2001 HIGHER SCHOOL CERTIFICATE EXAMINATION

Physics

Centre Number

Section I (continued)

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.

2·2×

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

This effect demonstrates relativity in 2 frames of refrence

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

$t_v = \frac{t_0}{\sqrt{1-\frac{v^2}{c^2}}}$ micro = 2.2×10^{-6} s

$5 = \frac{2.2}{\sqrt{(3\times10^8)^2 - v^2}}$

$5\sqrt{c^2-v^2} = 2.2$

$\sqrt{c^2-v^2} = 0.44$

$c^2 - v^2 = (0.44)^2$

$-v^2 = (0.44)^2 - c^2$

$v^2 = c^2 - (0.44)^2$

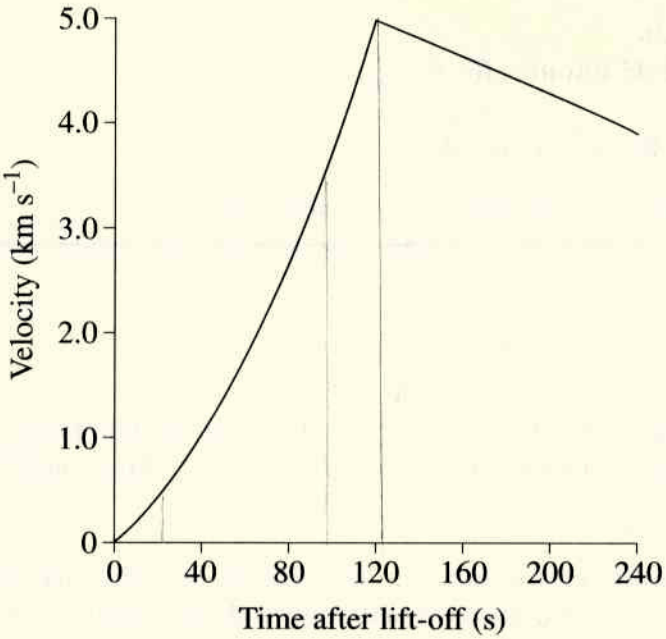
$v = \sqrt{c^2-(0.44)^2}$ $\left(\frac{2.2\times10}{5\times10} - c\right)$

$\approx 3\times10^8$ m/s

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**

The acceleration at t=100s is greater than at t=20s. The tangent at t=100s is steeper than at t=20s. The acceleration is fairly constant.

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

From the graph it is shown that for the first 120 seconds of the flight, the acceleration is the greatest, hence the most distance travelled during the first 2 minutes. However from t=120s to t=220s, the velocity is lower hence less distance is travelled.