3.2 Particles and Radiation: 10-minute Pack

AQA 7408 · Calculator allowed · about 10 minutes

Total Marks

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 The specific charge of a particle is used to compare how strongly different particles respond to electric and magnetic fields.

(a) State what is meant by the specific charge of a particle. **(1)**

(b) Calculate the specific charge of a proton. Mass of proton = 1.673×10^{-27} kg, charge of proton = 1.60×10^{-19} C. **(2)**

(c) An α particle consists of 2 protons and 2 neutrons bound together, with mass of neutron = 1.675×10^{-27} kg. Calculate the specific charge of an α particle. **(3)**

(d) A hydrogen nucleus (a single proton) has a greater specific charge than an α particle, even though the α particle carries twice the charge of a proton. Explain why this is the case, without further calculation. **(2)**

(Total for Question 1 is 8 marks)

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Mark scheme · 3.2 Particles and Radiation: 10-minute Pack

Question 1

(a) the charge of a particle divided by its mass (charge-to-mass ratio) oe **B1**

(a) Answer: Specific charge = charge / mass of the particle.

(b) correct substitution: specific charge = $1.60 \times 10^{-19} / 1.673 \times 10^{-27}$ **M1**

(b) 9.56×10^{7} C/kg (awrt, cao) **A1**

(b) Answer: 9.56×10^{7} C/kg

(c) total mass = $2(1.673 \times 10^{-27}) + 2(1.675 \times 10^{-27}) = 6.696 \times 10^{-27}$ kg **M1**

(c) total charge = $2 \times 1.60 \times 10^{-19} = 3.20 \times 10^{-19}$ C, and specific charge = charge/mass correctly substituted **M1**

(c) 4.78×10^{7} C/kg (awrt, ft from their total mass) **A1**

(c) Answer: 4.78×10^{7} C/kg

(d) the α particle's mass is about 4 times the proton's mass (2 protons + 2 neutrons vs 1 proton), while its charge is only 2 times the proton's charge **B1**

(d) since specific charge = charge/mass, the proportionally much larger increase in mass than in charge results in a smaller specific charge for the α particle oe **B1**

(d) Answer: The α particle's mass increases by a factor of about 4 while its charge only increases by a factor of 2, so its charge-to-mass ratio (specific charge) is smaller than the proton's.

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