CL14_Q1. Using the Schrödinger's wave equation find the wave function associated with particle having energy 10 eV travelling along positive x-direction approach a potential step of height 7 eV.

CL14_Q2. Define the terms reflection coefficient and transmission coefficient with respect to step potential.

CL14_Q3 A stream of particles of mass **m** and total energy **E** moves towards a potential step of height $\boldsymbol{V_0}$, if the energy of the electrons is lesser than the step potential $(\boldsymbol{E} > \boldsymbol{V_0})$ then by applying continuity conditions obtain the expression for reflection coefficient.

CL14_Q4. The probability of reflection from a potential step is given by $\frac{(k_2-k_1)^2}{(k_2+k_1)^2}$, where the *k*'s are the wavenumbers in the two regions. If a 5 eV electron encounters a 2 eV potential step, what is the probability that it will be reflected?

CL15_Q1. A particle of mass $\boldsymbol{m}$ and total energy $\boldsymbol{E}$ moves from a region of constant potential V_1 to a region of potential V_2 . If $E < V_2$ find the associated wave function and reflection coefficient for the particle experience a step potential.

CL15_Q2. Explain the term penetration depth for a step potential.

CL15_Q3. A proton of energy 3 eV approaches a potential step of height 4 eV. Evaluate the possible depth of penetration into the classically forbidden region.

CL15_Q5. A spherical dust particle of radius $10^{-5}m$ and density $10^4\ Kg/m^3$, moving at a speed of $10^{-2}m/s$ encounters a step potential of height equal to twice the K.E of the particle. Estimate the penetration depth of the particle inside the step.

CL18_Q1. Obtain the energy Eigen values for a particle bound in an infinite potential well. Comment on why the particle cannot have zero energy?

CL18_Q2. Show that the probability of locating the particle between the limits 0 to 0.5L is the same in any quantum state. Here L is the width of the well.

CL18_Q3. Plot the first two states Eigen functions for a particle in an infinite potential well.

CL18_Q4. Plot the probability densities for the first three excited quantum states of an electron trapped in an infinite potential well of width L. Calculate the probability of locating the electron in the third excited state between the limits ⅜L and ⅝L where L is the width of the well?

CL18_Q5. Show that the energy of an electron confined in a 1-D symmetric potential well of length 'L' and infinite depth is quantized. Is the electron trapped in a potential well allowed to take zero energy? If not, why?

CL18_Q1. Derive the expression of energy Eigen values for a particle in an infinite potential well using the admissible solutions.

CL18_Q2. The wave function associated with a particle in a infinite potential box is $\psi = \left(\frac{2}{L}\right)^{1/2} sin\left(\frac{\pi x}{L}\right)$ for $0 \leq x \leq L$. What is the probability of finding the particle in the region $(i)\ 0 \leq x \leq L/2$ and $(ii)\ 0 \leq x \leq 3L/4$?

CL18_Q3. Plot the probability densities for the first three excited quantum states of an electron trapped in an infinite potential well of width L.

CL18_Q4. A particle is free to move in a one dimensional region of zero potential between the two rigid walls at $x = -a$ and $x = a$. If E_n is the energy of the nth state and ΔE_n is the energy separation between the $(n+1)^{th}$ and n^{th} state, then show that $\frac{\Delta E_n}{E_n} = \frac{(2n+1)}{n^2}$

CL18_Q5. The lowest energy level of a particle confined to a one-dimensional region of space with fixed dimension L is E_o (i.e., a "particle in a box"). If an identical particle is confined to a similar region with fixed distance $\frac{1}{9}L$, what is the energy of the lowest energy level that the particles have in common? Express your answer in terms of E_o

CL21_Q1. Compare the energy levels of the first three quantum states of identically sized finite and infinite potential wells.

CL21_Q2. Why do finite square wells have only a finite number of bound energy values? What are the characteristics of bound energy values?

CL21_Q3. A particle trapped in a finite potential well. Sketch the Eigen functions for first three energy states.

CL21_Q4. Plot the first two states Eigen wave functions and the probability function for a particle in a finite potential well.

CL21_Q1. How are the energy values of a quantum mechanical oscillator fundamentally different from the energy values of a classical oscillator?

CL21_Q2. The energy of a linear harmonic oscillator in the third excited state is 0.1 eV. Find the frequency of the oscillator.

