

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

..... Time dilation .....

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

..... Actual lifetime is 2.2 microseconds, but recorded lifetime from the accelerator = 5.0 microseconds therefore they would of been travelling close to the speed of light.

..... Speed of light  $c = 3.00 \times 10^8 \text{ ms}^{-1}$  .....

.....  $2.2 \times 2.2725 \dots \dots = 5.0$  microseconds .....

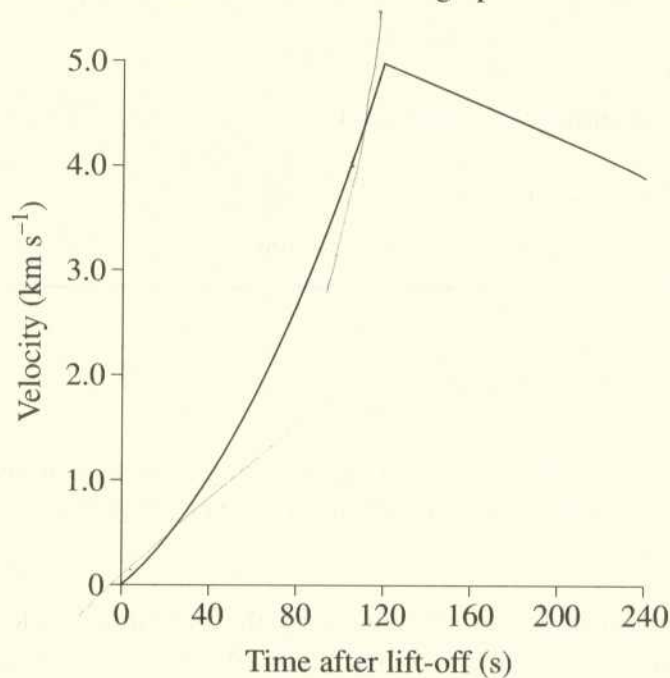
..... therefore the speed that they left the accelerator would be approx  $\frac{1}{2}$  speed of light.

.....  
.....

Marks

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

At  $t = 20$  s, the rocket is accelerating less than when  $t = 100$  s, as the gradient of the graph at  $t = 100$  s is much more steep than at  $t = 20$  s.

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

The rocket steadily increased velocity from time  $t = 0$  to time  $t = 120$  s. As the rocket's propellant is consumed. At  $t = 120$  s, the propellant is exhausted and the rocket goes into orbit as it discards the part of the rocket responsible for propulsion.