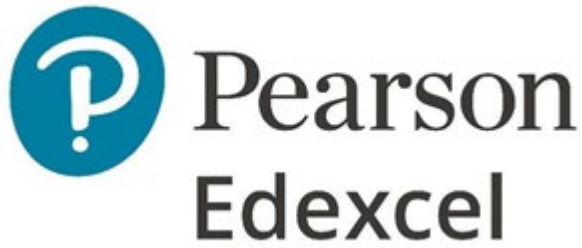

Additional Assessment Materials

Summer 2021

Pearson Edexcel GCE A Level Physics

Topic 10: Nuclear and Particle Physics

Test 1

(Public release version)

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Additional Assessment Materials, Summer 2021

General guidance to Additional Assessment Materials for use in 2021

Context

- Additional Assessment Materials are being produced for GCSE, AS and A levels (with the exception of Art and Design).
- The Additional Assessment Materials presented in this booklet are an **optional** part of the range of evidence teachers may use when deciding on a candidate's grade.
- 2021 Additional Assessment Materials have been drawn from previous examination materials, namely past papers.
- Additional Assessment Materials have come from past papers both published (those materials available publicly) and unpublished (those currently under padlock to our centres) presented in a different format to allow teachers to adapt them for use with candidate.

Purpose

- The purpose of this resource to provide qualification-specific sets/groups of questions covering the knowledge, skills and understanding relevant to this Pearson qualification.
- This document should be used in conjunction with the mapping guidance which will map content and/or skills covered within each set of questions.
- These materials are only intended to support the summer 2021 series.

1

16 A muon (μ) is a lepton with a mass of 106 MeV/c^2.

(a) Calculate the mass of a muon in kg.

(3)

Mass of muon = ... kg

(b) Muons are produced from the decay of pions in the upper atmosphere.

An example of this decay is given by the equation

$$\pi^- \rightarrow \mu^- + \bar{\nu}_\mu$$

(i) Explain how this decay obeys the laws of conservation of charge, baryon number and lepton number.

(3)

(ii) The masses of these three particles, in MeV/c^2, are given below.

π^-	μ^-	$\bar{\nu}_\mu$
140	106	≈0

Explain why the total kinetic energy of the products of this decay is approximately 34 MeV. Assume the π^- is stationary.

(2)

(iii) State which two conservation laws could be used to calculate the kinetic energy of the μ^- and the $\bar{\nu}_\mu$ just after the decay of the π^-.

(2)

*(iv) The muons are produced at a height of 10 km in the atmosphere. The velocity of the muons is $0.99c$. The average lifetime for muons is normally 2.2 μs and yet muons produced in the upper atmosphere are found in significant numbers at sea level.

Discuss this apparent anomaly.

(6)

(Total for Question 16 = 16 marks)

16 The neutral lambda Λ^0 particle is a baryon of mass 1116 MeV/c^2 and contains one strange quark.

(a) The table shows quarks and their relative charge.

Quark	Charge / *e*
u	+2/3
d	–1/3
s	–1/3

State, with justification, the quark content of a Λ^0 particle.

(2)

(b) Calculate the mass of the Λ^0 particle in kg.

(3)

Mass of Λ^0 particle = ... kg

(c) A student suggests five ways a Λ^0 particle might decay. These are

$\Lambda^0 \rightarrow p + \pi^-$
$\Lambda^0 \rightarrow e^+ + e^-$
$\Lambda^0 \rightarrow n + \pi^0$
$\Lambda^0 \rightarrow n$
$\Lambda^0 \rightarrow p + \pi^0$

Deduce which of these decay processes are **not** possible.

(6)

(d) Lambda particles were first detected in experiments which made use of cosmic rays entering the atmosphere. Cosmic rays are mainly high-energy protons which have a mass less than that of a lambda particle.

Explain why a cosmic ray could lead to the creation of a lambda particle.

(2)

(e) The Λ^0 particle cannot be directly observed in particle experiments, however some of the decay products can.

Explain why the Λ^0 particle cannot be directly observed but information about it can be obtained by studying its decay particles.

(3)

(Total for Question 16 = 16 marks)

TOTAL FOR PAPER IS 32 MARKS