EP1108 - 2021
Assignment - Lasers and Plasmas

1) Consider a gas laser which has a wavelength of 6328Å in vacuum. The upper level has a lifetime of $10^{-10}s$ under spontaneous decay. Take the refractive index of the lasing medium to be $n_0 = 1$
i) Calculate the energy gap between the 2 lasing energy levels in eV
ii) Calculate the Einstein A and B coefficients
iii) Suppose the cavity length of the optical resonator is 20cm. Neglecting Doppler/thermal broadening, calculate how many resonant modes will be present in the laser beam

2) Consider a diode laser which has an output wavelength of 650nm and refractive index of 3.5.
i) Suppose the laser has a resonant cavity itself of length 2cm and a cross-sectional area of 0.04cm^2. It has one side completely reflective, the other side has 95% reflectivity. The laser light has an intensity of 10mW/m^2. Estimate the number of stimulated photons present in the resonant cavity during steady-state operation
ii) How much power is needed to run this diode laser (assuming no thermal losses)?

3) Consider an ionized gas which has number density 10^{12}cm^{-3} and temperature of 1000K. Can this be considered a plasma?

4) A dye laser can tune its wavelengths to 407nm and 457nm. To use this for beat-wave acceleration, what plasma density is required? What is the maximum energy to which electrons can be accelerated to with this setup?