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E–981

M. Sc. (Fourth Semester) (Main/ATKT)

EXAMINATION, May-June, 2021

PHYSICS

Paper First

(Nuclear and Particle Physics)

Time : Three Hours] [*Maximum Marks : 80*

Note : Attempt all Sections as directed.

Section—A 1 each

(Objective/Multiple Choice Questions)

Note : Attempt all questions.

Choose the correct answer :

1. The bending energy per nucleon is maximum for the nucleus :
   (a) ^{56}Fe
   (b) ^{4}He
   (c) ^{208}Pb
   (d) ^{101}Mo

2. From meson field theory the potential energy of interaction between two nucleons is proportional to :
   (a) $\frac{e^{-\mu_r}}{r^2}$
   (b) $\frac{e^{-\mu_r}}{r}$
   (c) $\frac{e^{-\mu_r{}^2}}{r^2}$
   (d) $\frac{e^{-\mu_r{}^2}}{r}$

3. If the nuclear radius of ^{27}Al is 3.6 fermi, the approximate nuclear radius of ^{64}Cu M in fermi is :
   (a) 4.8
   (b) 3.6
   (c) 2.4
   (d) 1.2

4. According to the shell model, the ground state of $^{15}_{8}O$ nucleus is :
   (a) $\frac{3^+}{2}$
   (b) $\frac{1^+}{2}$
   (c) $\frac{3^-}{2}$
   (d) $\frac{1^-}{2}$

5. An atom of mass number 15 and atomic number 7 captures an α-particle and then emits a proton, the mass number and atomic number of the resulting atom will be :

   (a) 16 and 5 respectively

   (b) 17 and 7 respectively

   (c) 18 and 8 respectively

   (d) 19 and 6 respectively

6. Which one of the following reactions is allowed ?

   (a) $p \rightarrow n + e^+$

   (b) $p \rightarrow e^+ + \nu_e$

   (c) $p \rightarrow \pi^+ + \gamma$

   (d) $\bar{p} + n \rightarrow \pi^- + \pi^0$

7. One Becquerel is defined as :

   (a) 1 disintegration per sec.

   (b) 10^6 disintegration per sec.

   (c) 3.7×10^{10} disintegration per sec.

   (d) 10^3 disintegration per sec.

8. Which of the following elementary particles is a lepton ?

   (a) Photon

   (b) μ-meson

   (c) π-meson

   (d) Proton

9. Choose the particle with + 3 strangeness number from the list given below :

   (a) K^+

   (b) Σ^+

   (c) Ω^-

   (d) Ω^+

10. Nuclear forces are :

    (a) Short range attractive forces

    (b) Short range repulsive forces

    (c) Long range attractive forces

    (d) Long range repulsive forces

11. The spin and parity of $_4Be^9$ nucleus, as predicted by the shell model, are respectively :

    (a) $\frac{3}{2}$ and odd

    (b) $\frac{1}{2}$ and odd

    (c) $\frac{3}{2}$ and even

    (d) $\frac{1}{2}$ even

12. By capturing an electron, $^{54}_{25}Mn_{29}$ transforms into $^{54}_{24}Cr_{30}$ releasing :
    (a) A nutrino
    (b) An antineutrino
    (c) An α -particle
    (d) A positron

13. The intensity absorbed in the materials of depth d with absorption co-efficient μ_1 when I_0 is the incident intensity of X-ray is :
    (a) $\left(1 - e^{-\mu d}\right)$
    (b) $I_0\left(1 - e^{-\mu d}\right)$
    (c) $\mu I_0\left(1 - e^{-\mu d}\right)$
    (d) μd

14. The nucleus of the atom $^{9}Be_4$ consists 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

15. Which of the following reactions violate lepton number conservation ?
    (a) $e^+ + e^- \rightarrow \nu + \bar{\nu}$
    (b) $e^- + p \rightarrow v + n$
    (c) $e^+ + n \rightarrow p + v$
    (d) $\mu^- \rightarrow e^- + v + \bar{v}$

16. A nuclear reaction wound be endothermic, if the Q-value is :
    (a) $Q > 0$
    (b) $Q < 0$
    (c) $Q = 0$
    (d) None of the above

17. Weak nuclear forces act on :
    (a) Both hadrons and leptons
    (b) Hadrons only
    (c) All particles
    (d) All charged particles

18. The ground state of the deuteron is :
    (a) pure $3S_1$ state
    (b) pure $3P_1$ state
    (c) mixture of $3S_1$ and $3P_1$ states
    (d) mixture of $3S_1$ and $3D_1$ states

19. The particle which most easily penetrates through the nucleus of an atom is :
    (a) Electron
    (b) Neutron
    (c) Proton
    (d) Alpha particle

20. The sun releases energy by :

    (a) Nuclear fission

    (b) Nuclear fusion

    (c) Hydrothermal process

    (d) None of the above

Section—B 2 each

(Very Short Answer Type Questions)

Note : Attempt all questions.

1. What is scattering length ?
2. What is threshold kinetic energy ?
3. What do you mean by parity violation ?
4. What is magic number ?
5. What is Lepton ?
6. What do you mean by Reaction cross section ?
7. What is elementary particle ?
8. What is exchange force ?

Section—C 3 each

(Short Answer Type Questions)

Note : Attempt all questions.

1. Explain the meson theory of nuclear forces.
2. Explain the Q-value and give brief description about direct and compound nuclear reaction.
3. Explain the multiple transition in nuclei.
4. Explain the Liquid drop model.

5. Explain the fundamental interaction and classify the elementary particle.
6. Explain the Beta decay.
7. Explain the scattering matrix and reciprocity theorem.
8. Explain Tensor force.

Section—D 5 each

(Long Answer Type Questions)

Note : Attempt any *four* questions.

1. What is two-nucleon system ? Explain the ground stale of the deuteron.
2. Explain the Breit-Wigner single level formula.
3. Explain Pauli's neutrino hypothesis and Fermi theory of beta decay.
4. Explain the collective model of Bohr and Mottelson.
5. Explain the SU(2) and SU(3) multiplets and their properties.
6. Explain the shell model.