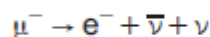# A level Physics B

H557/02 Scientific literacy in physics

Question Set 6

1   This question is about muon decay. Muons are charged leptons. They are formed by cosmic rays interacting with the upper atmosphere.

The decay equation of a negative muon, μ^- is:

$$\mu^- \to e^- + \bar{\nu} + \nu$$

where $\bar{\nu} + \nu$ represent an antineutrino and a neutrino respectively.

(a)   Explain how the decay equation shows that charge and lepton number are both conserved and name one other property that is conserved in the decay.

[3]

(b)   The maximum total energy of the particles formed from the muon is about 106 MeV.

Show that this suggests that the mass of the muon is about 200 times that of an electron.

[3]

(c)   Muons travel through the atmosphere at 98% of the speed of light.
The half-life of a muon at rest is about 1.5×10^{-6} s.

Show that about 0.0005% of the original muons will remain after travelling 8 km through the atmosphere, ignoring relativistic effects.

[3]

(d) i   In a measurement it is found that about 9% of the muons remain after travelling through 8 km of atmosphere.

Explain why a greater number of muons remain than suggested by the non-relativistic calculation in **(b)**.

[3]

(d) ii   Use your answer to **(c)** and the measured value of 9% of muons remaining after passing through 8 km of atmosphere to calculate the relativistic factor γ for the muons.

[3]

Total Marks for Question Set 6: 15

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