İzmir Kâtip Çelebi University
Materials Science and Engineering
Mse228 Engineering Quantum Mechanics
Midterm Examination
April 11, 2018 09:30 – 11:30
Good Luck!

NAME-SURNAME:

SIGNATURE:

ID:

DEPARTMENT:

DURATION: 120 minutes

◇ **Answer all the questions.**
◇ **Write the solutions explicitly and clearly. Use the physical terminology.**
◇ **Calculator is allowed.**
◇ **You are not allowed to use any other electronic equipment in the exam.**

Question	Grade	Out of
1A		10
1B		10
2		30
3A		10
3B		10
4		20
5A		10
5B		10
TOTAL		110

1. A) The work function of a tungsten surface is 5.4 eV. When the surface is illuminated by light of wavelength 175 nm, the maximum photo-electron energy is 1.7 eV. Find Planck's constant from these data.

B) An electron has a de Broglie wavelength equal to the diameter of the hydrogen atom. What is the kinetic energy of the electron? How does this energy compare with the ground-state energy of the hydrogen atom?

2. An x-ray of wavelength 0.050 nm scatters from a gold target.

   a) Can the x-ray be Compton-scattered from an electron bound by as much as 62 keV ?

   b) What is the largest wavelength of scattered photon that can be observed?

   c) What is the kinetic energy of the most energetic recoil electron?

3. A) A particle of charge q and mass m is accelerated from rest through a small potential difference V.

   a) Find its de Broglie wavelength, assuming that the particle is nonrelativistic.

   b) Calculate λ if the particle is an electron and V=50 V.

   B) A proton has a kinetic energy of 1.0 MeV. If its momentum is measured with an uncertainty of 5.0%, what is the minimum uncertainty in its position?

4. An atom in an excited state normally remains in that state for a very short time ($\sim 10^{-8}\ s$) before emitting a photon and returning to a lower energy state. The "lifetime" of the excited state can be regarded as an uncertainty in the time Δt associated with a measurement of the energy of the state. This, in turn, implies an "energy width", namely, the corresponding energy uncertainty ΔE. Calculate

   a) the characteristic "energy width" of such a state,

   b) the uncertainty ratio of the frequency $\Delta\nu/\nu$ if the wavelength of the emitted photon is 300 nm.

5. A) Show that the speed of an electron in the n^{th} Bohr orbit of hydrogen is $\alpha c/n$, where α is the fine structure constant, equal to $e^2/4\pi\epsilon_0\hbar c$. What would be the speed in a hydrogen-like atom with a nuclear charge of Ze?

B) The electron in a hydrogen atom at rest makes a transition from the n=2 energy state to the n=1 ground state. Find the wavelength, frequency, and energy (eV) of the emitted photon.