AQA

A Level

A Level Physics

Particles

Name:

M M E

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Total Marks: /30

1. This question explores the fundamental forces that are invoked in the standard model and that act at the quantum level.

Total for Question 1: 10

(a) State the three fundamental interactions that are described by the Standard Model. [2]

(b) Describe the nature of the strong nuclear force and sketch a graph to show its variation with distance. [4]

(c) Explain the repulsion between two positively charged particles in terms the quantum-scale interactions and exchange particles. [2]

(d) Calculate the wavelength of a 5.0 MeV photon. [2]

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: 14

(a) In the Standard Model, all particles can be classified as either leptons, mesons, baryons or photons. Give an example of a lepton and a baryon and, if either 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. [3]

i. Up

ii. Strange

iii. Down

(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]

3. Reactions and interactions can be represented by both equations and diagrams. Just as in classical Newtonian mechanics, there are conservation laws that can be used to ascertain whether a certain reaction can take place.

Total for Question 3: 6

(a) State the quarks that a K^+ particle is made from. [1]

(b) K^+ decays via the weak interaction to produce three pions. Which pions are produced? [1]

(c) Show that strangeness is not conserved in this reaction. [1]

(d) Sketch a Feynman diagram to illustrate the reaction below. The exchange particle for this reaction is the W^- particle. [3]

$$\mu^- \longrightarrow e^- + \bar{\nu}_e + \nu_\mu$$