [5points]

(iii) Compute the total energy of the particle in electron volts. [7points]

QUESTION 3.

(a) Explain the meaning of the following terms:

(i) Valence band and conduction band. [3points]

(ii) Rectifier diode. [3points]

(iii) Quantum well dot. [4points]

(b) (i) Explain what is meant by nuclear binding energy. [3points]

(ii) Compute the nuclear binding energy of the isotope ^{238}U. Express the energy in MeV. The mass of one atom of this isotope is 238.0508 u. [7points]

(Here A = 238 and Z = 92 u = 1.6605×10^{-27} kg and c = 2.9979×10^{8} $\frac{m}{s}$).