Mid-I Exam (Spring 2020)

Science-II

Time: 90 min **Total: 22 marks**

(1) Determine the wave function, angular momentum and total energy of a free electron on a circular loop. Draw the real and imaginary parts of the ground, first and second excited state wave functions and compare the results. [4]

(2) Express the kinetic energy operator in terms of the spherical polar coordinates. [5]

(3) Discuss the quantum mechanics of the free electron theory of metals. Using your results, discuss how quantum states of the free eletrons are represented in the k-space and determine the Fermi radius of a metal. [5]

(4) Discuss the quantum mechanics of a particle confined in a one-dimensional well of (a) infinite barriers and (b) finite barriers. Compare the ground, first, and second excited state wave functions of these two systems. Discuss how the probability of finding the particle outside the well varies with the barrier height. [8]