InkPhysics

ANSWER BOOK

Constituents of the atom

Particles · Year 12

AQA 3.2.1.1 · CIE 11.1 · OCR A 6.4.1

10 questions · 29 marks

NAVY EDITION

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SECTION A · Warm-up

A1 Proton: charge $+1.60 \times 10^{-19}$ C, relative mass 1. Neutron: charge 0, relative mass 1. Electron: charge -1.60×10^{-19} C, relative mass about 1/1836. [2]

A2 Specific charge = Q/m = $(1.60 \times 10^{-19})/(1.67 \times 10^{-27}) = 9.58 \times 10^{7}$ C kg^{-1}. [2]

A3 Isotopes are atoms of the same element (same number of protons, same Z) that have different numbers of neutrons, and so different mass numbers A. [2]

SECTION B · Standard

B1 Specific charge = $(1.60 \times 10^{-19})/(9.11 \times 10^{-31}) = 1.76 \times 10^{11}$ C kg^{-1}. This is far larger than the proton's, because the electron has the same magnitude of charge but a much smaller mass. [3]

B2 Protons: 6 (Z = 6). Neutrons: A − Z = 14 − 6 = 8. The neutral atom has 6 electrons. [3]

B3 Charge = 2e = 3.2×10^{-19} C, mass ≈ $4 \times 1.67 \times 10^{-27} = 6.68 \times 10^{-27}$ kg. Specific charge = 4.79×10^{7} C kg^{-1}. [3]

B4 Charge = $2 \times 1.60 \times 10^{-19} = 3.2 \times 10^{-19}$ C. Mass ≈ $16 \times 1.67 \times 10^{-27} = 2.67 \times 10^{-26}$ kg. Specific charge = 1.20×10^{7} C kg^{-1}. [3]

SECTION C · Stretch

C1 Protons: 92. Neutrons: 238 − 92 = 146. Charge = 92e = 1.47×10^{-17} C. Specific charge = $(92 \times 1.60 \times 10^{-19})/(238 \times 1.67 \times 10^{-27}) = 3.70 \times 10^{7}$ C kg^{-1}. [4]

C2 Proton: $(1.60 \times 10^{-19})/(1.67 \times 10^{-27}) = 9.58 \times 10^{7}$ C kg^{-1}. Alpha: 4.79×10^{7} C kg^{-1}. The proton's is greater (about twice), because the alpha has twice the charge but four times the mass. [4]

C3 Specific charge is charge divided by mass. The electron carries the same magnitude of charge as the proton but has a mass roughly 1836 times smaller, so its charge-to-mass ratio is far larger than that of the proton or the (uncharged) neutron. [6]

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