

**B.Sc. PHYSICS
FOURTH SEMESTER
NUCLEAR & PARTICLE PHYSICS**

**SET
A**

**BSP – 401
[USE OMR FOR OBJECTIVE PART]**

Duration: 3 hrs.

Full Marks: 70

Time: 30 min.

(Objective)

Marks: 20

1X20=20

Choose the correct answer from the following:

- If M is the atomic mass, A is mass number, then $(M-A)/A$ is called
 - Packing fraction
 - Mass defect
 - Fermi energy
 - Binding energy
- Nuclear fission can be explained by
 - Shell model
 - Bohr atom model
 - Quark model
 - Liquid drop model
- A nucleus having mass number A decays by alpha emission. The Q value of the process is E . The energy of alpha particle is
 - $E\left(\frac{A-4}{A}\right)$
 - $E\left(\frac{A}{A-4}\right)$
 - $E\left(\frac{4}{A}\right)$
 - $E\left(\frac{4}{A-4}\right)$
- A neutron when disintegrates, gives
 - A proton and an electron with an anti-neutrino
 - A proton and an electron with a neutrino
 - A proton and a positron with a neutrino
 - A proton and a positron with an anti-neutrino
- The atomic number is not changed by which type of radioactive decay?
 - Beta
 - Gamma
 - Alpha
 - None of the mentioned
- Three types of radioactive elements are emitted when unstable nuclei undergo radioactive decay. Which of the following is not one of them
 - Alpha
 - Beta
 - Gamma
 - Delta
- Which statement is true for all three types of radioactive emission?
 - They are deflected by electric field
 - They ionizes gases
 - They are completely absorbed by a thin aluminium sheet
 - They emit light
- Which of the following substances cannot be emitted by radioactive substances during their decay?
 - Protons
 - Neutrinos
 - Helium nuclei
 - Electrons

9. Which of the following acts as ionizing gas in Geiger Muller counter?
 a. Alcohol
 b. Argon
 c. Krypton
 d. Hydrogen
10. Which of the following is the main disadvantage of solid state semiconductor detector?
 a. Low accuracy
 b. Low sensitivity
 c. It should be maintained at low temperature
 d. High pressure has to be produced
11. The magnetic moment for the orbital quantum number $l=2$ is
 a. $\sqrt{2} \frac{e\hbar}{2m}$
 b. $\sqrt{6} \frac{e\hbar}{2m}$
 c. $\frac{e\hbar}{2m}$
 d. $\sqrt{3} \frac{e\hbar}{2m}$
12. The scintillation counter
 a. Uses a material which emits light when a charged particle strikes it
 b. Is not used for counting β -particles
 c. Counts only α -rays
 d. Its counts only β -particles
13. What is the approximate mass no (A) of a nucleus having radius 2.71Fm?
 a. 4
 b. 8
 c. 7
 d. 6
14. The atomic number is equivalent to which of the following?
 a. The number of neutrons in the atom
 b. The number of protons in the atom
 c. The number of nucleons in the atom
 d. The number of α -particles in the atom
15. What is the mass of the products of a nuclear fission reaction compared to the original products?
 a. Greater
 b. Less
 c. the same
 d. varies according to the reaction
16. ${}_3\text{Li}^7 + {}_1\text{H}^1 \rightarrow ({}_4\text{Be}^8)^*$ This reaction is an example of
 a. (p, γ) reaction
 b. (p, n) reaction
 c. (p, p) reaction
 d. (p, d) reaction
17. Which particle is bombarded on heavy nucleus of nuclear fuel?
 a. Electron
 b. Proton
 c. Neutron
 d. Photon
18. An antiproton is an atomic particle that has
 a. the mass of a proton and the charge of an electron
 b. the mass of an electron and the charge of a proton.
 c. the mass of a neutron and the charge of a proton
 d. the mass of a proton and the charge of a neutron

19. Particles that participate in the strong nuclear interaction are called
- Neutrinos
 - hadrons
 - Leptons
 - electrons
20. Which of the following reactions violates lepton number conservation?
- $e^+ + e^- \rightarrow \nu + \bar{\nu}$
 - $e^- + p \rightarrow \nu + n$
 - $e^+ + n \rightarrow p + \nu$
 - $\mu^- \rightarrow e^- + \nu + \bar{\nu}$

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(Descriptive)

Time : 2 hrs. 30 mins.

Marks : 50

[Answer question no.1 & any four (4) from the rest]

- Define Q-value of a nuclear reaction. Derive the expression for the Q-value of the reaction in terms of kinetic energies of the incident and product particles. And also write the physical significance of Q-value. 2+6+2
=10
- Find the relationship between impact parameter, angle of scattering and distance of nearest approach as applied to gray scattering. 10
- Which of the following reactions can occur under conservation of charge, conservation of Baryon number and conservation of strangeness: 10
 - $p + p = n + p + \pi^+$
 - $p + p = p + \Lambda^0 + \Sigma^+$
 - $\pi^- + p = n + \pi^0$

4. a. Describe the construction and working principle of GM counter with a neat. 2+4+4
=10
 b. Describe the plateau curve of GM counter.
5. What is mass defect? Explain graphically the variation of binding energy per nucleon with mass number and also the stability of the nucleus. 2+4+4
=10
6. Explain the process 2+2+2+2
+2=10
 a. Positron Emission
 b. Electron Capture
 c. Internal conversion
 d. Inverse β -decay
 e. β -decay
7. a. State the condition for α -decay. 6+4=10
 b. Calculate the kinetic energy of the α -particle emitted by the decay of ${}_{86}\text{Rn}^{222}$. Given mass of ${}_{86}\text{Rn}^{222} = 222.017531\text{amu}$. Mass of polonium nucleus = 218.008930 amu. Mass of α -particle = 4.002603 amu.
8. a. The binding energy of a nucleus is 225 MeV. Determine the mass defect in atomic mass unit. 3+3+4
=10
 b. Find the density of ${}_{12}\text{C}^{12}$ nucleus.
 c. The binding energy of ${}_{10}\text{N}^{20}$ is 160.64 MeV. Find the atomic mass. Given mass of proton = 1.007825 amu and of neutron = 1.008665 amu.

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