NATIONAL OPEN UNIVERSITY OF NIGERIA
14/16 AHMADU BELLO WAY, VICTORIA ISLAND, LAGOS
SCHOOL OF SCIENCE AND TECHNOLOGY
MARCH/APRIL 2014 EXAMINATION

COURSE CODE: PHY 409
COURSE TITLE: ELEMENTARY PARTICLE PHYSICS
TIME ALLOWED: 3HOURS
INSTRUCTION: ANSWER ANY FIVE QUESTIONS.

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.* **2 marks**

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

(b) (i) What are *quarks*
2 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.
5 marks

2.(a)(i) Briefly, discuss the *four forces in nature*. **4 marks**

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

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

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

Determine the energies of the particles μ^- and $\bar{\gamma}_\mu$ in terms of the masses of the pi-meson and muon $\left(m_\Pi \text{ and } m_\mu\right)$. **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 for those that are impossible, state the conservation laws that are violated.

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

$\pi^{-¿}+p \rightarrow \Sigma^0+K^0¿$ (strong interaction) **4 marks**

(ii) $n \rightarrow p+e^{-¿+\nu_e¿}$

$n \rightarrow p+e^{-¿+\overline{\nu}_e¿}$ (weak decay) **4 marks**

(b)(i) A $\mu^{-¿¿}$ meson collides with a proton, and a neutron plus another particle are created. What is the other particle?
2 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 **2 marks**

(ii) electromagnetic interaction **2 marks**

(b) (i) What do you understand by *resonances* in particle physics? **6 marks**

(ii) Why are the interaction carriers called bosons? **4 marks**

5.(a) Briefly discuss the concepts of:

(i) C parity and G parity **4 marks**

(ii) Hypercharge **4 marks**

(b) (i)What are hadrons? **3 marks**

(ii) Why must the quarks in a hadron have different colours? **3 marks**

6(a)(i) Give an example each of Λ decay, Σ decay Ξ decay and Ω^{-ii} decay **2 marks**

(ii) Briefly discuss the concept of isospin **4 marks**

(b)Write short notes on each the following:

(i) weak nuclear interaction **4 marks**

(ii) strange particles **4 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? **3 marks**

(b) Show that

(i) magnetic force law is invariant under parity transformation **3 marks**

(ii) in the presence of a free magnetic monopole, the force law is not invariant under parity transformation. **4 marks**