Seat No. : _____

DA-114

December-2013

B.Sc. Sem.-V

303 : Physics

(Electromagnetism & Nuclear Physics)

Time : 3 Hours] [Max. Marks : 70

આપેલ : $^{232}Th = 232.038124u$, $^{238}U = 238.048608u$, $^{4}He = 4.0026u$

Given : $^{232}Th = 232.038124u$, $^{238}U = 238.048608u$, $^{4}He = 4.0026u$

1. (a) અવાહક માધ્યમ માટે સમતલ તરંગક્ષેત્ર સમીકરણ લખો અને તેનો ઉકેલ આપો. 7

Write the wave field equation of a non-conducting medium and give its solution.

અથવા/OR

દર્શાવો કે દરેક ચક્ર દરમ્યાન એકમ ~~કદ~~ $dU/d\tau$ દીઠ ઉત્સર્જીત ઊર્જા, હીસ્ટરેસીસ લુપના ક્ષેત્રફળ બરોબર હોય છે.

Show that the energy dissipated per unit volume $dU/d\tau$ in each cycle is proportional to the area enclosed by the hysteresis loop.

(b) વિદ્યુતચુંબકીય ક્ષેત્ર માટેના મેક્સવેલ સમીકરણોનું અર્થઘટન કરો. 7

Interpret Maxwell's equations for electromagnetic field.

અથવા/OR

પોઈન્ટીંગ પ્રમેય લખો અને સાબિત કરો.

State and prove Poynting's theorem.

2. (a) Lienard-Wiechert સ્થિતિમાન મેળવો. 7

Obtain Lienard-Wiechert potentials.

અથવા/OR

રેખીય એન્ટેના સમજાવો અને દર્શાવો કે અર્ધ-તરંગ એન્ટેના રેડીયેટર કરતાં વધારે શક્તિશાળી છે.

Explain linear antenna and show that the healf-wave antenna is much more efficient than radiator.

(b) કુલ ઉત્સર્જીત પાવર અને દોલિત દ્વિધ્રુવીનો ઉત્સર્જીત અવરોધ ગણો. 7

Compute total power radiated and radiation resistance of an oscillating Dipole.

અથવા/OR

Larmor સૂત્ર મેળવો.

Derive Larmor formula.

$$P = \frac{e^2 (\dot{v})^2}{6\pi\epsilon_0 c^3}$$

3. (a) (i) α-કણોની અવધિ સમજાવો અને ચર્ચો straggling ની અસર. 9

Explain the range of α-particles and discuss the effect of straggling.

(ii) ટૂંકનોંધ લખો : Geiger Nuttal નિયમ

Write short note on : Geiger Nuttal law.

(iii) દર્શાવો કે α-ક્ષય કરતાં ^{238}U વધારે અસ્થિર છે.

Show that ^{238}U is unstable against α-decay.

અથવા/OR

(ગ) ન્યુટ્રાનાન શોધવા માટેનો Cowan and Reins પ્રયોગનું વર્ણન કરો.

Describe Cowan and Reins experiment for the detection of neutrino.

(b) (i) α-વિઘટન ઊર્જા માટેનું સમીકરણ તારવો. 5

Derive the equation of α-disintegration energy.

(ii) 10.54 MeV ગતિ-ઊર્જા સાથે α-ઉત્સર્જક ^{212}Po, α-કણો ઉત્સર્જીત કરે છે. તો α-વિઘટન ઊર્જા ગણો.

The α-emitter ^{212}Po emits α-particles with kinetic energy 10.54 MeV. Calculate the α-disintegration energy.

અથવા/OR

(ડ) દીર્ઘ અવધિ α-કણોનું ઉત્સર્જન સમજાવો.

Explain the emission of long range α-particles.

4 (a) Weizsacher's અર્ધઆનુભાવિક દળ સમીકરણ પરથી સૌથી વધુ સ્થાયી isobar નો ન્યુક્લીયર વિદ્યુતભાર તથા છૂટી પડતી ઊર્જાનું સૂત્ર મેળવો. 8

From Weizsacher's semi-empirical mass formula, derive the equation of nuclear charge for most stable isobar and energy release for transition leading to it.

અથવા/OR

(a) Weizsacher's અર્ધઆનુભાવિક દળ સમીકરણના અસંમિત શક્તિપદ B_a તથા સમતલ શક્તિપદ B_s મેળવો.

Derive surface energy term B_s and asymmetry term B_a of Weizsacher's semi-empirical mass formula.

