

所別： 光電類

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科目： 近代物理

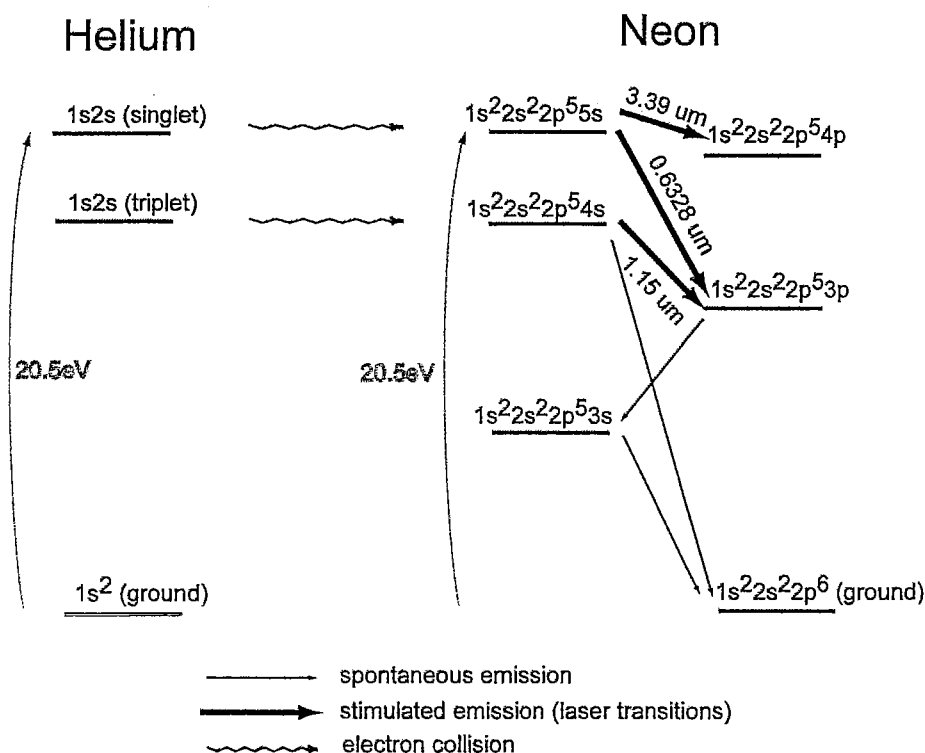
Boltzmann constant $k=8.617 \times 10^{-5} \text{ eV/K}$

Electron mass $m_e=0.511 \text{ MeV}/c^2$

Planck's constant $h=4.136 \times 10^{-15} \text{ eV} \cdot \text{s}$

*計算題需計算過程，無計算過程者不予計分

1. (10 pts) Helium and Neon are noble gases containing only one atom per molecule. The excited states of the He and Ne atoms (simplified) of He-Ne laser operation is shown in Fig. 1. States are labeled by the orbital configuration of the electrons. Can we have the emission from $1s^2 2s^2 2p^5 5s$ to $1s^2 2s^2 2p^5 4s$? If YES, what is the emission wavelength? If NO, explain your reasoning.



2. (10 pts) A monochromatic light impinges on a metal with a work function of 1.8 eV . Calculate the maximum speed of the photon-induced electron (unit in m/sec).

注意:背面有試題

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3. (10 pts) A free-electron with a kinetic energy of 10 eV. Assume that we can measure the speed of the electron with an accuracy of 1.0%. Evaluate the accuracy of the measured position of the electron (unit in nm).
4. (10 pts) Assume there is $2.5 \times 10^{25}/\text{m}^3$ atomic hydrogen atoms in one cubic meter.
Find the number of these atoms in their 1st excited states at 1×10^4 °C based on the Maxwell-Boltzmann statistics.
5. (10 pts) The index of refraction of a crown glass can be approximation by $n(\lambda) = 1.5255 + (4825 \text{ nm}^2)/\lambda^2$. Calculate the group velocity of light at $\lambda = 500 \text{ nm}$.
6. (20 pts) Considering that a person on a space station observes a particle moving at a velocity with x and y components $V_x = V_y = -V_0$. The rest mass of the particle is m_0 . If another spaceship moves along the x axis with a velocity V_0 relative to the space station, what is the velocity, momentum, kinetic energy, and energy of the particle observed in the spaceship?
7. If a hydrogen atom is at 2nd excited state,
(5 pts) (a) Estimate the kinetic energy using uncertainty principle.
(10 pts) (b) Draw the spatial distribution of the largest possible orbital angular momentum and the corresponding magnetic moment based on Bohr's model and Schrodinger equation. All the magnitudes of angular momentum and magnetic moment needs to be calculated and indicated in the drawing.
8. (5 pts) If light passes through a non-absorbing thin film with refractive index n in the air, find out the condition of the film thickness to minimize the reflectance.
9. (10 pts) For two metals with free electron densities of $8.47 \times 10^{28}/\text{m}^3$ and $5.9 \times 10^{28}/\text{m}^3$, respectively, which one has a higher Fermi energy? Calculate the average speed of the conductive electron in this metal at $T=300 \text{ K}$.