

HOMEWORK 3
(due Tues. Feb.21)

Read: Finish reading the Lightman selection on relativity. Read Feynman, Chapters 1 (to acquaint yourselves with the atomic/molecular theory of matter) & 4 (read this carefully; energy is fundamental to all we will discuss after $E=mc^2$).

Problems: (Problems are to be handed in at the due date.)

1. The charged pion (π^+) decays into other particles. It has an average decay time of 2.6×10^{-8} sec.
 - a. If a π^+ is travelling in a lab at $0.9999c$ what is its average decay time?
 - b. How far does it travel before decaying (on the average)?
 - c. The π^+ turns into three particles (usually muon and 2 neutrinos) when it decays. Suppose the muon is produced along the direction of the π^+ motion and has a velocity of $0.99c$ **in the π^+ rest frame**. What is the muon velocity in the lab?
2. Judy and Andy are twins. Judy gets on a rocket that goes to a star system 20 light years away from earth (as measured from earth, i.e. Andy's frame of reference).
 - a. She travels at $0.8c$. How many years does it take her to reach the star according to Andy?
 - b. What will Judy's clock read when she reaches the star?
 - c. What distance will Judy have measured (in light years)?
 - d. When Judy reaches the star she sends Andy a radio message announcing her clock reading. When does the signal reach Andy according to his clock?
3. In nuclear fission of Plutonium239 about $1/2000$ of the mass-energy is converted to radiation and kinetic energy of the fission fragments.
 - a. What is the gram molecular weight of Pu239? How many Pu239 nuclei are in 10 moles (or in the equivalent of 10 gram molecular weights)?
 - b. What is the mass of one Pu239 nucleus? What is the rest energy?
 - c. For one such fission how much energy is converted in units of Joules?
 - d. When 10 moles undergo fission how much energy is converted?
4. Estimate the amount of electricity or electrical power that is consumed in the greater Boston area. (Show your reasoning clearly.) How much mass would have to be converted to energy in order to supply that electrical power?



S. Dali, The Persistence of Memory