NATIONAL OPEN UNIVERSITY OF NIGERIA
14-16 AHMADU BELLO WAY, VICTORIA ISLAND, LAGOS
SCHOOL OF SCIENCE AND TECHNOLOGY
JANUARY/FEBRUARY 2013 EXAMINATION

COURSE CODE: **PHY 409**
COURSE TITLE: **Elementary Particle Physics**
CREDIT UNIT: **3**
INSTTRUCTION: **Answer any five questions.**
TIME: **3 Hours**

PHYSICAL CONSTANTS:

Speed of light $c = 2.9979 ms^{-1}$; **mass of electro** $m_e = 0.9110 \times 10^{-31} kg$;

Electronic charge $e = 1.6022 \times 10^{-19} C$; **Avogadro's number** $N_A = 6.0221 \times 10^{26} kmol^{-1}$;

Boltzmann constant $k = 1.3806 \times 10^{-23} J K^{-1}$; **Plank's constant** $h = 6.6257 \times 10^{-34} Js$

1.(a)(i) Define the term *elementary particle*.   **4 marks**

   (ii) List five (5) each of *gaseous ionization* and *solid-state* particle detectors   **5 marks**

(b) (i) What are *quarks*   **4 marks**

(ii) Draw a table showing the elementary particles (not anti-particles) according to their families with the following properties: name, symbol, charge, and spin.   **7 marks**

2.(a)(i) Briefly, discuss the *four forces in nature*.   **8 marks**

(ii) List the exact or absolute conservation laws which are obeyed by reaction or interactions involving elementary particles   **4 marks**

(b)(i) Consider a reaction where a Π^- meson decays into a μ^- meson and an antineutrino $\bar{\gamma}$ i.e,

$$\Pi^- \to \bar{\mu} + \bar{\gamma}_\mu$$

Determine the energies of the particles μ^- and $\bar{\gamma}_\mu$ in terms of the masses of the pi-meson and muon $\left(m_\Pi \ and \ m_\mu \right)$.   **4 marks**

(ii) A particle Σ^0 decays at rest to a Λ^0 particle. Determine the energy of the released photon.

       4 marks

3.(a) In the following pairs, determine which of the reactions is possible and those that are impossible. State the conservation laws that are violated.

(i) $\pi^{-} + p \to \Sigma^{0} + \eta^{0}$

$\pi^{-} + p \to \Sigma^{0} + K^{0}$ **(strong interaction)**   **6 marks**

(ii) $n \to p + e^{-} + \nu_{e}$

$n \to p + e^{-} + \overline{\nu}_{e}$ **(weak decay)**   **6 marks**

(b)(i) A μ^{-} **meson collides with a proton, and a neutron plus another particle are created. What is the other particle?**   **4 marks**

(ii) Find the maximum kinetic energy of the electron emitted in the beta decay of the free electron. The neutron-proton mass difference is 1.30 MeV.   **4 marks**

4. (a) Name and mention the properties of the carriers of the following interactions:

(i) gravitational interaction   **5 marks**

(ii) electromagnetic interaction   **5 marks**

(b) (i) What do you understand by *resonances* in particle physics? 5 marks

(ii) Why are the interaction carriers called bosons?   **5 marks**

5.(a) Briefly discuss the

(i) C parity and G parity   **5 marks**

(ii) Hypercharge   **5 marks**

(b) (i)What are hadrons?   **5 marks**

(ii) Why must the quarks in a hadron have different colours?   **5 marks**

6(a)(i) Give an example each of Λ decay, Σ decay Ξ decay and Ω^{-} decay 5 marks

(ii) Briefly discuss the concept of isospin   **5 marks**

(b)Write short notes on each the following:

(i) weak nuclear interaction   **5 marks**

(ii) strange particles   **5 marks**

7 (a) (i) Briefly explain the parity transformation of the coordinate of a particle. 4 marks

(ii) What do you understand by the conservation of parity?   4 marks

(b) Show that

(i) magnetic force law is invariant under parity transformation   6 marks

(ii) in the presence of a free magnetic monopole, the force law is not invariant under parity transformation.   6 marks