7. (a) Consider a mono-atomic one-dimensional lattice (Figure 2), where M and K are the mass of the atom and inter-atomic spring constant, respectively.

Figure 2 : Mono-atomic one-dimensional lattice

(i) Write down the equation of motion for the vibration of the n-th atom.

(ii) Obtain the expression of frequency of vibrational modes.

(b) Obtain the expression of Bragg's law for X-ray diffraction in crystals.

(c) If the first order Bragg's peak for X-rays of wavelength 2.50 Å is observed at 30°, determine the inter-planar spacing of the reflecting planes. [(2+4)+2+2=10]

8. (a) (i) Define magnetization **(M)**. (ii) Write down the equation relating magnetization, magnetic induction **(B)** and external magnetic field **(H)**. (iii) Find the expression of magnetic moment, μ_m, due to the circular (orbital) motion of an electron about its nucleus.

(b) Develop the Langevin (classical) theory of diamagnetism and derive the expression of diamagnetic susceptibility. [(1+1+2)+6=10]

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BACHELOR OF SCIENCE EXAMINATION, 2019

(2nd Year, 4th Semester)

PHYSICS

Paper : GE - 4

Time : Two hours Full Marks : 50

The figures in the margin indicate full marks.

Answer any ***five*** questions.

1. (a) Explain Wien's displacement law. Deduce Wein's displacement law from Planck's radiation law.

(b) What are the difficulties of classical physics to explain the black body radiation ?

(c) What is the maximum wavelength of electromagnetic radiation which can eject electrons from a metal having a work function of 3 eV ? [(2+4)+2+2=10]

2. (a) Explain why the classical electromagnetic theory fails to explain the photoelectric effect.

(b) The photoelectric threshold for a certain metal is 300 nm. Determine the maximum energy of the electrons ejected by a radiation of 200 nm. Given $h = 6.625 \times 10^{-34}$ Js.

(c) Discuss the theoretical background of Millikan's experiment to verify Einstein's photo electric equation. [2+3+5=10]

(Turn Over)

3. (a) What are the characteristics of de Broglie matter wave ? Deduce the expression for the wavelength of de Broglie matter wave.

(b) Does the concept of Bohr orbit violate the Heisenberg's uncertainty principle ?

(c) The position and momentum of a 1 KeV electron are simultaneously determined. If its position is located to within 1 Å, what is the percentage of uncertainty in its momentum ?

(d) What do you understand by group velocity and phase velocity for the de Broglie wave ?

[(2+4)+1+2+1=10]

4. (a) What is the origin of nuclear magnetic moment ?

(b) What do you understand by the binding energy of the nucleus. Explain the significance of the plot of binding energy per nucleon versus mass number.

(b) 1 gm of radium is reduced by 2.1 mg in 5 years by α-decay. Calculate the half-life of radium.

(d) What is the difference between secular and transient radioactive equilibrium ? [2+(1+2)+3+2=10]

5. (a) A particle is restricted to move over the x-axis and its quantum mechanical state is described by the wave function, $\Psi = Ax$, (A is a constant) when $0 < x < 1$ and $\Psi = 0$, elsewhere.

(i) Find the probability that the particle can be found between $x = 0.20$ and $x = 0.40$.

(ii) Find the expectation value, $\langle x \rangle$, of the particle's position.

(b) By using the time-dependent Schrodinger equation and its complex conjugate obtain the equation of continuity of probability density, $\rho = \psi^* \psi$. [(2+3)+5=10]

6. Consider the step poential as described in Figure 1, where energy (E) of the incoming particle of mass m is lower than the height of the potential (V_0), i, e., $E < V_0$.

(a) Write down the Schrodinger equations in regions I and II, separately.

(b) Derive the expressions of wave functions in the respective regions, by solving the Schrödinger equations, separately.

(c) Find the expressions of reflection and transmission amplitudes with the help of those wave functions.

[(1+1)+(1+2)+(2.5+2.5)=10]

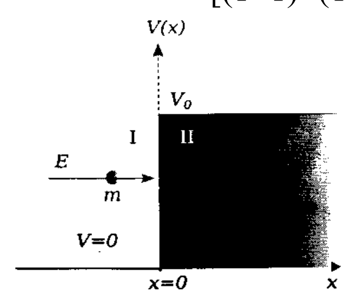

Figure 1 : A particle of energy E approaches a step potential of height V_0, where $E < V_0$.