

ELEMENTARY PARTICLE PHYSICS

WS 2016/2017: Exercise sheet 1

1. In the so-called Heaviside unit system the electromagnetic fine structure constant α is given as $\alpha = e_H^2/(4\pi\hbar c)$. Here, the elementary electric charge in the Heaviside system, e_H , is related to the one in the MKSA (SI) system as $e_H^2 = e_{SI}^2/\epsilon_0$ with $e_{SI} = 1.6 \star 10^{-19}C$ and $\epsilon_0 = 8.854 \star 10^{-12}C^2/(Nm^2)$. What do you get for α and for Coulomb's law in a system with $\hbar c = 1$?
2. In its proper time frame the μ has a life time of $2.2 \star 10^{-6}$ sec. How fast does it have to fly to survive a distance of 600 m ? How long does that take in the lab frame ?
3. Show that the decay $\gamma \rightarrow e^+e^-$ of a free photon is not possible kinematically.
4. Compute the center of mass energy \sqrt{s} , $s = (p_1 + p_2)^2$ in an e^+e^- collision
 - a) in a (hypothetical) fixed target experiment (e^- at rest)
 - b) and in a collider ($E(e^+) = E(e^-)$)

What beam energy $E(e^+)$ is needed in both cases to create a particle with mass $m = 90$ GeV ?