PHYSICS 161

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Text: Gravitation: Hartle
Homework no. 2
Due: Tue. Feb . 7

1

The free neutron decays into a proton, an electron, and an anti-neutrino (of negligible rest mass) according to the reaction:

$$n \rightarrow p + e^{-} + \nu$$

known as beta decay. Is it possible for the total kinetic energy of the decay products to equal 0.781 MeV? Explain your answer. Note the rest mass energies $m_p c^2$=938.271 MeV, $m_e c^2$=0.510998 MeV, and $m_n c^2$=939.565 MeV.

2

Hartle 5-4

3

Hartle 5-6

4

Hartle 5-9

5

The first step of hydrogen burning in the core of the sun is given by the fusion of two protons into a Deuteron according to the reaction

$${}_1H^1 + {}_1H^1 \rightarrow {}_1H^2 + e^{+} + \nu$$

where ${}_1H^1$ and ${}_1H^2$ represent the proton and the Deuteron, where the Deuteron consists of a bound proton and neutron. The rest-mass energy of the Deuteron is given by

$$m_D c^2 = m_p c^2 + m_n c^2 - B_D$$

where B_D is the binding energy of the Deuteron. Assuming the motions of the particles are non-relativsitic, and assuming B_D=2.22 MeV, compute the amount of energy released by this interaction. Note, you can assume the rest-mass of the neutrino is zero in this calculation.