Edexcel

A Level

A Level Physics

Particle physics

Name:

M M E

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Total Marks: /30

1. In 1911 the paradigm of Thomson's 'plum pudding' model - that the atom comprised a collection of negative plums in a positive pudding - began to be challenged. Since then, particle physics has progressed significantly. This question explores the fundamental forces that are invoked in the nuclear model.

Total for Question 1: 17

(a) Calculate the density of a $^{7}_{3}Li$ atom (with a radius of 152 pm) and of its nucleus. Explain your results in the context of the nuclear model. Assume that the radius of a proton is 1.2 fm. [4]

(b) Describe an experiment that you could perform to demonstrate the key principles of the nuclear model: that the majority of a nucleus is empty space and that the centre of the atom is positively charged. [3]

(c) An ${}^{4}_{2}He^{2+}$ particle is travelling towards the nucleus of an ${}^{108}_{47}Ag$ atom. Its kinetic energy is 1.4×10^{-12} J. Calculate an upper limit for the radius of the Ag nucleus. Why is it an upper bound? [3]

(d) Calculate the gravitational attraction and the electrostatic repulsion between the two protons in a helium nucleus, which are separated by a distance of approximately 10^{-15} m. [4]

(e) It should be clear that a third force is required to keep the protons together. Describe the nature of this force and illustrate its variation with distance. [3]

2. This question will asses your knowledge of the classification of particles and of the transformations that can take place between these classes.

Total for Question 2: 13

(a) In the quark-lepton model, all particles can be classified as either leptons, mesons, baryons or photons. Give an example of a lepton, a meson and a baryon and, for those that are not fundamental particles, state what they are made of. [3]

(b) Express the β^+ decay equation in terms of the transformation of hadrons and leptons. [2]

(c) Express the β^- decay equation in terms of the transformation of fundamental particles. [2]

(d) State the charges on the following quarks and their antiparticles. [2]

i. Up

ii. Strange

(e) By considering the charge of the individual quarks involved, show that the net charges of a proton and an anti-proton are of equal magnitude but opposite polarity. [1]

(f) Muons are created by cosmic rays high in the atmosphere (at altitudes of about 15000 m) and should have a lifetime of approximately 2 μs. Briefly explain why a muon, with a velocity of 29.8 cmns^{-1}, can be observed at sea level. [3]