(b) (i) ન્યુક્લીઓન ઉત્સર્જન સમજાવો અને ન્યુક્લીઓન અલગીકરણ ઊર્જાનું સમીકરણ મેળવો. 6

Explain nucleon emission and obtain equation of nucleon separation energy.

(ii) Nuclear isomerism પર ટૂંકનોંધ લખો.

Write short note on nuclear isomerism.

અથવા/OR

(b) નોંધ લખો : γ-ઉત્સર્જન માટે પસંદગી નિયમો.

Write a note on : Selection rules for γ-emission.

(6)

5. ટૂંકમાં જવાબ આપો : 14

Answer in brief :

(i) મુક્ત અવકાશમાં વિદ્યુતચુંબકીય તરંગનો વેગ એટલે શું ? → $v_0 = \frac{1}{\mu_0 \epsilon_0^{1/2}}$

What is the velocity of electromagnetic wave in free space ?

(ii) સદિશ g અને સદિશ N વચ્ચેનો સંબંધ આપો. → $g = \mu\epsilon N$

Give the relation between vector g and vector N. where $N = [E \times H]$

electromagnetic momentum density, Poynting vector

$g = [D \times B]$

(iii) વ્યાખ્યાયિત કરો : રેડીયેશન ઝોન

Define : Radiation Zone.

(iv) TEM નું પુરૂં નામ લખો. →

Give full form of TEM. Transverse electromagnetic wave

$= [\epsilon E \times \mu H]$

$= \mu\epsilon [E \times H]$

$= \mu\epsilon N$

(v) દૃશ્યપ્રકાશ કેવી રીતે ઉત્પન્ન થાય ?

How is visible light produced ?

(vi) $^{228}Th_{90}$ નો ક્ષય આપો. →

Give the decay of $^{228}Th_{90}$. $^{228}_{90}Th \xrightarrow{\text{ક્ષય}} ^{224}_{88}Ra + \alpha\ (^4_2He)$

(vii) ^{28}Al નો β-ક્ષય આપો. → $^{28}_{13}Al \rightarrow ^{28}_{14}Si + ^0_{-1}e + Q$

Give β-decay of ^{28}Al.

(viii) (4n + 3) કઈ રેડીયો એક્ટિવ શ્રેણી રજૂ કરે છે ?

(4n + 3) represents which radioactive series ? Actinium series

(ix) વ્યાખ્યાયિત કરો : રૂપાંતરિત સહગુણક →

Define : Conversion coefficient

(4n+2) → Uranium series

4n → Thorium series

(x) k-કેપ્ચર પ્રતિક્રિયાનું ઉદાહરણ આપો.

Give an example of k-capture reaction.

(xi) વ્યાખ્યાયિત કરો : Helicity

Define : Helicity $H = \frac{\vec{p} \cdot \vec{s}}{|\vec{p}||\vec{s}|}$ $H = -1$ → neutrino

$H = +1$ → anti-neutrino

(xii) પ્રતિક્રિયા પૂર્ણ કરો : $^{64}Cu_{29} \rightarrow ^{64}_{28}Ni + \ldots + \ldots$ $e + \bar{\nu}$

Complete the reaction : $^{64}Cu_{29} \rightarrow \ldots + \ldots + \ldots$

(xiii) Mirror nuclei એટલે શું ? દર્પણ મધ્યવર્તી કેન્દ્ર જ્યાં તત્વ ક્રમાંક (Z) ના પ્રોટોન સંખ્યા ન્યૂટ્રોન તત્વ (N) તત્વ ક્રમાંક (Z) ના પ્રોટોન સંખ્યા ન્યૂટ્રોન તત્વ ક્રમાંક (N) પર.

What are mirror nuclei ? ન્યૂટ્રોન સંખ્યા સમાન હોય તો તેવા નાભિકને mirror મધ્યવર્તી કહે છે.

(xiv) દળક્ષતિ એટલે શું ? એક ન્યૂક્લિયસ આણ્વીક દળ તેના ઘટકોના દળનો સરવાળો કરતાં ઓછું હોય તેવું

What is mass defect ? વધારાનો તફાવત.

(3) The region in which $|r| >> \lambda$ is called radiation zone.

The region in which $|r| << \lambda$ is called near zone.

λ is wave length

$|r|$ is position vector of point P.

Seat No. : _____

N15-109

November-2014

B.Sc., Sem.-V

303 : Physics

Time : 3 Hours] **[Max. Marks : 70**

Instructions : (1) Notational are as usual per syllabus.
(2) Figures on R.H.S. indicate marks.

