

SECTION B

The questions refer to the Case Study. Direct quotes from the original passage will not be awarded marks.

B6. (a) Write brief notes about **one** of the following (paragraphs 3-5).

- The Higgs boson
- Grand Unification Theories
- Dark matter and dark energy.

[3]

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(b) (i) Calculate the speed of a proton with 50 MeV of energy (paragraph 12).

[2]

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(ii) Use the same method to calculate the speed of a 7 TeV proton (paragraph 12). [1]

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(iii) Explain briefly which of your two answers (b)(i) or (b)(ii) cannot be valid.

[2]

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(c) Explain briefly the role of the liquid helium in producing strong magnetic fields (paragraph 10, 15, 24).

[2]

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- (d) (i) Assuming a typical grain of sand to be a cube, make an estimate for the length of its side and hence its volume in m^3 . [2]

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- (ii) Use your answer to (d)(i) to check whether 1.0×10^{-9} gram of hydrogen occupies the volume of a grain of sand at room temperature and pressure (10^5Pa). (paragraph 20). [3]

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- (e) Some theoretical physicists believe that the large hadron collider might destroy the planet (paragraph 18) due to the formation of tiny black holes. The event horizon of a black hole is the distance from a black hole within which nothing can escape. This distance for a black hole formed from two protons is around 10^{-54}m . Explain why such a black hole would be unlikely to pull in the whole mass of the Earth rapidly. [2]

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- (f) Explain briefly why ‘contaminating the proton tubes with soot’ would be a problem (paragraph 24). [1]

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- (g) In the novel *Angels and Demons* an anti-matter bomb is produced. Calculate the energy released by an anti-matter reaction where $3.1 \times 10^{-6} \text{ kg}$ of anti-matter is annihilated (paragraph 27). [2]

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