所別：大氣物理研究所碩士班　　科目：近代物理學

1. Two events occur at points x_1 and x_2 in the x axis at the same time t in the inertial reference frame S. In reference frame S' moving along x axis at speed v relative to frame S.

   (a) What is the spatial separation of these evens measured in frame S'? (10%)

   (b) What is the time interval of these events measured in frame S'? (10%)

2. In an inertial reference frame S, suppose two photons, one with energy 5 MeV and the second with energy 3 MeV, approach each other along the x axis. (a) What is the rest energy of this system? (10%) (b) In another inertial frame S' moving along the x axis at the speed v relative to frame S, what is the rest energy of the system of the two photos? (10%)

3. Planck's law, expressed in terms of the frequency f, for the energy density distribution function $u(f)$ of the radiation in the cavity $u(f)=\frac{8\pi hc^{-3}f^3}{e^{hf/kT}-1}$. The energy reaching Earth from the sun at the top of the atmosphere is 1500W/m^2. Assuming that Earth radiates like a blackbody at uniform temperature, and at thermal equilibrium.
   (a) What is the temperature of Earth? (10%)
   (b) Find the peak of the spectrum of the thermal radiation of Earth? (10%)
   (Note that, Boltzmann's constant $k=1.38\times10^{-23}J/K=8.617\times10^{-5}eV/K$,
   Planck's constant $h=6.626\times10^{-34}J.s$, Stefan's constant $\sigma=5.67\times10^{-8}W/m^2K^4$)

4. Why doesn't the energy of the hydrogen atom depend on the orbital quantum? (5%)

5. A hydrogen atom is in a state with quantum numbers, principal quantum number $n=4$, orbital quantum number $l=3$. (a) What are the possible values of the total angular momentum quantum number j? (5%) (b) What are the possible values of the magnitude of the total angular momentum? (5%) (c) What are the possible z components of the total angular momentum? (10%)

6. Consider a particle moving in a two-dimensional space defined by $V(x,y)=V_0$ for $-\frac{l}{2}<x<\frac{l}{2}$ and $-\frac{l}{2}<y<\frac{l}{2}$, and V=∞ elsewhere. (a) Write down the eigenstates for the particle in this well. (10%) (b) Find the expression for the corresponding energies. (5%)