1. (A) Discuss in detail the hysteresis. 7

OR

Derive the equations for gauge transformation.

(B) Prove the Poynting's theorem. 7

OR

For the electromagnetic wave travelling in non-conducting media show that, time averaged energy flow is in the direction of a propagation of the wave and equals to the multiplication of the phase velocity with the average energy density.

2. (A) Derive expressions for $\varphi(\vec{r}, t)$ and $\vec{A}(\vec{r}, t)$ in the case of retarded potentials. 7

OR

Derive the equations for Lienard-Wiechert potentials.

(B) Derive Larmor formula for the fields of an accelerated charge. 7

OR

Explain the radiation from an oscillating dipole. Derive formula for dipole moment.

3. (A) Discuss the classical paradox of α-decay principle. Explain how the paradox was resolved by Gamow with the help of wave mechanics ? 7

OR

(i) Explain long range α-particles. 3

(ii) Derive formula $Q_\alpha = \frac{A}{A-4} K_\alpha$. 4

(B) Discuss the Fermi's theory of β – decay and derive the formula $\rho_1 = \frac{1}{2\pi^2\hbar^3}\frac{pE}{C^2}$. 7

OR

Describe Cowan and Reines experiment for the detection of neutrino.

4. (A) Discuss in detail the multipolarity in γ-Transition. 7

OR

Explain in detail the internal conversion.

(B) Explain binding energy of nucleus. Draw the plot of (B/A) against A and state the conclusions. 7

OR

Write Weizsacher's mass semi-empirical formula for binding energy of nucleus and obtain volume energy term B_v, surface energy term B_s and Coulomb energy term B_c.

5. Answer the following in brief : 14

(i) What is retentivity ?

(ii) Write names of any two ferromagnetic substances.

(iii) State Coulomb gauge condition.

(iv) Write formula for skin depth.

(v) On which factor Lienard-Wiechert potentials depend on ?

(vi) Write down Hertz's relations for the oscillating dipole.

(vii) What do you mean by radiation resistance ?

(viii) What is alpha particle ?

(ix) Why Beta decay is called the weak interaction ?

(x) Why the neutrino is the most difficult particle to detect ?

(xi) Complete the equation : ${}^{37}_{17}Cl \rightarrow {}^{37}_{18}A +$ _____ + _____.

(xii) Write selection rules for γ-ray emission.

(xiii) What do you mean by isobaric family ?

(xiv) Why the ratio Z^2/A is called fission parameter ?

Patel Bhavin R

Seat No. : _____

Harish

ND-101

December-2015

B.Sc., Sem.-V

Core Coures-303 : Physics ([redacted]**)**

Time : 3 Hours] **[Max. Marks : 70**

Instructions : (1) All questions carry equal marks

(2) Symbols have their usual meaning.

(3) Number shown in bracket at the end of each question indicates mark.

1. (a) State and prove Poynting theorem. (7)

OR

Show that the energy dissipated per unit volume $\left(\frac{du}{dT}\right)$ in each cycle is proportional to the area enclosed by the hysteresis loop. – 165

(b) Write a note on skin effect. In case of sea water, why the radio communication by submarine become difficult at the depth of several metres ? – 197 (7)
Calculate the skin depth for copper having conductivity 58×10^6 mhos/m at frequency 1 MHz ($\mu = 1.26$)

OR

(1) Discuss the polarization of electromagnetic waves. – 186 (5)

(2) Obtain velocity of electromagnetic wave in free space using $\varepsilon_0 = 8.85 \times 10^{-12}$ MKS and $\mu_0 = 4\pi \times 10^{-7}$ MKS. Toward what conclusion your answer lead ? (2)

$v = \frac{1}{\sqrt{\varepsilon_0 \mu_0}}$: Ans.

(a) Prove that for dipole, radiated power is proportional to the ratio p^2/λ^4. (7)

OR

Discuss the radiation from an electron in arbitrary motion and obtain Lienard-Wiechert potential.

