6. The Standard Model explains how the basic building blocks of matter interact, governed by four fundamental forces.

(a) Name the type of particle that is composed of a quark–antiquark pair. **1**

(b) A particle known as a positive kaon (K^+) is composed of an up quark and an anti-strange quark.

(i) The negative kaon particle (K^-) is the antiparticle of the K^+ particle.

State the names of the quarks that make up the K^- particle. **1**

(ii) The W-boson is the force-mediating particle associated with the decay of kaons.

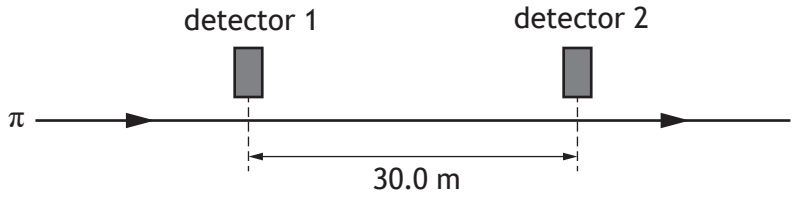
Name the fundamental force involved in the decay of kaons. **1**

6. (continued)

(c) Another particle, known as a pion (π), is a product of kaon decay.

A beam of pions, travelling in a straight line at a speed of $0.95c$, passes between two detectors.

The detectors are 30.0 m apart as measured by a stationary observer.



(i) Calculate the time taken for a pion to travel between the two detectors in the frame of reference of the stationary observer. **3**

Space for working and answer

(ii) Calculate the distance between the two detectors in the frame of reference of the pions. **3**

Space for working and answer

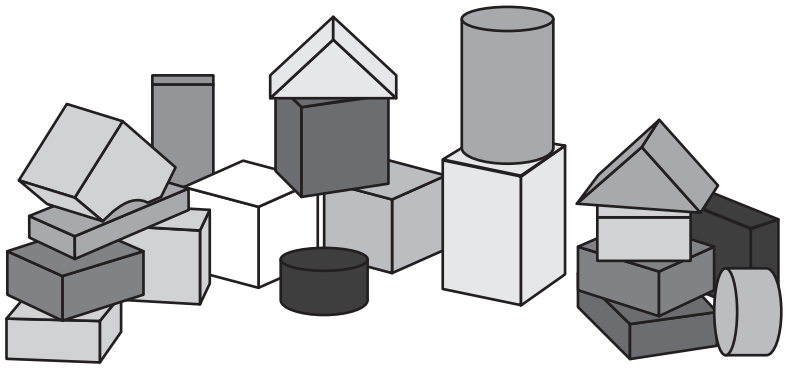
6. (continued)

(d) Pions have a mean lifetime of 26 ns in their frame of reference.

Explain why a greater number of pions are detected at the second detector than would be expected if relativistic effects are not taken into account. **1**

(e) The use of analogies from everyday life can help improve the understanding of physics concepts.

A website states that the Standard Model is like a set of children's building blocks with all sorts of different shapes and sizes, and these building blocks make up all matter.



Using your knowledge of physics, comment on this analogy. **3**

DO NOT WRITE IN THIS MARGIN

6. (e) (continued)