所別：大氣物理研究所碩士班 不分組 科目：近代物理學

1. A clock is placed in a satellite that orbits Earth with a period of 95 minutes. By what time interval will this clock differ from an identical clock on Earth after 3 years? (Assume special relativity applies) (10%)
2. At what value of the speed does the measured mass of a particle exceed its rest mass by 20%? (10%)
3. Compute the force exerted on the palm of your hand by the beam from a 100 W flashlight if the light reflects from your hand. What would be the mass of a particle that exerts the same force if you hold it at Earth's surface? (10%)
4. The energy reaching Earth from the sun at the top of the atmosphere is $1500 W/m^2$. Assuming that the Earth radiates like a blackbody at uniform temperature, and at thermal equilibrium. What is the temperature of Earth? (10%)
5. (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 proton? (5%)
6. By using the Bohr model of the hydrogen, compute the radius of the n=10 orbit in singly ionized helium (He^+). (10%)
7. A free particle moves back and forth between rigid walls separated by a distance L.
   (a) Show that the allowed values of the de Broglie wavelength are given by $\lambda = 2L/n$ where n is a positive integer. (5%)
   (b) Derive a general expression for the allowed kinetic energy of the particle. (5%)
8. An electron moving in a thin metal wire L=1.0 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 0<x<L/4. (10%)
9. Given three containers all at the same temperature, one filled with a gas of classical molecules, one with a fermion gas, and one with a boson gas, which will have the highest pressure? (5%)

Useful constants:

Stefan's constant $\sigma = 5.67\times10^{-8} W/m^2K^4$

Boltzmann's constant $k = 1.38\times10^{-23} J/K = 8.617\times10^{-5} eV/K$

proton mass $m_p = 1.67\times10^{-27} kg$, electron mass $m_e = 9.11\times10^{-31} kg$

Bohr radius $a_0 = 0.053nm$

Planck's constant $h = 6.626\times10^{-34} J.s$