Recitation IV

1) A muon $\mu$ with rest mass $m_\mu = 105.5 \text{MeV}/c^2$ and a total energy $E_\mu = 150 \text{MeV}$ decays into an electron ($m_e = 0.511 \text{MeV}/c^2$) and a non-detected particle $X$. The electron is emitted at right angle from the direction of the muon with a laboratory energy $E_e = 37.1 \pm 0.1 \text{MeV}$. What is the mass of the unknown particle?

2) The mass of the Earth is $M_{\text{Earth}} = 6 \times 10^{24} \text{kg}$, the mass of the Moon is $M_{\text{Moon}} = 7.3 \times 10^{22} \text{kg}$ and the distance between them is $D = 365 \times 10^6 \text{m}$. What is the mass of the Earth Moon system (take a circular orbit of the Moon around the Earth, $G = 6.67 \times 10^{-11} \text{N m}^2\text{kg}^{-2}$)?

3) The mass of the Sun is $M_{\text{Sun}} = 2 \times 10^{30} \text{kg}$, its radius is $R_{\text{Sun}} = 7 \times 10^8 \text{m}$ and its surface temperature is $T_{\text{Sun}} = 6000 \text{ }^\circ\text{K}$. The Sun is powered mostly by the nuclear reaction $H_2 + H_3 \rightarrow He_4 + n$. The masses of the elements appearing in this reaction are $m_{H_2} = 2.014102u$, $m_{H_3} = 3.016049u$, $m_{He_4} = 4.002602u$ and $m_n = 1.008665u$. ($N_A = 6.02 \times 10^{23}$)

a) How much power is radiated by the Sun?

b) How much energy is released by the nuclear reaction?

c) How many reactions per second are needed to account for the Sun power?

d) Estimate an upper limit for the Sun live time?