

2001 HIGHER SCHOOL CERTIFICATE EXAMINATION  
**Physics**

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Centre Number

**Section I (continued)**

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Student Number

**Part B – 60 marks**

**Attempt Questions 16–26**

**Allow about 1 hour and 45 minutes for this part**

Answer the questions in the spaces provided.

Show all relevant working in questions involving calculations.

**Marks**

**Question 16 (4 marks)**

Muons are very short-lived particles that are created when energetic protons collide with each other. A beam of muons can be produced by very-high-energy particle accelerators.

The high-speed muons produced for an experiment by the Fermilab accelerator are measured to have a lifetime of 5.0 microseconds. When these muons are brought to rest, their lifetime is measured to be 2.2 microseconds.

- (a) Name the effect demonstrated by these observations of the lifetimes of the muons. **1**

Traveling at or near the speed of light Dilates Time  
Time Dilation

- (b) Calculate the velocity of the muons as they leave the accelerator. **3**

proton →      ← proton

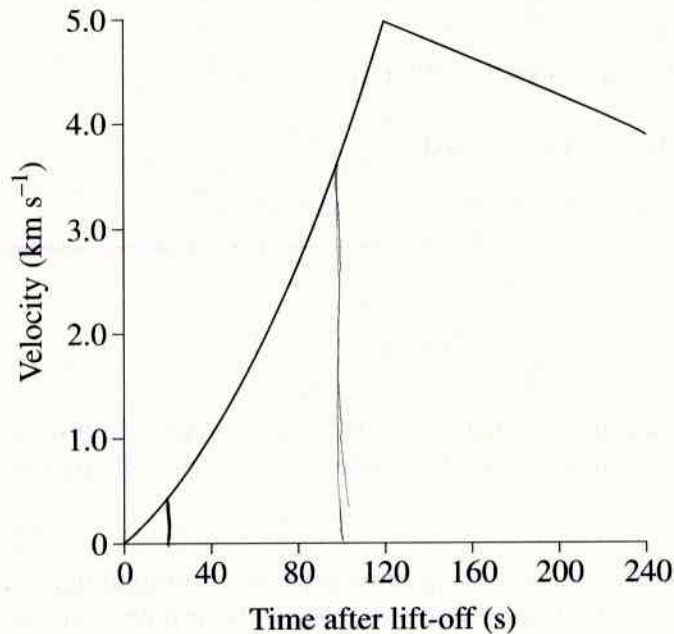
↓

muon

velocity of muon = 2 x velocity of a proton

**Question 17** (6 marks)

A rocket was launched vertically to probe the upper atmosphere. The vertical velocity of the rocket as a function of time is shown in the graph.



- (a) Using either words or calculations, compare the acceleration of the rocket at  $t = 20$  s with its acceleration at  $t = 100$  s. 2

The gradient at  $t = 100$  is slightly steeper than at  $t = 20$  & ∴ the acceleration at  $t = 100$  is greater.

- (b) Account for the shape of the graph over the range of time shown. 4

As the rocket is fired into the air it accelerates at a fairly steady rate until it reaches slightly over  $5 \text{ km s}^{-1}$  then it begins a negative acceleration back down to earth the slow fall is probably caused from a parachute.