InkPhysics

ANSWER BOOK

Conservation laws

Particles · Year 12

AQA 3.2.1.7 · CIE 11.1, 11.2 · OCR A 6.4.2

10 questions · 31 marks

NAVY EDITION

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SECTION A · Warm-up

A1 Charge, baryon number, lepton number, and energy (and momentum). Strangeness is conserved in strong interactions but not always in weak ones. [3]

A2 A down quark changes into an up quark (d → u). [2]

A3 An up quark changes into a down quark (u → d). [2]

SECTION B · Standard

B1 Charge: (+1) + (+1) = +2 → (+1) + 0 + (+1) = +2 ✓. Baryon number: 1 + 1 = 2 → 1 + 1 + 0 = 2 ✓. Both are conserved. [4]

B2 If strangeness is conserved, the interaction can proceed by the strong interaction. If strangeness changes (by ±1), it cannot be strong and must proceed by the weak interaction, which is the only one that can change strangeness. [3]

B3 Charge: 0 → (+1) + (−1) + 0 = 0 ✓. Baryon number: 1 → 1 + 0 + 0 = 1 ✓. Lepton number: 0 → 0 + (+1) + (−1) = 0 ✓. All conserved. [4]

B4 Lepton number is not conserved: the left side has 0, but the positron on the right has L_e = −1, giving −1. An electron neutrino (L_e = +1) must also be emitted to conserve lepton number. [3]

SECTION C · Stretch

C1 Charge: 2 = 1 + 0 + q_X, so q_X = +1. Baryon number: 2 = 1 + 1 + B_X, so B_X = 0. X is therefore a positive meson (for example a π^+). [4]

C2 The initial particles (π^- and p) have strangeness 0, so the total must stay 0 in a strong interaction. Since K^0 has strangeness +1, X must have strangeness −1 so that (+1) + (−1) = 0. [4]

C3 Conservation of energy and momentum are universal laws of physics that hold in all processes, not just particular interactions. Any interaction must therefore obey them, whether it is strong, weak, electromagnetic or gravitational. [3]