(b) Explain concept of retarded potential and show that both ϕ and A satisfies inhomogeneous equations. (7)

OR

(1) Prove that charge oscillating between two spheres is equivalent to an oscillating dipole moment. (5)

(2) A radiator approximate to an electric dipole of length 250 m and oscillating at a frequency of 60 kHz. Assuming that the current is maintained over length, evaluate radiation resistance of the radiator. (2)

3. (a) Describe continuous spectrum of β-rays. Discuss the difficulties arises in understanding it. (8)

OR

(1) Write a note on long range α-particles. (4)

(2) Derive formula of α-disintegration energy. Show that disintegration energy of α-particle emission is equal to the kinetic energy of α-particle. (4)

(b) Derive an equation for factor for density of states ρ(E) for β-decay. (6)

OR

(1) Assume nucleus radius to be $R = 1.3\ A^{1/3}$ fm. Calculate the minimum energy required by an α-particle from entirely classical view point to overcome the Coulomb barrier of $_{84}Po^{210}$ nucleus. (3)

(2) Show that $_{94}Pu^{236}$ nucleus is unstable against α-decay. $M_{_{94}Pu^{236}} = 236.04607$ u, $M_{_{92}U^{232}} = 232.03717$ u and $M_{_{2}He^{4}} = 4.00260$ u. (931.51 MeV/u) (3)

4. (a) Discuss the conclusions drawn from the binding energy curve. (6)

OR

(b) Write a note on internal conversion of γ-rays.

(b) Define Isobaric family. Obtain parabolic relationship for A = 91 isobaric family. Using mass formula, obtain (8)

(1) Nuclear charge (z_0) of the most stable nuclei.

(2) Derive the equations for Energy emission during β^+ and β^- decay.

OR

(1) Write a note on selection rules for γ-emission. (4)

(2) Why α-emission is a frequently occurring process ? Explain on the basis of excitation energy. (4)

5. Each of the following question carries 1 mark. Give answer in short. (14)

(1) Write Maxwell's third equation. ફેરાડેનો નિયમ $\vec{\nabla} \times \vec{E} = -\frac{\partial \vec{B}}{\partial t}$

(2) What are electromagnetic waves ?

(3) What is Hysteresis ? ચોક્કસ ચુંબકીયક્ષેત્રની પ્રબળતામાં ઘટા વધારા સાથે ઘટતા જતા ચુંબકત્વને હિસ્ટ્રીસીસ કહે છે.

(4) What is Attenuation ?

(5) Define dipole. એક સમાન અંતર દ્વારા આવતા સમાન અને વિરુદ્ધ વિદ્યુત ચુંબકીય દ્વિધ્રુવોની એક જોડી રાખી તેને ડાઈપોલ કહે છે.

(6) Define scalar and vector potential.

(7) What is quadrupole ?

(8) Write Geiger-Nuttal law. $\log R = A \log \lambda + B$

(9) What is charge and mass of a neutrino ? ન્યુટ્રીનો એ ઇલેક્ટ્રિક અને ચાર્જરહિત છે.
zero mass & zero chr

(10) State helicity of neutrino.

(11) Define internal conversion electron.

(12) Define mass defect.

(13) What are mirror nuclei ?

(14) What is nucleon emission ?

Diya Dudhat

Seat No. : _____

MD-118

November-2016

B.Sc., Sem.-V

CC- 303 : Physics

Time : 3 Hours] **[Max. Marks : 70**

Instructions : (1) All questions carry equal marks.
(2) Symbols carry usual meanings.

1. (a) Discuss the different cases of polarization of electromagnetic waves. 186 **7**

OR

Show that the energy dissipated per unit volume $\left(\frac{d\upsilon}{d\tau}\right)$ in each cycle is proportional to the area enclosed by the hysteresis loop. 165

(b) Give the interpretation of Maxwell's equations for electromagnetic field in detail. 168 **7**

OR

(i) Write a note on 'Skin effect'. 197 **4**

(ii) Find the skin depth for low frequency radio waves of wavelength 3×10^3 metre in sea water. The electrical conductivity of which is 4 ℧/m. ($C = 3 \times 10^8$ m/s; $\mu = 4\pi \times 10^{-7}$ MKS) **3**

2. (a) Discuss the radiation from a single charge particle electron in arbitrary motion and obtain Lienard-Wiechert potentials. 239 **7**

OR

Discuss the radiation from an accelerated charged particle at low velocity and obtain Larmor formula for total radiated power. 247

(b) Derive expression for $\phi\left(\vec{r},t\right)$ and $\vec{A}\left(\vec{r},t\right)$ in the case of retarded potentials. 228 **7**

(237) (239)

OR

(i) For an oscillating dipole, total radiated power is $\frac{CP_0^2}{12\pi\epsilon_0}\left(\frac{2\pi}{\lambda}\right)^4$ then find out radiation resistance. 280 **4**

(ii) An electric dipole of antenna is 0.01 metre length radiates radiation of 100 MHz frequency with the power of 100 watt, find out radiation resistance and the current in the antenna for dipole. **3**

3. (a) (i) Explain α-particle fine structure. 23 4

(ii) $^{212}_{83}Bi$ decays with a half life of 60.5 minutes by emitting 5 groups of α-particles with energy 6.08 MeV, 6.04 MeV, 5.76 MeV, 5.62 MeV and 5.60 MeV. Calculate the α-disintegration energies. What is the daughter nucleus ? Sketch its level scheme. 4 3

OR

What was α-decay paradox ? Explain how it was solved. 139, 28. 7

3-1 (b) Derive an equation for factor for density of states ρ(E) for β-decay. 7

B. 150

OR

164, 2) Describe Cowan and Reins experiment for the delection of neutrino.

