İzmir Kâtip Çelebi University
Materials Science and Engineering Department
Mse228 Engineering Quantum Mechanics
Midterm Examination
April 12, 2017 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.**
◇ **You are allowed to use Formulae Sheet.**
◇ **Calculator is allowed.**
◇ **You are not allowed to use any other electronic equipment in the exam.**

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

1. A) Electrons are accelerated in television tubes through potential differences of about 20 kV. Find the highest frequency of the electromagnetic waves emitted when these electrons strike the screen of the tube.

B) An electron moves in the x-direction with a speed of 3.6×10^6 m/s. We can measure its speed to a precision of 2%. With what precision can we simultaneously measure its x coordinate?

2. Suppose that light of total intensity 1.0 $\mu W/cm^2$ falls on a clean iron sample 1.0 cm^2 in area. Assume that the iron sample reflects 96% of the light and that only 3.0% of the absorbed energy lies in the violet region of the spectrum above the threshold frequency.

   i What intensity is actually available for the photoelectric effect?

   ii Assuming that all the photons in the violet region have an effective wavelength of 250 nm, how many electrons will be emitted per second? (Hints: For an efficiency of 100%, one photon of energy, $h\nu$, will produce one electron & Intensity=Power/Area & Power=Energy/Time)

   iii Calculate the current in the phototube in amperes.

   iv If the cutoff frequency is $\nu_0 = 1.1 \times 10^{15}\ Hz$, find the work function, ϕ, for iron.

   v Find the stopping voltage for iron if photoelectrons are produced by light with $\lambda = 250\ nm$.

3. X-rays of wavelength $\lambda = 0.200\ nm$ are aimed at a block of carbon. The scattered x-rays are observed at an angle of 45.0^o to the incident beam. Calculate the increased wavelength of the scattered x-rays at this angle.

4. If moving at 900 m/s, what would be the wavelength of

   i an electron?

   ii a 25,000 kg airplane?

   iii Which is more likely to exhibit a wave nature?

5. A) An electron is in the n = 5 state of hydrogen. To what states can the electron make transitions, and what are the energies of the emitted radiations?

B) A collection of hydrogen atoms in the ground state is illuminated with ultraviolet light of wavelength 59.0 nm. Find the kinetic energy of the emitted electrons.