Do not write outside the box

0 4 **Table 1** shows data of speed v and kinetic energy E_k for electrons from a modern version of the Bertozzi experiment.

Table 1

v / 10^8 m s^{-1}	E_k / MeV
2.60	0.5
2.73	0.7
2.88	1.3
2.96	2.6
2.99	5.8

0 4 . 1 Classical mechanics predicts that $E_k \propto v^2$.

Deduce whether the data in **Table 1** are consistent with this prediction.

[2 marks]

Do not write outside the box

0 4 . 2 Discuss how Einstein's theory of special relativity explains the data in **Table 1**.

[4 marks]

0 4 . 3 Calculate, in J, the kinetic energy of one electron travelling at a speed of $0.95c$.

[3 marks]

kinetic energy = _____ J

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END OF QUESTIONS

Do not write outside the box

0 4 . 1 A muon travels at a speed of $0.95c$ relative to an observer.

The muon travels a distance of 2.5×10^3 m between two points in the frame of reference of the observer.

Calculate the distance between these two points in the frame of reference of the muon.

[2 marks]

distance = _____ m

0 4 . 2 Measurements of muons created by cosmic rays can be used to demonstrate relativistic time dilation.

State the measurements made and the observation that provides evidence for relativistic time dilation.

[2 marks]

Do not write outside the box

0 4 . 3 As the muons travel through the atmosphere, their speeds are reduced by interaction with the particles in the air.

Discuss, with reference to relativity, the effect that this reduction of speed has on the rate of detection of the muons on the surface of the Earth.

[3 marks]

7

END OF QUESTIONS

Do not write outside the box

0 4 . 1 State what is meant by an inertial frame of reference.

[1 mark]

0 4 . 2 A pair of detectors is set up to measure the intensity of a parallel beam of unstable particles.
In the reference frame of the laboratory, the detectors are separated by a distance of $45\ \text{m}$. The speed of the particles in the beam is $0.97c$.

The intensity of the beam at the second detector is 12.5% of the intensity at the first detector.

Calculate the half-life of the particles in the reference frame in which they are at rest.

[4 marks]

half-life = _____ s

0 4 . 3 In calculations involving time dilation, it is important to identify proper time.

Identify the proper time in the calculation in Question **04.2**.

[1 mark]

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END OF QUESTIONS