

PHYS-3301 Homework 10 Due 20 Nov 2013

This homework is due in the dropbox outside 2L26 by 11:59PM on the due date. If you wish to turn it in ahead of time, you may email a PDF or give a hardcopy to Dr. Frey.

1. **Photo-Production of Electrons and Positrons** *Based on a problem by J. D. Jackson*

The universe is filled with photons left over from the Big Bang which have a typical energy 2.5×10^{-4} eV. This is called the cosmic microwave background (CMB) radiation. Suppose another photon of energy E hits a typical CMB photon head-on. What is the minimum value of E required for the two photons to produce an electron-positron pair? Electrons and positrons have mass $m = 0.5 \text{ MeV}/c^2$.

2. **Reflected Sound** *based on Barton*

Consider a police car situated to the left of a large tractor-trailer truck. The sound of the police siren reflects off the back of the truck and back to the police officer. In the police car's frame, the initial sound frequency is ω . In the two situations below, what is the frequency of the reflected wave that the police officer hears? *Hint:* In the rest frame of the reflecting surface, the reflected sound wave has the same frequency as the incident sound wave.

- (a) In a frame with no wind, the police car moves at speed $u < c_s$ toward the truck, which is stationary.
- (b) In a frame with no wind, the truck moves at speed $u < c_s$ toward the police car, which is stationary. If your answer is different than the previous part, explain.