Question 15 **(10 marks)**

Photons with sufficient energy can, on interacting with matter, produce an electron-positron pair.

(a) (i) Show that the lepton number is conserved in such an interaction. (3 marks)

(ii) Given $E = mc^2$, determine the minimum frequency of a photon that could produce an electron-positron pair. (4 marks)

A neutron will decay into a proton and an electron as shown in the equation below.

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

(b) (i) Demonstrate that the baryon number is preserved in the way that the equation is written above but the lepton number is not. (2 marks)

(ii) Identify the third particle in the decay to ensure that the lepton number is conserved. (1 mark)