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

COURSE CODE: PHY409
COURSE TITLE: ELEMENTARY PARTICLE PHYSICS (3 units)
TIME ALLOWED: 3 Hours
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

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

$\mu_0 = 4\pi \times 10^{-7} Henry/m$.

1a. List the four forces or interactions in particle physics with their respective carriers.

b. Explain any two of the forces in question (1a) above.

c. Express mathematically how the width of the resonance of a particle is related to the life-time of the particle.

2a. Define the following;

(i) Symmetry model
(ii) Resonance as it relates to elementary particle

b. List the two type of symmetry model

c. The mass of the Z^0 boson is 91.200 MeV/C^2. Calculate the range of the weak interaction

3a. State the CPT theorem of Quantum field theory

b. Explain the term Time-reversal invariance as it applies to electromagnetic and strong interactions

c. Test the following reactions and state which ones will occur in nature;

(i) $\mu^- \rightarrow e^- + \gamma$

(ii) $\mu^- \rightarrow e^+ + e^- + e^-$

(iii) $\mu^- \rightarrow \bar{e} + \gamma_\mu + \bar{\gamma}_e$

(iv) $p \rightarrow e^+ + \gamma$

4a. Classify all the conservation laws into two groups and write short notes on any two of these laws

b. Show that the laws of gravitation, electrostatic and magnetic forces are invariant under the parity transformation

5a. Define the strangeness quantum number, S

5b. State the reason why the following particles $\Lambda, \Sigma \ and \ K$ are called strange

5c. With the aid of a table, list the strangeness quantum number with their respective hadrons

6a. State the law of conservation of energy and linear momentum

b. Consider a reaction where Π^- meson decays into a μ^- meson and an antineutrino $\bar{\gamma}$ as follows:

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

Derive the energies of the particles μ^- and $\bar{\gamma}$ in terms of the masses of the pi-meson and the muon (m_Π and m_μ)

7a. Define the following terms:

(i) Elementary particle

(ii) Quark

(iii) Quark confinement

(iv) Mesons

(v) Baryons

b. Classify the following according to their spin:

(i) Fermions

(ii) Bosons

c. The collision of a proton with another proton in an accelerator is an example of production of elementary particle. Write down the equation for the reaction process. Hence tabulate the types of Quark

and their corresponding anti-quark according to the following properties: symbol, charge and spin