**STELLA MARIS COLLEGE (AUTONOMOUS) CHENNAI – 600 086.**
**(For candidates admitted during the academic year 2011-12 & thereafter)**

**SUBJECT CODE : 11PH/MC/NP64**

**B.Sc. DEGREE EXAMINATION APRIL 2017**
**BRANCH III - PHYSICS**
**SIXTH SEMESTER**

**REG. No._________________**

**COURSE : MAJOR – CORE**
**PAPER : NUCLEAR PHYSICS**
**TIME : 30 MINS.** **MAX. MARKS : 30**

**SECTION – A**
**TO BE ANSWERED IN THE QUESTION PAPER ITSELF**
**ANSWER ALL QUESTIONS:**

**I. CHOOSE THE CORRECT ANSWER:**

1. The contribution of coulomb energy in the semi-empirical mass formula of a nucleus of mass number A and atomic number Z is of the form (a = constant)-----
(a) $aZA^{2/3}$ (b) $aZ(Z-1)/ A^{1/3}$ (c) $aZ(Z+1)/ A$ (d) $aZ^2 / A^{2/3}$

2. Nuclear forces are ______
(a) Gravitational attractive (b) Electrostatic repulsive
(c) Long range and strong attractive (d) Short range and strong attractive

3. The classical electron radius is of the order of ____
(a) $10^{-8}$ cm (b) $10^{-11}$ cm (c) $10^{-13}$ cm (d) $10^{-15}$ cm

4. Nuclei which are α-emitters are more likely to have mass number A such that ______
(a) $A < 200$ (b) $200 < A < 100$ (c) $100 < A < 50$ (d) $A > 50$

5. In Fermi theory of β-decay, the number of emitted electrons with momentum p and Energy E, in the allowed approximation, is proportional to ($E_0$ is the total energy given up by the nucleus) ______
(a) $E_0 – E$ (b) $p( E_0 – E)$ (c) $p^2 ( E_0 – E)^2$ (d) $p ( E_0 – E)^2$

6. The mean life time of one of the atoms of a radioactive sample is ___________
(a) $1/\lambda$ (b) $\lambda$ (c) $\lambda \ln 2$ (d) $2 \ln \lambda$

7. A cyclotron has an oscillation frequency of $12 \times 10^6$ cps and dee radius of 53.3 cms. The mass of deuteron is $3.3 \times 10^{-27}$ kg. The value of magnetic induction B required is _____
(a) 1.6 $Wb/m^2$ (b) 0.8 $Wb/m^2$ (c) 3.2 $Wb/m^2$ (d) 4.8 $Wb/m^2$

8. In a synchrotron, the magnetic field must change to compensate for _________
(a) Loss of energy due to air resistance (b) Relativistic mass increases
(c) Increase in the radius of the circular path (d) Heating of the coils

9. The quadrupole moment of the nucleus is a _________
(a) Tensor (b) Scalar (c) Vector (d) None of these

10. The Nuclear reaction 4 $_1H^1 \rightarrow {}_2He^4 + 2\ {}_{-1}e^0$ +26 MeV represents ___________
(a) Fusion (b) Fission (c) β-decay (d) ϒ - decay

11. The typical energies released in nuclear fission and fusion reaction are respectively _______________.
(a) 50 MeV and 1000 MeV (b) 200 MeV and 1000 MeV
(c) 1000 MeV and 50 MeV (d) 200 MeV and 10 MeV

12. The decay chain of the nucleus $_{92}U^{238}$ involves eight α-decays and six β-decay. The final nucleus at the end of the process wills have_______________.
(a) Z = 82, A = 206 (b) Z = 84, A = 224 (c) Z = 88, A = 206 (d) Z = 76, A =200

13. Which of the following elementary particle is a lepton
(a) Photon (b) μ -meson (c) π-meson (d) proton

14. Choose the particle with zero Baryon number from the list given below
(a) Pion (b) Neutron (c) proton (d) $\Delta^+$

15. The nucleus of the atom $^9Be_4$ consist of ____
(a) 13 up quarks and 13 down quarks (b) 13 up quarks and 14 down quarks
(c) 14 up quarks and 13 down quarks (d) 14 up quarks and 14 down quarks

## II. FILL IN THE BLANKS:

16. Mass defect, Δ m is ____________________.
17. The relation of Geiger- Nuttal law is __________________.
18. Geiger Muller counter cannot provide information about the ___________ or __________ causing pulse.
19. The ratio of secondary neutrons produced to original neutrons is called _____________.
20. CPT means ______________ , _____________, __________ .

## III. STATE WHETHER TRUE OR FALSE:

21. In the semi-empirical formulae the observed parity of odd Z and odd N nuclei in nature is taken care of δ-term.
22. $C^{14}$ is used to determine the age of the specimen.
23. Nuclear emulsion detector can be easily affected by temperature.
24. The sun release energy by spontaneous combustion.
25. The quark structure of $\Delta^{++}$ is UUU.

## IV. ANSWER BRIEFLY:

26. What are magic numbers?

27. Unit of radioactivity is?

28. What is the energy produced from Van de Graff generator?

29. What is chain reaction?

30. Abbreviation of NQR is?

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|---|---|---|---|
| **COURSE** | **:** | **MAJOR – CORE** | |
| **PAPER** | **:** | **NUCLEAR PHYSICS** | |
| **TIME** | **:** | **2 ½ HOURS** | **MAX. MARKS : 70** |

**SECTION – B**

**ANSWER ANY FIVE QUESTIONS: (5X 5 = 25 )**

1. The radii of oxygen and lead nuclei are found to be 3 fm and 7 fm respectively. Their masses are 2.7 x $10^{-26}$ kg and 3.4 x $10^{-25}$ kg respectively. Calculate their densities.

2. The activity of certain nuclide decreases to 15% of its original value of 10 days. Find its half-life.

3. A frequency modulated cyclotron is capable of accelerating protons to 500 MeV. What is the ratio of highest to lowest frequency needed to accomplish this?

4. Find out the Q-value of the reaction $^{208}$Pb ($^{56}$Fe, $^{54}$Fe) $^{210}$Pb
   Given :
   M($^{208}$ Pb) = 207.976641 amu
   M($^{56}$Fe) = 55.934939 amu
   M($^{210}$ Pb)= 209.984178 amu
   M($^{54}$Fe) = 53.939612 amu    Also find the threshold for this reaction.

5. Determine the following reaction are allowed or forbidden.
   (i) $p + p \rightarrow K^{+} + \Sigma^{+}$
   (ii) $p + \pi^{-} \rightarrow \Sigma^{0} + \eta^{0}$
   (iii) $p + p \rightarrow p + p + p + Q$

6. Explain NMR and mention its few applications.

7. What is nuclear fission and explain C-N cycle.

**SECTION C**

**ANSWER ANY THREE QUESTIONS: (3X15= 45)**

8. Derive the various factors which contribute to binding energy of the nucleus and derive semi empirical formula based on these factors.

9. Define activity. Derive the relation $A = A_0 e^{-\lambda t}$ and explain secular equilibrium.

10. Give an account of principle of working of a cyclotron. Discuss the limitations of energy that can be obtained by this machine and its possible improvement.

11. Define and calculate the threshold energy of an endoergic nuclear reactions that proceeds through the formation of a compound nucleus.

12. Discuss the quantum numbers associated with elementary particles. Give the corresponding conservation laws. Give at least one example in support of each conservation law.