4. (a) Write Weizsacher's semi-empirical mass formula and derive volume energy B_V and Coulomb energy B_C terms. 184 D 7

OR

With necessary diagram obtain mass parabola for isobaric family with A = 91. 7

(b) Explain nuclear isomerism. 184 - D

OR

Explain multipolarity in γ-transitions. 170 - D

5. Answer the following questions in short : 14

(1) Give the definition of electric dipole.

(2) What is retentivity ?

(3) Write names of any two ferromagnetic substances.

(4) Write Lorentz gauge condition.

(5) Give full name of TEM.

(6) On which factors Leinard-Wiechert potentials depend on ?

(7) How is visible light produced ?

(8) 4n + 1 represents which radio active series? → neptunium series

(9) Give two properties of neutrino. → ① zero chg ② spin su = 1/2

P.3 (10) State helicity of neutrino.

(P)(S) (11) Give the decay of $^{228}Th_{90}$. → $^{224}_{88}Ra + \alpha$

(12) Give β-decay of $^{28}_{13}Al$. → $^{28}_{14}Si + -e + \bar{\nu}$

(13) Give an example of k-capture reaction.

(14) Define conversion electron.

thorium 4n

neptunium 4n+1

uranium 4n+2

actinium 4n+3

Seat No. : 4241

NM-110

November-2017

B.Sc., Sem.-V

CC-303 : Physics

(Electromagnetism and Nuclear Physics)

Time : 3 Hours] **[Max. Marks : 70**

Instructions : (1) **All** questions carry equal marks.
(2) Symbols used have their usual scientific meanings.

1. (a) Discuss the Lorentz gauge and hence show that the scalar and vector potentials satisfy the same equation. **7**

OR

Explain field energy and field momentum.

(b) Discuss electromagnetic waves travelling in non-conducting media in detail. **7**

OR

Explain polarization of plane waves.

3

2. (a) Discuss the energy flux associated with plane wave propagation and hence prove that $<\bar{N}> = \frac{1}{2}\left(\frac{\epsilon}{\mu}\right)^{1/2} |\bar{E}_o|^2 \hat{e}_k$. **5**

OR

Discuss the retarded potentials in detail.

(b) Calculate the radiation field produced by an electric dipole having oscillations in detail. **9**

OR

(i) Discuss Lienard-Wiechert potentials.

(ii) Obtain Lorentz formula for potentials of a charge moving in uniform motion.

3. (a) Explain the range of α-particles and hence discuss the effect of straggling. 4 7

OR

(i) Show that α-disintegration energy Q_α is given by $Q_\alpha = \left(\frac{A}{A-4}\right) K_\alpha$ where K_α is kinetic energy of α-particle. 4

(ii) Explain α-decay-paradox and explain how it was overcome. 3

(b) Discuss breakdown of the conservation laws in β-decay in detail. 7

OR

Explain Fermi theory of β-decay. 7

4. (a) Explain γ-ray emission with selection rule. 7

OR

Discuss semi-empirical mass formula. 3

(b) Explain internal conversion of γ-rays and nuclear isomerism. 7

OR

Discuss the mass parabola of odd A isobars (nuclei) in detail. 7

5. Answer in short. **14**

(1) Write Maxwell's equations of electromagnetism.

(2) Write equation of continuity or law of conservation of charge.

(3) Write statement of Poyenting theorem. → 1

(4) What is helicity in polarization of electromagnetism ? →

(5) Define Skin depth.

(6) Define retarded potentials.

(7) What is the conclusion available from Larmor formula ?

(8) Write Gieger-Nuttal law. → 1

(9) What are long-range α-particles ? → 1

(10) Write the importance of Pauli's neutrino hypothesis. → 1 5

(11) Write, "Fermi's Golden rule."

(12) What is Fermi-Kurie Plot ?

(13) What is "isobaric family" ? → 1

(14) What is nuclear fission and symmetric fission ?
