

PHYSICS 2P51: Assignment 2 - Due Jan 25, 2017

Readings Chapter 20 and chapter 23.

1. X-ray tubes

- (a) What does bremsstrahlung mean?
- (b) Calculate the velocity (in m/s) with which (non-relativistic) electrons strike the target of an x-ray tube operated at 10,000 V.
- (c) What is the short-wavelength limit of the continuous spectrum emitted by the tube if it is operated at 10,000 V?
- (d) The characteristic K_α xray of Cu has a wavelength of 0.1542 nm. While Bremsstrahlung radiation is emitted for all incident electron energies, characteristic x-rays are only excited if the electron kinetic energy is greater than some minimum value. What is the minimum xray tube voltage that will excite this characteristic ray ?

2. Flourescent versus Incandescent Bulbs

Explain why incandescent bulbs are both hotter and less energy-efficient than flourescent bulbs.

3. Light Emitting Diodes

Recall that the bandgap energy in a semiconductor is the difference in energy between the highest occupied states and the lowest unoccupied state at $T=0K$. At $T > 0K$, some of the excited states become occupied according to the Boltzmann distribution. When the electrons make a transition from the excited state to the ground state light is emitted. This process is called luminescence or phosphorescence.

- (a) Look up the bandgaps of the semiconductors GaAs and GaP. (Give your reference)
- (b) Which of these two materials can be used to make a visible LED? What colour is the LED?

4. Lasers

- (a) If laser action occurs by the transition from an excited state to the ground state, $E_1 = 0$, and if it produces the wavelength of 590 nm wavelength, what is the energy level of the excited state in eV?

- (b) Transition occurs between a metastable state E_3 and energy state E_2 , just above the ground state. If emission is at $1.06 \mu\text{m}$, and if E_2 is $0.3 \times 10^{-19} J$, what is the energy of the E_3 state in eV?