3.8 Nuclear Physics: 10-minute Pack

AQA 7408 · Calculator allowed · about 10 minutes

Total Marks

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 A cobalt-60 source (proton number 27) used in radiotherapy decays by β-minus emission to an excited nucleus of nickel-60, which subsequently decays to its ground state by emitting γ radiation.

(a) Determine the proton number and nucleon number of the nickel nucleus formed by this β-minus decay, and write a balanced nuclear equation for the decay, including the antineutrino. **(3)**

(b) Explain why the nickel-60 nucleus produced is described as 'excited', and state how it loses its excess energy. **(2)**

(c) State why the emission of a γ photon does not change the proton number or nucleon number of the nucleus, and state why γ radiation, unlike α and β particles, is not deflected by electric or magnetic fields. **(3)**

(Total for Question 1 is 8 marks)

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Mark scheme · 3.8 Nuclear Physics: 10-minute Pack

Question 1

(a) proton number of nickel nucleus = 28 **B1**

(a) nucleon number of nickel nucleus = 60 (unchanged by β-minus decay) **B1**

(a) correct equation: ^60_27 Co -> ^60_28 Ni + ^0_-1 e + antineutrino$_e$ (allow β^- symbol for the electron) **B1**

(a) Answer: ^60_27 Co -> ^60_28 Ni + ^0_-1 e + antineutrino$_e$

(b) the nucleus is produced with excess (internal) energy, i.e. it is not in its lowest possible energy state (ground state), oe **B1**

(b) it loses this excess energy by emitting one or more γ-ray photons as it de-excites to the ground state, oe **B1**

(b) Answer: The nucleus has excess internal energy above its ground state; it loses this energy by emitting γ-ray photon(s).

(c) a γ photon is electromagnetic radiation (energy) with no mass and no charge, not a particle made of nucleons, so its emission does not alter the proton or nucleon number, oe **B1**

(c) γ radiation carries no (electric) charge, so it experiences no force in an electric or magnetic field, oe **B1**

(c) α and β particles are charged and are therefore deflected (in opposite senses, since they have opposite-sign charge), unlike γ, oe **B1**

(c) Answer: Gamma photons carry no charge and no nucleons, so proton/nucleon numbers are unchanged and γ is undeflected by fields, unlike the charged α and β particles.

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