所別：太空科學研究所碩士班　　科目：近代物理

1. Consider two inertial reference frames S' and S. The frame S' moves with speed v relative to frame S. When an observer in each frame measures the following quantities,
   (a) The distance between two events. (5%)
   (b) The speed of light. (5%)
   (c) The time interval between two events. (5%)
   Which measurements made by the two observers yield the same results? You must use the space-time diagram or Lorentz transformation to explain your reason for each answer.
2. Consider two particles, each with the rest mass m. Before the collision between the two particles, in the inertial reference frame S, the particles are moving toward each other, with speeds u. After a totally inelastic collision, the system of the two particles with the total rest mass M is at rest in the frame S. The same events as seen in inertial reference frame S' moving at speed u relative to frame S, so that one of the initial particles is at rest. (a) In frame S', what is the initial speed of the other particle? (10%)
   (b) After the collision, in frame S', what are the final momentum and the rest mass of the system? (20%)
   (c) After the collision, in frame S, what is the rest mass of the system? (5%)
3. (a) Why is it extremely difficult to observe the Compton effect using visible light? (10%)
   (b) What is the energy of a photon whose wavelength is equal to the Compton wavelength of the electron? (10%)
   (Note that the electron mass $m_e = 9.11\times10^{-31} kg$, Planck's constant $h = 6.626\times10^{-34} J.s$)
4. An electron moving in a thin metal wire d=0.1 cm long. The potential inside the wire is constant on the average, but rises sharply at each end.
   (a) If the electron's energy is equal to the average kinetic energy of molecules in a gas at T=300K, what is the electron's quantum number n? (10%)
   (b) If the electron is in its ground state. What would be the probability of finding it somewhere in the region d/4<x<d. (10%)
   (Note that the Boltzmann's constant $k = 1.38\times10^{-23} J/K = 8.617\times10^{-5} eV/K$)
5. What is Bose-Einstein condensation? (10%)