PHY 602.1 **Reg No.....**

CREDIT BASED SIXTH SEMESTER B.Sc. DEGREE EXAMINATION
APRIL 2012
PHYSICS
PAPER VIII: NUCLEAR PHYSICS

Duration: 3 Hours **Max Marks: 70**

PART –A

1. Answer any <u>TEN</u> of the following. **1x10=10**

(a) How does the radioactivity of a given substance vary with temperature?

(b) What happens to the mass of an element when it emits two beta particles from its nucleus?

(c) Write the relation between range and energy of α-particle.

(d) Write the unit of nuclear reaction cross-section.

(e) What are thermal neutrons?

(f) What are isotones?

(g) What is meant by the term critical size of a fissile material?

(h) What is the condition for spontaneous fission?

(i) Why quenching agents are introduced into a GM tube?

(j) Write down the expression for the maximum energy of the particles in a cyclotron.

(k) What are hadrons?

(l) What is East-West effect?

PART-B

UNIT-I

Answer any <u>TWO</u> of the following. **2x1=20**

2. (a) Mention the four radioactive series.

(b) What is radioactive equilibrium? Deduce the condition for secular equilibrium.

(c) A piece of ancient bone shows an activity of 1.56×10^3 disintegrations per second per kg of C-14. Determine the age of the bone. Half life of C-14 is 5568 years and activity of fresh sample of C-14 is 15.6×10^3 disintegrations per second per kg.

(2+4+4)

3. (a) Explain Q-value of a nuclear reaction.

(b) Derive an expression for nuclear reaction cross section.

(c) A certain quantity of ore is found to contain 1 kg of U^{238} with a half life of 4.5×10^{9} years and some amount of Ra^{226} with a half life of 1620 years. Find the mass of radium which is in equilibrium with uranium. **(2+4+4)**

4. (a) Why Netpunium series is not found in nature?

   (b) Which are the paradoxes of beta ray spectra? Explain these on the basis of Pauli's neutrino hypothesis.

   (c) Calculate the threshold energy required to initiate the reaction $^{31}_{15}P(n,p)^{31}_{14}Si$. Given atomic masses of $^{1}_{1}H$ = 1.00814 amu, neutron = 1.00895 amu, $^{31}_{15}P$ = 30.98356 amu, $^{31}_{14}P$ = 30.98514 amu. **(2+4+4)**

UNIT-II

Answer any <u>TWO</u> of the following. **2X10=20**

5. (a) What are mirror nuclei? Give an example.

   (b) Deduce semiempirical formula for nuclear mass.

   (c) Estimate the rest mass of a meson . Given range of nuclear force to be 1.5 fm

   h = 6.625×10^{-34} Js.

   (2+4+4)

6. (a) Show that nuclear density is a constant.

   (b) Explain Yukawa's meson field theory.

   (c) It is proposed to produce 100 MW of electrical power on an average in a nuclear reactor having 20% efficiency, using U-235. Calculate the amount of U-235 required per day for continous operation. Given energy released per fission of U-235 is 200MeV. **(2+4+4)**

7. (a) What is a magnetic bottle? Where is it used?

   (b) Deduce the four factor formula.

   (c) A reactor develops energy at the rate of 32×10^{6} Watts. How many atoms of Uranium – 235 undergo fission per second? Assume that on the average an energy of 200 MeV is released per fission. **(2+4+4)**

UNIT-III

Answer any <u>TWO</u> of the following. **2x10=20**

8. (a) Why the length of drift tubes in LINAC gradually increased?

   (b) Draw a labelled diagram of a semiconductor deterctor and explain its working.

   (c) A betatron working on an operating frequency of 40Hz has a stable orbit of radius 0.8 m. Find the final energy and energy gained per revolution by the electron.

Magnetic flux density at the orbit = 0.5T. Assume that the velocity of electron is nearly equal to be velocity of light.

GivenL: Velocity of light in vacuum = 3×10^8 ms^{-1} **(2+4+4)**

9. (a) How are the fundamental particles classified based on mass?

   (b) Describe the theory and arrive at an expression for the final energy of the particle in a cyclotron.

   (c) A cyclotron with Dees of diameter 1.8m has a magnetic field of 0.8 tesla. Calculate the energy to which the doubly ionised helium ion can be accelerated. Also calculate the number of revolutions the particle makes in attaining this energy. Given Mass of Proton = mass of neutron = 1.67×10^{-27} kg. **(2+4+4)**

10. (a) What are Van Allen belts?

    (b) Write a note on variation of cosmic ray intensity with latitude and altitude.

