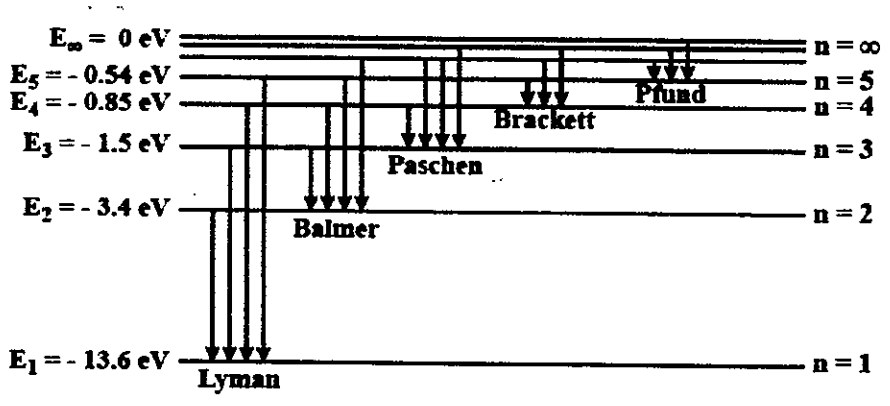
1. This question is based on the theory of Relativity. The first spacecraft is moving at the 0.9C with respect to the Earth. C is the speed of the light in a vacuum. The second spacecraft is to pass the first spacecraft at the speed of 0.3C in the same direction.
   (a) Can the second spacecraft travel faster than the light? (3 points)
   (b) What is the speed of the second spacecraft with respect to the Earth? (7 points)

2. This question is based on the photoelectric effect. Light of wavelength 350 nm and intensity of 1 W/m^2 is directed at a potassium surface. The work function of potassium is 2.2 eV. The Plank 's constant is 6.626×10^{-34} J·s or 4.136×10^{-15} eV·s
   (a) Is this a visible light? (3 points)
   (b) Only 1% of the incident photons produce photoelectrons, how many are emitted per second if the potassium surface has an area of 1 cm^2 ? (7 points)

3. This question is based on the de Broglie wave theory. An electron has a de Broglie wavelength of 2×10^{-12} m. The rest energy of the electron is 511 keV. Please find
   (a) its kinetic energy? (5 points)
   (b) its group velocity? (5 points)

4. Please describe the characteristics of the LASER (Light Amplification by Stimulated Emission of Radiation) and how to produce this kind of light. (10 points)

5. The question is based on a hydrogen atom shown below. Please calculate the second line of the Balmer series predicted by Bohr's model. (10 points)



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6. A sample is placed in a 0.3-T magnetic field and suitably excited. How far apart are the Zeeman component of the 450-nm spectral line of the element? (10 points)

7. Find the possible values of the total angular-momentum quantum number J under LS coupling of two atomic electrons whose orbital quantum numbers are $l_1 = 1$ and $l_2 = 2$. (10 points)

8. Draw the schematic diagram and illustrate the operation principles of Josephson junction and SQUID. (10 points) Write the full name of SQUID. (5 points)

9. The ionization potential of sodium is 5.14 eV, the electron affinity of fluoride is 3.40 eV, and the equilibrium separation of sodium fluoride is 0.193 nm. (a) how much energy is needed to form Na^+ and F^- ions from neutral sodium and fluoride atoms? (5 points) (b) the dissociate energy of NaF is 4.99 eV. What is the energy due to the repulsion of the ions at the equilibrium separation? (10 points) Coulomb constant is 9×10^9 Nm^2/C^2, and fundamental charge is 1.6×10^{-19} C.

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