



QUESTION WORKBOOK

Particle interactions and exchange particles

Particles · Year 12

AQA 3.2.1.4 · OCR A 6.4.2(h), 6.4.2(k)

19 questions · 53 marks

PRINT EDITION

SECTION A · Warm-up

A1 Name the four fundamental interactions (forces). [2]

A2 Name the exchange particle responsible for the electromagnetic interaction. [1]

A3 State the exchange particles responsible for the weak interaction. [2]

A4 State the neutrino or antineutrino emitted in (a) beta-minus decay and (b) electron capture. [2]

A5 A neutron becomes a proton during an interaction, so a down quark becomes an up quark. State which fundamental interaction must be responsible. [1]

- A6** In a simple interaction diagram, state what the wavy line represents, and give the rule that must be satisfied at every junction. [2]

SECTION B · Standard

- B1** State the exchange particle associated with each of the four fundamental interactions, and identify the one that is not an established part of physics. [3]

- B2** Explain what is meant by an exchange particle, and how it accounts for a force between two particles. [3]

- B3** Describe the beta-minus decay of a neutron in terms of an exchange particle, naming the exchange particle and all the products. [4]

- B4** Describe the beta-plus decay of a proton in terms of an exchange particle and its products. [3]

- B5** A fast-moving electron collides with a proton and the interaction $e^- + p \rightarrow n + \nu_e$ occurs. Name the exchange particle, and use the charges at the two junctions to justify your choice. [3]

- B6** Two electrons approach each other and are pushed apart without touching. Name the interaction responsible and its exchange particle, and explain how you can tell that the weak interaction is not responsible. [3]

- B7** Electron capture and an electron–proton collision can both be represented by $p + e^- \rightarrow n + \nu_e$. State one similarity and one difference between the two processes, and name the exchange particle in each. [4]

- B8** Explain why the photon exchanged in an electromagnetic interaction is described as virtual. [2]

SECTION C · Stretch

- C1** Electron capture can be represented by a proton and an electron interacting to give a neutron and a neutrino. State the exchange particle involved and write the overall interaction. [4]

- C2** Explain why the weak interaction has a very short range compared with the electromagnetic interaction. [4]

- C3** State one similarity and one difference between the electromagnetic and weak interactions in terms of their exchange particles. [3]

- C4** A particle detector records two events. In event 1, a muon turns into an electron, with two neutrinos also produced. In event 2, a moving electron is deflected as it passes another charged particle, with both particles unchanged in type. Deduce which fundamental interaction is responsible for each event, naming the exchange particle involved in each. [4]

- C5** In beta-plus decay a proton becomes a neutron in two stages: $p \rightarrow n + W^+$, then $W^+ \rightarrow e^+ + \nu_e$. Show that charge is conserved at each stage. [3]