    (c) A cyclotron in which magnetic flux density is 2T, is used to accelerate protons. How rapidly should the electric field between the dee's be reversed? Also find the number of times the proton comes into the gap per second. Given $\frac{e}{m}$ of proton equal to 0.9×10^8 C kg^{-1}. **(2+4+4)**

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PHY 602.1 **Reg No.....**

CREDIT BASED SIXTH SEMESTER B.Sc. DEGREE EXAMINATION APRIL 2013

PHYSICS

PAPER VIII: NUCLEAR PHYSICS

Duration: 3 Hours **Max Marks: 80**

Note: Part A is compulsory and answer any TWO questions from each Unit of Part B.

PART –A

1. Answer any TEN of the following.
1x10=10

(m) Express decay law of radioactive substances in mathematical form.

(n) State the displacement law which governs the α decay.

(o) What is threshold energy?

(p) What is the nuclear charge of 3^{Li^6} if $\lambda_e = 1.6 \times 10^{-13}$?

(q) What is Nuclear magneton?

(r) What is photo fission?

(s) How many photons are involved in proton-proton cycle?

(t) What are drift tubes?

(u) Why silicon detector is mostly used?

(v) What are cosmic rays?

(w) What is annihilation of matter?

(x) What is the structure of leptons?

B. Answer any FIVE of the following.
2x5=10

(a) State and explain Geiger Nutlal Law.

(b) Explain Q value of a nuclear reaction.

(c) Show that nuclear density is a constant.

(d) Explain why heavy nuclei cannot be used as moderators.

(e) Explain cosmic ray showers.

(f) Give the properties of a neutrino.

PART-B
UNIT-I

2. Answer TWO full questions of the following.
10x2=20

(a) What is radioactive equilibrium? Deduce the condition for secular equilibrium and transient equilibrium.

(b) How much time will it take for a 8mCi source to reduce to 1mCi source? Half life of the source 10 years.

(6+4)

3. (a) Write a note on radioactive series.

   (b) A piece of an ancient wooden boat shows an activity of C-14 as 3.9 dis/min/g. Estimate the age of the boat if the activity of fresh C-14 is 15-6 dis/min/g. (T ½ of C-14 is 5568 years).

   (6+4)

4. (a) Explain Rutherford's experiment on first ratified transmutation of elements.

   (b) Calculate the range and energy of –pontils moving with a velocity of $2 \times \frac{10^7\ m}{sec}$.

   $a = 9.6 \times 10^{-24}$ $b = 3.18 \times 10^{-3}$

   (6+4)

UNIT-II

Answer <u>TWO</u> full questions of the following.
10x2=20

5. (a) What is proton-electron hypothesis? Give reasons for the failure of this hypothesis. Also explain how proton-neutron hypothesis was accepted for the constitution of the nucleus.

   (b) The masses of the hydrogas atom and the neutron are 1.008142 amu and 1.008982.amu respectively. Calculate the packing fraction and the binding energy per nucleus of ^{16}O nucleus.

   (6+4)

6. (a) Obtain the expression for nuclear mass of a nucleus based on liquid drop model.

   (b) Calculate the energy in ev required Helium into its constituent particles.

   Given: Mass of proton = 1.007825um; neutron = 1.008665 amu.

   Helium atom = 4.002603 amu.

   (6+4)

7. (a) With a neat diagram explain the working of a nuclear reactor.

   (b) Calculate the power output of a nuclear reactor which consumes 2kg of 235U per day. The average energy released per fission of 235U nuclei is 200MeV.

   (6+4)

UNIT-III

Answer <u>TWO</u> full questions of the following.
10x2=20

8. (a) What is cyclotron? What is its principle? With a neat labeled diagram, describe the construction and action of a cyclotron. Discuss its limitations.

   (b) Calculate the frequency of the oscillating potential applied to a cyclotron as to accelerate deuterons when the magnetic inductance has a constant value of 2.5 Wb/m^2. **(6+4)**

9. (a) Draw a labeled diagram of a semiconductor detector and explain its working. What are its avantages?

   (b) In a linear accelerator protons are accelerated. The velocity of the proton in the first drift tube is $4.7 \times 10^6 m/sec$ and the length of the orbit tube is 1m. What would be the energy of the protons emerging out of the foutth drift tube? And also find the length of the fourth drift tube. Mass of proton: $1.67 \times 10^{-26} Kg$.

   (6+4)

10. (a) What are fundamental particles? Explain the classification of fundamental particles with respect to mass, spin and interaction.

