



NATIONAL OPEN UNIVERSITY OF NIGERIA
PLOT 91, CADASTRAL ZONE, NNAMDI AZIKIWE EXPRESSWAY, JABI - ABUJA
FACULTY OF SCIENCES

DEPARTMENT OF PURE AND APPLIED SCIENCE

2021_2 EXAMINATIONS.

COURSE CODE: PHY401
COURSE TITLE: ELEMENTARY PARTICLES PHYSICS
CREDIT UNIT: 3
TIME ALLOWED: (2½ HRS)

INSTRUCTION: *Answer question 1 and any other four questions*

QUESTION 1

A. Which of the following reactions violate a conservation law?

Where there is a violation, state the law that is violated.

$$\mu^+ \rightarrow e^+ + \gamma$$

$$e^- \rightarrow \nu_e + \gamma$$

$$p + p \rightarrow p + \Sigma^+ + K^-$$

$$p \rightarrow e^+ + \nu_e$$

$$p \rightarrow e^+ + n + \nu_e$$

$$n \rightarrow p + e^- + \bar{\nu}_e$$

$$\pi^+ \rightarrow \mu^+ + \nu_\mu$$

(14 marks)

B. For each of the following decays state a conservation law that forbids it:

$$n \rightarrow p + e^-$$

$$n \rightarrow \pi^+ + e^-$$

$$n \rightarrow p + \pi^-$$

$$n \rightarrow p + \gamma$$

(8marks)

QUESTION 2

- A. Explain the meaning of the terms: boson, fermion, hadron, lepton, baryon. (4 marks)
- B. Give one example of a particle for each of the above (4 marks)
- C. Which of the above name is, and which is not, applicable to the photon? (4 marks)

QUESTION 3

Consider the following high-energy reactions or particle decays, Indicate for each case:

A. allowed or forbidden,

B. reason if forbidden,

$$(1) \pi^- + p \rightarrow \pi^0 + n$$

$$(2) \pi^0 \rightarrow \gamma + \gamma + \gamma$$

$$(3) \pi^0 \rightarrow \gamma + \gamma$$

$$(4) \pi^+ \rightarrow \mu^+ + \nu_\mu$$

$$(5) \pi^+ \rightarrow \mu^+ + \bar{\nu}_\mu \quad (12\text{marks})$$

$$(6) p + \bar{p} \rightarrow \Lambda^0 + \Lambda^0$$

QUESTION 4

The following is a list of conservation laws (or symmetries) for interactions between particles. For each indicate by S,E,W those classes of interactions — strong, electromagnetic, weak — for which no violation of the symmetry or conservation law has been observed. For each of these conservation laws, indicate an experiment which established a violation.

(i) I-spin conservation

(ii) I_3 conservation

(iii) strangeness conservation

(iv) invariance under CP (12 marks)

QUESTION 5

Suppose that π^- has spin 0 and negative intrinsic parity. If it is captured by a deuterium nucleus from a p orbit in the reaction

$$\pi^- + d \rightarrow n + n,$$

Show that the two neutrons must be in a singlet state. The deuteron's spin-parity is 1^+ . (12 marks)

QUESTION 6

A. What is the G-parity operator? And why was it introduced in particle physics? (4marks)

B. What are the eigenvalues of the G-operator for pions of different charges, and for a state of n pions? (4marks)

C. What are the G values for ρ , ω , ϕ , and η mesons? (4marks)