InkPhysics

QUESTION WORKBOOK

Classification of particles

Particles · Year 12

AQA 3.2.1.5 · CIE 11.2.6 · OCR A 6.4.2(c), 6.4.2(d)

20 questions · 55 marks

PRINT EDITION

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SECTION A · Warm-up

A1 State the two groups into which particles are classified according to whether they experience the strong interaction, and identify which group does. [2]

A2 Distinguish between a baryon and a meson. [2]

A3 Give two examples of leptons. [2]

A4 State the number of quarks in a baryon and in a meson. [1]

A5 The strong nuclear force between nucleons is carried by an exchange particle. Name this particle and state the class of hadron to which it belongs. [2]

A6 State what a kaon decays into, and name the interaction responsible for the decay. [2]

SECTION B · Standard

B1 State the baryon number of a baryon, an antibaryon and a meson, and explain how baryon number is used. [3]

B2 State the lepton number of an electron, a positron and an electron antineutrino. [3]

B3 A free neutron decays: $n \rightarrow p + e^{-} + \text{anti-}\nu_e$. Show that this decay conserves both baryon number and lepton number. [4]

B4 Describe how strange particles are produced and how they decay, and state what this implies about strangeness. [3]

B5 A muon decays by $\mu^- \rightarrow e^- + \text{anti-}\nu_e + \nu_\mu$. Show that both electron lepton number and muon lepton number are conserved in this decay. [3]

B6 A student claims that the muon must be a meson because its mass lies between the mass of the electron and the mass of the proton. Explain why the muon is in fact a lepton. [3]

B7 Explain why the proton is the only stable free baryon. [3]

B8 State two differences between a kaon and a pion. [2]

SECTION C · Stretch

C1 A proposed interaction is $p + e^- \rightarrow n + \nu_e$. By checking charge, baryon number and lepton number, state whether it is allowed. [4]

C2 Classify each of these particles as a baryon, a meson or a lepton: proton, pion, muon, neutron, electron neutrino. [3]

C3 State two properties that distinguish a lepton from a hadron. [3]

C4 In a cosmic-ray experiment a new particle X is observed. X is only ever created together with a second new particle, in collisions that occur on strong-interaction timescales, but X decays into pions comparatively slowly, with a lifetime of about 10^{-10} s. Deduce, with reasons, whether X is a strange particle, and name the interaction by which it decays. [4]

C5 Explain why the interaction $\nu_\mu + n \rightarrow e^- + p$ is never observed, even though it conserves both charge and baryon number. [3]

C6 A particle has baryon number 0, charge −1 and strangeness 0, and it experiences the strong interaction. Deduce its classification, and name a particle it could be. [3]