    (b) What radius is needed in proton synchrotron to attain particles of energy 10GeV assuming that a guide field of $2wb/m^2$ is available?

    (6+4)

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PHY 602.3 **Reg No.....**

CREDIT BASED SIXTH SEMESTER B.Sc. DEGREE EXAMINATION APRIL 2014

PHYSICS

PAPER VIII: NUCLEAR PHYSICS

Duration: 3 Hours **Max Marks: 80**

PART –A

1. (A) Answer any TEN of the following. 1X10=10

(y) What are isotones?

(z) What is nuclear magneton?

(aa) What are magic numbers?

(bb) What is magnetic bottle?

(cc) What is mean life of a radioactive substance?

(dd) State the displacement law which governs the ␣ decay.

(ee) What is a nuclear reaction cross section?

(ff) What are transuranic elements?

(gg) Give the necessary condition for the working of a betatron.

(hh) Why silicon detector is mostly used?

(ii) What is annihilation of matter?

(jj) What are quarks?

(b) Answer any FIVE questions of the following. 2X5=10

i) What is mass defect? Explain.

ii) What is the basic difference between liquid drop model and shell model?

iii) Obtain an expression for alpha particle disintegration energy.

iv) What is radioactive dating? Explain.

v) With a labeled diagram explain the construction of LINAC.

vi) What are Van Allen belts? Explain briefly.

PART-B

UNIT-I

Answer any TWO full questions from the following: 10x2=20

2. (a) Explain Yukawa's Meson Field Theory and explain how the rest mass of meson can be estimated using uncertainity principle.

(b) Calculate the binding energy of Lithium-7 nucleus.

Given : Mass of Lithium nucleus is 7.01022 amu

Mass of proton = 1.00728 amu

Mass of neutron = 1.00867 amu **(6+4)**

3. (a) Write a note on properties and classifications of neutrons.

   (b) It is proposed to produce 100 MW of electrical power on an average in a nuclear reactor having 15% efficiency, using U-235. Calculate the amount of U-235 required per day for continuous operation.

   Given: Energy released per fission of U-235 is 200 MeV **(6+4)**

4. (a) Deduce the four factor formula for a nuclear reactor.

   (b) A reactor develops energy at the rate of . How many atoms of Uranium-235 undergo fission per second? Assume that on an average 200 MeV of energy is released per fission. **(6+4)**

UNIT-II

Answer any <u>TWO</u> of the following. **10x2=20**

5. (a) With elements A, B and C forming a radioactive series, derive an expression for the number of atoms of B if at start B was not present in the sample.

   (b) Calculate the time required for 10% of a sample of Thorium to disintegrate. for Thorium is years. **(6+4)**

6. (a) What is Q value and threshold energy of a nuclear reaction? Derive an expression for threshold energy of a nuclear reaction.

   (b) The Q value of the reaction is -5.4 MeV. Determine the threshold energy of the neutrons for this reaction.
   Given : Mass of neutron = 1.008665 amu
   Mass of sodium = 22.9898 amu **(6+4)**

7. (a) Which are the paradoxes of Beta ray spectra? Explain these on the basis of Pauli's neutrino hypothesis. Also briefly explain the neutrino hypothesis of –decay.

   (b) Thorium-228 emits -particles of energy 5.42 MeV. Calculate the - disintegration energy.
   (6+4)

UNIT-III

Answer any <u>TWO</u> of the following. **10x2=20**

8. (a) Describe the theory and arrive at an expression for the final energy of the particle in a cyclotron.

   (b) Calculate the frequency of oscillating potential that must be applied to accelerate deuterons, when the magnetic induction has a constant value of 2
   Given: The mass of deuteron = Kg. **(6+4)**

9. (a) Describe with diagram the working of a GM counter and explain its characteristics. Comment on the quenching action of a GM tube.

   (b) The radius of cyclotron dee is 0.4 m and the applied magnetic field is 1.5 Wb/m . What is the maximum energy of a beam of protons?

   Given: Mass of a proton = Kg. **(6+4)**

10. (a) What are fundamental particles? Explain the classification of fundamental particles with respect to mass, spin and interaction.

   (b) A betatron working on an operating frequency of 40Hz has a stable orbit of radius 0.8m. Find the final energy and energy gained per revolution by the electron.

