7. Scientists have recently discovered a type of particle called a pentaquark. Pentaquarks are very short lived and contain five quarks.

A lambda b (Λ_b) pentaquark contains the following quarks: 2 up, 1 down, 1 charm, and 1 anticharm quark.

(a) Quarks and leptons are fundamental particles.

(i) Explain what is meant by the term *fundamental particle*. **1**

(ii) State the name given to the group of matter particles that contains quarks and leptons. **1**

(b) The table contains information about the charge on the quarks that make up the Λ_b pentaquark.

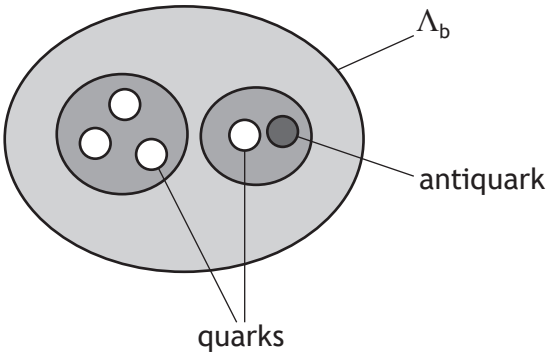
Type of quark	Charge
up	$+\frac{2}{3}e$
down	$-\frac{1}{3}e$
charm	$+\frac{2}{3}e$
anticharm	$-\frac{2}{3}e$

Determine the total charge on the Λ_b pentaquark. **2**

Space for working and answer

7. (continued)

(c) One theory to explain the structure of the Λ_b pentaquark suggests that three of the quarks group together and one quark and the antiquark group together within the pentaquark.



(i) State the type of particle that is made of a quark-antiquark pair. **1**

(ii) The mean lifetime of another quark-antiquark pair is $8{\cdot}0 \times 10^{-21}$ s in its own frame of reference.

During an experiment the quark-antiquark pair is travelling with a velocity of $0{\cdot}91c$ relative to a stationary observer.

Calculate the mean lifetime of this quark-antiquark pair relative to the stationary observer. **3**

Space for working and answer

7. (continued)

(d) The Λ_b pentaquark has a mass-energy equivalence of 4450 MeV.

One eV is equal to $1{\cdot}60 \times 10^{-19}$ J.

(i) Determine the energy, in joules, of the Λ_b pentaquark. **1**

Space for working and answer

(ii) Calculate the mass of the Λ_b pentaquark. **3**

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