Modern Physics
Problem Set 4

JC-19) **Work Function**
(10 points) Metal 1 has a larger work function than metal 2. Both are illuminated with the same short-wavelength ultraviolet light. Do photoelectrons from metal 1 have a higher speed, lower speed or the same speed as photoelectrons from metal 2? Justify your answer.

JC-20) **Orbiting Space Shuttle**
(10 points) The orbiting space shuttle moved around Earth well above 99 percent of the atmosphere, yet it still accumulated an electric charge on its skin due, in part, to the loss of electrons caused by the photoelectric effect with sunlight. Suppose the skin of the shuttle were coated with Ni, which has a relatively large work function $\phi = 4.87$ eV at the temperatures encountered in orbit. What is the maximum wavelength in the solar spectrum that could result in the emission of photoelectrons from the shuttle's skin?

JC-21) **Finding Plank's Constant from Data**
(10 points) The work function of a tungsten surface is 5.4 eV. When the surface is illuminated by a light of wavelength 175 nm, the maximum photoelectron energy is 1.7 eV. Find Plank's constant from these data.

JC-22) **Cosmic Microwave Background**
The cosmic microwave background radiation is a thermal radiation left over from the big bang. It fills the observable universe almost uniformly. The cosmic microwave background has a thermal blackbody spectrum at a temperature of 2.7 K.

a) (10 points) What is the wavelength at the maximum intensity of the spectrum of the background radiation?
b) (10 points) What is the total power incident on Earth from the background radiation?

JC-23) **Plank's Constant**
(10 points) If Plank's constant were smaller than it is now, would quantum phenomena be more or less conspicuous than they are now? Justify your answer.

JC-24) **The Sun's Radiation**
The wavelength of maximum intensity of the sun's radiation is observed to be near 5×10^2 nm. Assume Earth to be a blackbody.

a) (5 points) Calculate the sun's surface temperature.
b) (5 points) Calculate the power per unit area emitted from the sun's surface.
c) (10 points) Calculate the energy received by Earth each day from the sun.