   Given: Magnetic flux density at the orbit = 0.5T. Velocity of electrons is nearly equal to velocity of light in vacuum = **(6+4)**

PHY602.3 **Reg. No.....**

CREDIT BASED SIXTH SEMESTER B.Sc. DEGREE EXAMINATION APRIL 2015

PHYSICS – VIII

Nuclear Physics

Duration: 3 Hours **Max Marl**

Note: Part A is compulsory and answer any TWO questions from each unit of Part – B.

PART – A

1. A. Answer any TEN of the following: **10×**

a) Write the formula for nuclear radius.
b) What is nuclear magneton?
c) What are thermal neutrons?
d) Give the names of any two materials used as moderator.
e) Give the expression for Geiger-Nuttal law.
f) What is tunnel effect?
g) State radioactive decay law.
h) What is nuclear reaction cross-section?
i) Mention two methods of quenching.
j) What is pair production?
k) Name the two classes of hadrons.
l) What are primary cosmic rays?

B. Answer any FIVE of the following: **5×**

a) Nuclear force is spin dependent. Explain.
b) What is a magnetic bottle? Where is it used?
c) What is radioactive dating? Explain.
d) Explain Q value of a nuclear reaction.
e) Explain the variation of cosmic ray intensity with latitude giving possible reasons.
f) According to the quark model, what is the structure of
i) proton and ii) neutron?

PART - B

UNIT - I

Answer any TWO full questions of the following: **2×1**

2. (a) Write a note on properties and classification of neutrons.
(b) Calculate the binding energy per nucleon of $_{26}Fe^{56}$ from the following data.
Mass of $_{26}Fe^{56}$=55.934939 amu
Mass of proton = 1.007276 amu
Mass of neutron = 1.008665 amu

3. (a) Obtain the semi-empirical mass formula for a nucleus based on liquid drop model.
   (b) Calculate the energy released when 1 kg of nuclear fuel is consumed if the fusion reaction $_1H^2 + _1H^2 \rightarrow _2He^4$ is possible. Mass of $_1H^2 = 2.014102$ amu, Avogadro number = 6.023×10^{26} per kg mole.

4. (a) Deduce the four factor formula for a nuclear reactor.
   (b) At what rate will $_{92}U^{235}$ will be consumed in a reactor operating at an output of 250MW? The average energy released per fission of U^{235} nuclei is 200 MeV.

UNIT - II

Answer any <u>TWO</u> full questions of the following: **2×1**

5. (a) With elements A, B and C forming a radioactive series, derive an expression for the number of atoms of B at any instant if at start B was not present in the sample.
   (b) The half life of radon – 222 is 3.8 days and that for radium – 226 is 1590 years. Calculate the mass of radon – 222 that would be in secular equilibrium with 5 gram of radium – 226.

6. (a) What are the paradoxes of beta ray spectra? Explain these on the basis of Pauli's neutrino hypothesis.
   (b) How long does it take for 60% of a sample of radon to decay?

   Half life of radon = 3.8 days.

7. (a) What is a nuclear reaction? Explain different types of nuclear reactions with examples.
   (b) Calculate the threshold energy of alpha particles for the following endoergic reaction.

   $_{12}Mg^{25} + _2He^4 \rightarrow _{13}Al^{27} + _1H^2$

   The masses of $_{12}Mg^{25}$, $_2He^4$, $_{13}Al^{27}$ and $_1H^2$ are 24.9936 amu, 4.0039 amu, 26.9901 amu and 2.0147 amu respectively.

UNIT - III

Answer any <u>TWO</u> full questions of the following: **2×1**

8. (a) Derive the betatron condition. With diagram, explain the construction and working of betatron.
   (b) A fixed frequency cyclotron has an oscillator frequency of 12MHz and Dee radius of 0.55m. It is used to accelerate deuterons. Calculate
      i) Magnetic flux density needed and
      ii) Energy to which deuterons are accelerated. Mass of deuteron = 2.0141 amu and its charge = 1.6×10^{-19}C.

9. (a) Describe with diagram, the working of a GM counter and explain its characteristics. Comment on the quenching action of a GM tube.
   (b) In a linear accelerator, protons are accelerated. The velocity of the proton in the first drift tube is 4.5×10^6m/s and the length of the first drift tube is 0.6m. What

would be the length of the tenth drift tube and the energy of the protons emerging out of the tenth drift tube? Mass of proton = 1.67×10^{-27}kg.

10. (a) What are fundamental particles? Explain the classification of fundamental particles with respect to i) spin and ii) mass

    (b) Calculate the final energy gained by electrons in a betatron to which is applied a maximum magnetic field of 0.5 tesla operating at 50Hz in a stable orbit of diameter 2 meter. Also calculate the average energy per revolution.

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