CL21_Q3. Sketch the wave functions and probability densities for the first two quantum states of quantum harmonic oscillators.

CL21_Q4. A lithium atom, mass **1.17×10^{-26} kg**, is vibrating with simple harmonic motion in a crystal lattice, where the force constant k is **64.0 N/m**. (a) what is the ground state energy of this system in eV? (b) What would be the wavelength of the photon that could excite this system to the $\boldsymbol{n}$ **= 1** level?

CL21_Q4.Establish Schrodinger's equation of a linear harmonic oscillator and write its solution.

CL22_Q1. Write down the Schrodinger wave equation for the hydrogen atom in spherical polar co-ordinates and explain the significance of different quantum numbers

CL22_Q2. Explain the stationary states of the hydrogen atom.

CL22_Q3. Electrons in hydrogen are described by four numbers, *n*, *l*, *m* and *ms*. What restrictions (if any) are there on these four numbers?

CL22_Q4. In the analysis of Schrodinger's equation for a hydrogen atom using spherical polar coordinates, elaborate the azimuthal and polar wave function. Also comment on the possible values of magnetic quantum number.

CL22_Q2. Plot the ground-state eigen function of the hydrogen atom as a function of the distance r.

CL19_Q1. What is meant by degeneracy of energy states in quantum systems?

CL19_Q2. Give examples for degenerate states for a particle in three dimensional box with infinite potential at the boundaries.

CL19_Q3. Calculate the Eigen value of the electron in the lowest energy level, confined in a 2D potential box of side 0.1 nm.

CL19_Q4. Using the appropriate boundary conditions obtain the energy eigen values and the corresponding eigenfunctions for a particle trapped in a three dimensional infinite potential box.

CL25_Q1. Discuss the variation of Fermi factor on temperature and consequent effect on probability of occupation of energy levels.

CL25_Q2. Use the Fermi distribution function to obtain the value of F_d for $E-E_F = 0.01$ eV at 200 K.

CL25_Q3. Show that the probability of occupancy of an energy level ΔE below the Fermi level is the same as that of the probability of non-occupancy of an energy level ΔE above the Fermi level.

CL25_Q4. At what temperature would the probability of occupancy of an energy state 0.01eV below the Fermi level be 0.95?

CL25_Q5. Estimate the temperature at which there is 2% probability that a state with energy 0.4 eV above the Fermi energy level is occupied.

CL25_Q6. Show that the density of states for conduction electron per unit volume of the metal is $g(E)dE = \frac{\pi}{2}\left(\frac{8m}{h^2}\right)^{\frac{3}{2}} E^{\frac{1}{2}}\, dE$

CL25_Q7. Calculate the number of states lying in an energy interval of $0.01\ eV$ above the Fermi-level for a crystal of unit volume with energy $E_F = 3.0\ eV$

CL24_Q1. Give the basic ideas of quantum free electron theory of metals.

CL24_Q2. Explain the (energy) distribution of free electrons at 0K based on the quantum free electron theory.

CL24_Q3. Discuss the free electron theory of electronic conduction in metals. Comment on the effect of temperature and impurities on conductivity.

CL24_Q4. State Mattheissen's rule and give an account of the nature of total resistivity both at high and low temperature.

CL24_Q5. Describe how quantum free electron theory has been successful in overcoming the failures of classical free- electron theory.

CL24_Q6. Elucidate the difference between classical free electro theory and quantum free electron theory.

CL27_Q1. Explain the concept of Fermi energy.

CL27_Q2. Obtain an expression for Fermi energy using the concept of density of states.

CL27_Q3. Determine the Fermi temperature and Fermi velocity in a metal with 18 x 10^{28} free electrons per unit volume.

CL27_Q4. Calculate th   e Fermi energy in eV for a metal at 0K, whose density is 10500 kg/m^3, atomic weight is 107.9, and it has one conduction electron per atom.

CL27_Q5. Using the expression of density of states, show that average energy of electrons in a metal at 0K is $\frac{3}{5}\ E_F$

CL27_Q6. A current of 5A can easily be carried in a copper wire of length 3m and resistance 20 mΩ at room temperature. Given: Density of copper = 8.95 x 10^3kg/m^3, mobility of charge carriers = 4.3 x 10^{-3} m^2/Vs and Fermi energy = 7eV. Estimate and compare the values of

a. Drift velocity

b. Thermal velocity

c. Fermi velocity