



QUESTION WORKBOOK

The consequences of special relativity

Turning points · Year 13

AQA 3.12.3.3, 3.12.3.4, 3.12.3.5

10 questions · 29 marks

NAVY SCREEN EDITION

SECTION A · Warm-up

A1 Define the proper time between two events. [2]

A2 Define the proper length of an object. [2]

A3 Using the idea of relativistic mass, explain why no object can be accelerated to the speed of light. [2]

SECTION B · Standard

B1 A muon's lifetime in its rest frame is $2.2 \mu\text{s}$. Calculate its lifetime as measured in a laboratory it passes at $0.95c$. [3]

- B2** A spacecraft of proper length 120 m passes Earth at $0.60c$. Calculate its length as measured from Earth. [3]

- B3** Outline how the arrival of cosmic-ray muons at the Earth's surface provides evidence for time dilation. [4]

- B4** An electron (rest energy 8.2×10^{-14} J) travels at $0.98c$. Calculate its total energy. [3]

SECTION C · Stretch

- C1** A spacecraft passes Earth at $0.80c$. Its on-board clock records 60 s between two signals, and its proper length is 90 m. Calculate the time between the signals and the craft's length as measured from Earth. [4]

- C2** Describe Bertozzi's experiment and explain what it demonstrated directly. [4]

- C3** Sketch, in words, the graph of an object's mass against its speed from rest toward c . [2]